CLEAN DEVELOPMENT MECHANISM
PROJECT DESIGN DOCUMENT FORM (CDM-SSC-PDD)
Version 03 - in effect as of: 22 December 2006

CONTENTS

Annexes

Revision history of this document

Version Number	Date	Description and reason of revision
01	21 January 2003	Initial adoption
02	8 July 2005	• The Board agreed to revise the CDM SSC PDD to reflect guidance and clarifications provided by the Board since version 01 of this document. • As a consequence, the guidelines for completing CDM SSC PDD have been revised accordingly to version 2. The latest version can be found at <http://cdm.unfccc.int/Reference/Documents>.
03	22 December 2006	• The Board agreed to revise the CDM project design document for small-scale activities (CDM-SSC-PDD), taking into account CDM-PDD and CDM-NM.

Abbreviations:

POME	Palm oil mill effluent
DOE	Designated Operational Entity
GHG	Greenhouse gas
CSTR	Continuously Stirred Tank Reactor
COD	Chemical oxygen demand
VSPP	Very Small Power Producer
PEA	Provincial Electricity Authority
CM	Combined Margin
OM	Operating Margin
BM	Build Margin

SECTION A. General description of small-scale project activity

A.1 Title of the small-scale project activity:

Thachana Palm Oil Company Wastewater Treatment Project in Thailand (the "Project")

Version 1.0, completed 31/05/2007.

A.2. Description of the small-scale project activity:

Thachana Palm Oil Co., Ltd. (Thachana) operates a palm oil mill with a production capacity of approximately 1,000 tonnes per day in the Surat Thani Province of Thailand. The palm oil milling process produces palm oil mill effluent (POME), a high organic content wastewater, which emits methane when treated in the anaerobic open lagoons prior to discharge to waterways

The purpose of the project activity is to construct and operate an anaerobic digester to treat POME which will increase both increase the efficiency of POME treatment and enable the capture of the generated methane. The captured methane will then be destructed in a 2 x 560 kW_{net} power plant to produce electricity for on-site consumption, with the excess being sold to the grid of the Provincial Electricity Authority (PEA) under the Very Small Power Producer (VSPP) scheme. In this way, the Project prevents a large amount of the methane that would otherwise escape into the atmosphere, reducing greenhouse gas emissions (GHGs) in the order of 24,000 tonnes annually.

The Project contributes to sustainable development of Thailand in the following ways:

- Improvement of local air quality. Apart from the reduction in GHGs, the Project will improve the environmental performance of Thachana's palm oil mill by reducing the COD load of effluent entering the open lagoons. POME treated in open lagoons not only emits a large amount of methane, a flammable gas, but also produces a strong pungent stench. By using the captured methane for energy generation and reducing fossil fuel consumption, the Project will also reduce emissions associated with the burning of fossil fuels.

- Reduction in reliance of fossil fuels. The project activity will contribute to the reduction in the general reliance on fossil fuels. As the Project will displace grid electricity, this will also lead to the reduction in the consumption of fossil fuel within the grid. While the Project itself is a small one, it is hoped that the replication of such projects nation-wide will amount to a significant reduction in the long term.

A.3. Project participants:

Table 1: Table of project participants

Name of Party involved	Private and/or public entity (ies) project participants	Kindly indicate if the Party involved wishes to be considered as project participant (Yes/No)
Thailand (host)	Thachana Palm Oil Co., Ltd.	No
Japan	Mitsubishi UFJ Securities Co., Ltd.	No

A.4. Technical description of the small-scale project activity:

A.4.1. Location of the small-scale project activity:

A.4.1.1. Host Party(ies):

Thailand

A.4.1.2. Region/State/Province etc.:

Surat Thani Province

A.4.1.3. City/Town/Community etc:

Tambon Kantulee, Amphur Thachana

A.4.1.4. Details of physical location, including information allowing the unique identification of this small-scale project activity :

The Project is located in the Thachana Palm Oil Factory at 182 Moo 12, Phetkaseam Road, Tambon Kantulee, Amphur Thachana, Surat Thani Province 84170, Thailand. The factory is surrounded by palm and rubber tree plantations. Within a 2 kilometers radius of the site, there is one temple and some scattered dwellings, none of which have been adversely affected by the factory's activities. The nearest school is located 5-6 kilometers from the project site.

Figure 1: Map of Thailand (Courtesy of the University of Texas Libraries, The University of Texas at Austin)

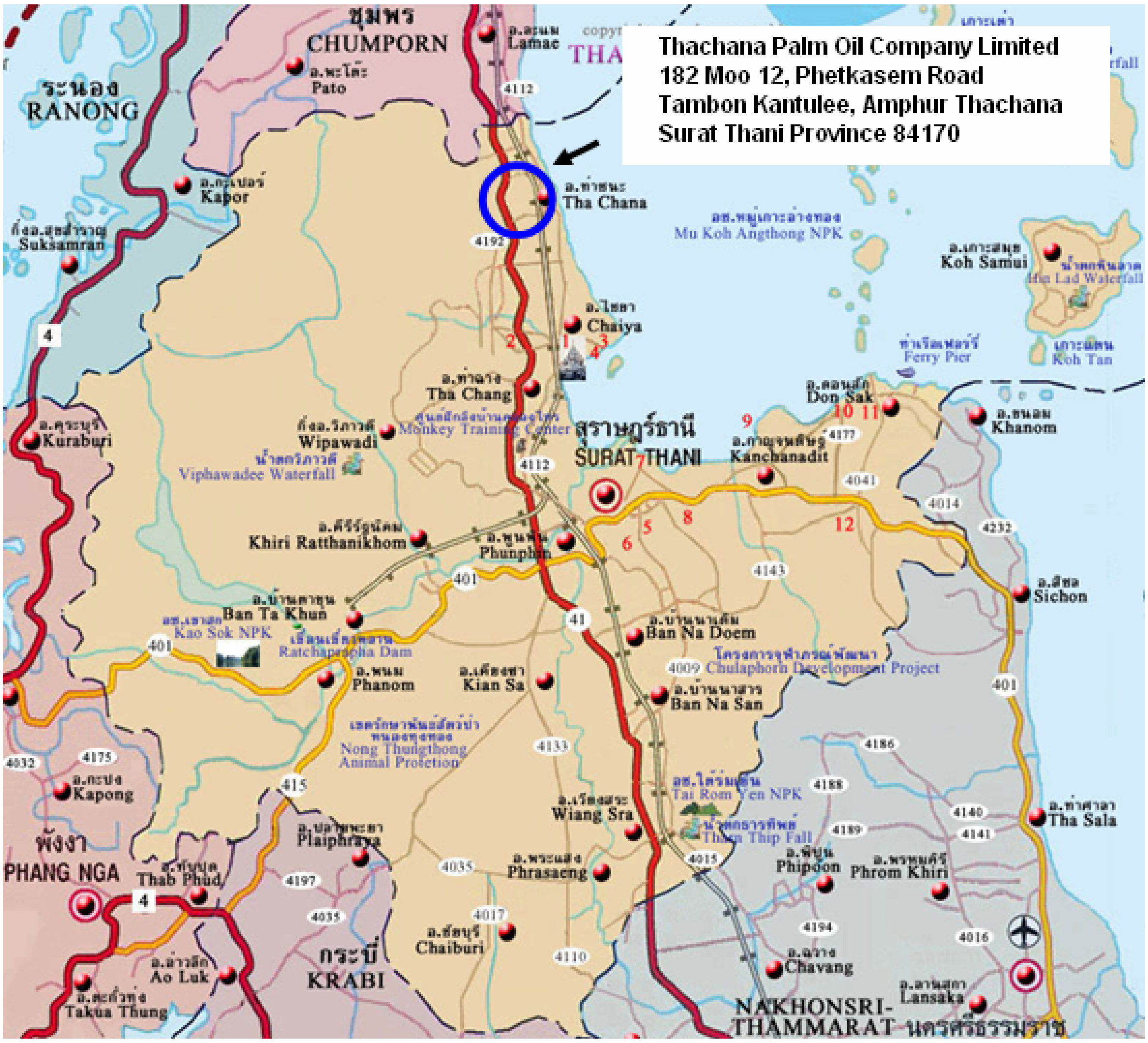

Figure 2: Map of Surat Thani Province and Project location

A.4.2. Type and category(ies) and technology/measure of the small-scale project activity:

The project activity falls under the following types and categories.

- Type (iii): Other project activities
  Category H: Methane recovery in wastewater treatment

- Type (i): Renewable energy projects
  Category D: Grid connected renewable electricity generation

In the absence of the Project, the POME is treated by an open lagoon system, consisting of three (3) anaerobic ponds all with a depth of over 5 metres. This mode of treatment is the prevalent practice in the industry, particularly where there is a relative abundance of land.

Under the Project, the raw effluent from the milling process will instead be diverted to an anaerobic digester – namely a Continuously Stirred Tank Reactor (CSTR) – with an average COD[1] removal efficiency of 77.5%. It is expected that the Project will produce biogas in excess of 10,000 m^3 per day.

The biogas that is generated in the CSTR is then purified and used as feed for the power plant, for the production of electricity. The power plant will consist of 16x132kW gas engines, ten (10) of which will be used at any one time, with the remaining six (6) as backup. The electricity will be used to supply on-site electricity needs, with the excess being sold to the grid. In case of excess biogas production, the excess is diverted to a flare. However, the flare is not expected to be operated under normal circumstances.

A process diagram is provided below.

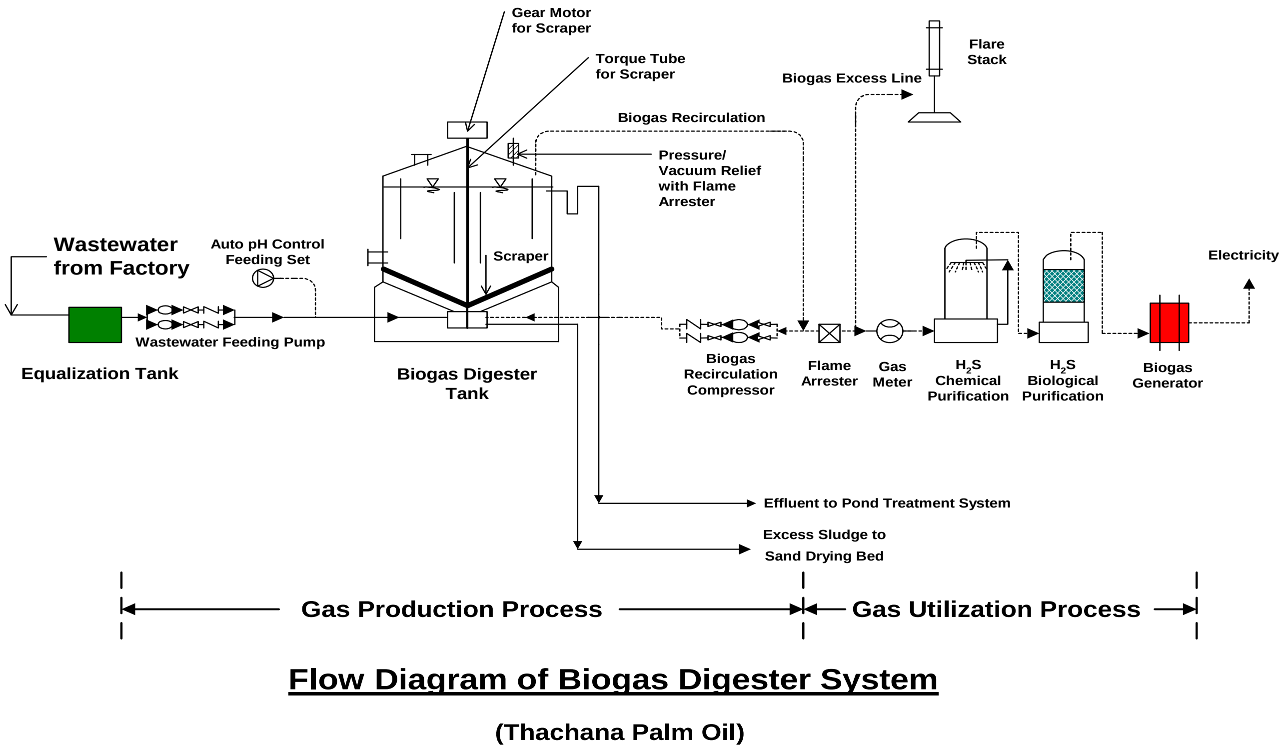

Figure 3: Flow diagram of POME treatment system

A.4.3 Estimated amount of emission reductions over the chosen crediting period:

The estimated amount of emission reductions over the first seven-year crediting period is shown below.

Table 2: *Ex ante* estimation of emission reductions

Years	Estimation of annual emission reductions in tonnes of CO_2e
Year 2007 (from Oct)	5,965
Year 2008	23,860
Year 2009	23,860

[1] Chemical oxygen demand

Year 2010	23,860
Year 2011	23,860
Year 2012	23,860
Year 2013	23,860
Year 2014 (to September)	17,895
Total estimated reductions (tonnes of CO_2e)	167,020
Total number of crediting years	7 (initial crediting period)
Annual average of the estimated reductions over the crediting period (tCO_2e)	23,860

A.4.4. Public funding of the small-scale project activity:

The Project does not involve funding from an Annex I country.

A.4.5. Confirmation that the small-scale project activity is not a debundled component of a large scale project activity:

As defined in paragraph 2 of Appendix C of the SSC M&P, a proposed small-scale project activity shall be deemed to be a debundled component of a large project activity if there is a registered small-scale CDM project activity or a request for registration by another small-scale project activity:

- By the same project participants;
- In the same project category and technology/measure; and
- Registered within the previous 2 years; and
- Whose project boundary is within 1 km of the project boundary of the proposed small-scale activity at the closest point.

The proposed project activity is not a debundled component of any larger project activity as there is no other small-scale project activity that fulfills the abovementioned criteria.

SECTION B. Application of a baseline and monitoring methodology

B.1. Title and reference of the approved baseline and monitoring methodology applied to the small-scale project activity:

The following two approved baseline and monitoring methodologies are applied.

- AMS-I.D. Grid connected renewable electricity generation
  Version 11, valid as of 18 May 2007
- AMS-III.H. Methane recovery in wastewater treatment
  Version 5, valid as of 18 May 2007

B.2 Justification of the choice of the project category:

The Project meets all the applicability conditions of the methodologies, as described below.

Table 3: Applicability conditions for AMS-I.D.

	Applicability condition	Project case
1	This category comprises renewable energy generation units, such as photovoltaics, hydro, tidal/wave, wind, geothermal and renewable biomass, that supply electricity to and/or displace electricity from an electricity distribution system that is or would have been supplied by at least one fossil fuel fired generating unit.	The Project uses biogas recovered from the wastewater treatment system to supply electricity to the grid under the Very Small Power Producer Program.
2	If the unit added has both renewable and non-renewable components (e.g.. a wind/diesel unit), the eligibility limit of 15MW for a small-scale CDM project activity applies only to the renewable component. If the unit added co-fires fossil fuel, the capacity of the entire unit shall not exceed the limit of 15MW.	The installed capacity of the unit added is 2112kW and is under the 15MW threshold.
3	Biomass combined heat and power (co-generation) systems that supply electricity to and/or displace electricity from a grid are included in this category. To qualify under this category, the sum of all forms of energy output shall not exceed 45 MWthermal e.g. for a biomass based co-generating system the rating for all the boilers combined shall not exceed 45 MWthermal.	Not applicable. The project activity does not involve co-generation.
4	In the case of project activities that involve the addition of renewable energy generation units at an existing renewable power generation facility, the added capacity of the units added by the project should be lower than 15 MW and should be physically distinct from the existing units.	Not applicable. The Project does not add to an existing renewable power generation facility.
5	Project activities that seek to retrofit or modify an existing facility for renewable energy generation are included in this category. To qualify as a small	Not applicable. The Project does not involve retrofitting or modifying an existing facility for renewable energy generation.

	scale project, the total output of the modified or retrofitted unit shall not exceed the limit of 15 MW.	

Table 4: Applicability conditions for AMS-III.H.

	Applicability condition	Project case
1	This project category comprises measures that recover methane from biogenic organic matter in wastewaters by means of one of the following options: … (vi) Introduction of a sequential stage of wastewater treatment with methane recovery and combustion, with or without sludge treatment, to an existing wastewater treatment system without methane recovery (e.g. introduction of treatment in an anaerobic reactor with methane recovery as a sequential treatment step for the wastewater that is presently being treated in an anaerobic lagoon without methane recovery).	The Project involves the introduction of an anaerobic digester to an existing wastewater system – an open lagoon system with no methane recovery. The digester, or CSTR, will act as the first stage of the new two-stage process.
2	If the recovered methane is used for heat and or electricity generation that component of the project activity can use a corresponding category under type I.	The approved baseline and monitoring methodology AMS-I.D. is used for the electricity generation component of the project activity.
3	Measures are limited to those that result in emission reductions of less than or equal to 60 kt CO2 equivalent annually.	*Ex ante* estimates for emission reductions due to the wastewater treatment was calculated as 20,335 tCO_2e annually, lower than the 60,000 tCO_2e threshold.

B.3. Description of the project boundary:

In line with the methodologies AMS-I.D. and AMS-III.H., the project boundary encompasses the following:

- the physical, geographical site of the renewable generation source; and
- the physical, geographical site where the wastewater and sludge treatment takes place.

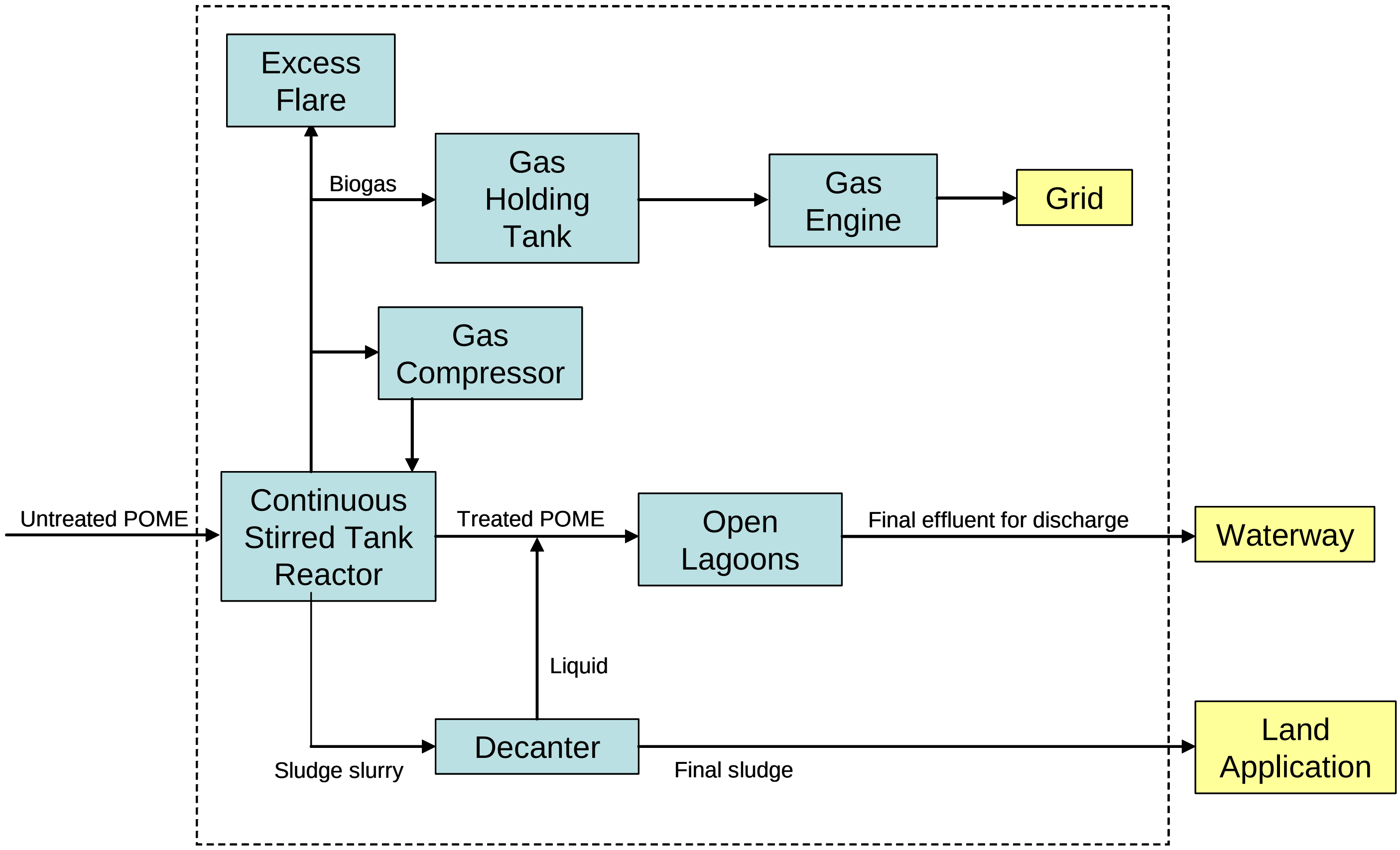

Figure 4: Diagram of project boundary

B.4. Description of baseline and its development:

For the POME treatment system, the baseline is described by paragraph 6.(vi) of AMS-III.H as being the existing anaerobic wastewater treatment system without methane recovery. In the Project's case, the system is a series of three (3) deep open anaerobic lagoons.

In accordance with AMS-I.D, the electricity baseline is the kWh produced by the renewable generating unit multiplied by an emission coefficient. The emission coefficient is calculated as per paragraph 9.(a), as a combined margin (CM) consisting of the combination of operating margin (OM) and build margin (BM) according to the procedures prescribed in the approved methodology ACM0002.

B.5. Description of how the anthropogenic emissions of GHG by sources are reduced below those that would have occurred in the absence of the registered small-scale CDM project activity:

Consistent with Attachment A to Appendix B of the simplified modalities and procedures for small-scale CDM project activities, the Project's additionality can be established if it faces at least one of the following barriers:

(1) Investment barrier
(2) Technological barrier
(3) Barrier due to prevailing practice
(4) Other barriers

Prior to the implementation of the CDM project, the POME was treated using a series of three (3) anaerobic lagoons. After a retention time of approximately 5.2 months, the COD content of the POME is reduced to below the legal limit for discharge. During this decomposition process, methane as well as the pungent hydrogen sulfide is released into the atmosphere. This is the prevalent and standard industry practice, with proven reliability for wastewater treatment, particularly in the tropical climate of South East Asia.

As compared to the low-cost, no-risk solution offered by the open lagoon system, the Project scenario, which is the treatment of POME in an anaerobic digester coupled with methane recovery and power generation, is a high-cost, high-risk option, and faces a combination of investment and technological barriers.

Investment barrier

The treatment of POME in anaerobic open lagoons is a prevalent and standard industry practice, being by far the least cost option for wastewater treatment that at the same time meets the legal discharge limit. While other options, such as the installation of an anaerobic digester (the Project carried out without the CDM) are also available, all require significant investments in comparison to the simple, low-tech open lagoon – which is effectively a hole in the ground.

Based on the total investment cost of 63.6 Million baht, electricity tariff of 2.00 baht/kWh and O& M costs of 5.3 Million baht per year, the resultant IRR in the absence of the CDM is around 5%. This will increase significantly, to a modestly attractive project, due to CER income.

Technology barrier

The implementation of the Project requires an upgrading of skills for the proper operation and maintenance of the anaerobic digester, as well as the gas engines. There are numerous variables, such as the COD load of incoming wastewater and the temperature conditions that affect the quantity and quality of the biogas. As the quality of the biogas feed is crucial to the operation of the gas engine, the upgrading of skills is a significant challenge to Thachana.

The challenge is even more significant when taking into account the context of the palm oil milling industry, where very few plant owners have ventured into advanced technology for wastewater treatment. Indeed, CSTR technology is a relatively new design for palm oil wastewater, and the technology is still not mature. Weighing up the possibility of malfunction and breakdowns due to this new technology, together with high cost, versus any revenue/cost savings due to biogas-generated energy, the technology barrier faced by Thachana is too high to justify the risk of going ahead under business-as-usual.

Given the modest returns of the Project, the risks presented to Thachana in the form of system failure, is too high to make the Project possible without the CDM.

It is noted that the only applicable regulation relating to wastewater treatment is the discharge limit of 20 $kgBOD/m^3$.

B.6. Emission reductions:

B.6.1. Explanation of methodological choices:

B.6.1.1 Wastewater treatment component

The baseline scenario for wastewater treatment corresponds with the scenario given in paragraph 6.(vi) of AMS-III.H, that is, the existing anaerobic wastewater treatment system without methane recovery for the case of introduction of a sequential anaerobic wastewater treatment system with methane recovery.

The emission reduction due to the wastewater treatment ($ER_{y,ww}$) is calculated as the difference between the baseline emission from wastewater (BE_y) and sum of the project emission (PE_y) and leakage ($Leakage_y$):

Equation 1

$$ER_{y,ww} = BE_y - \left(PE_y + Leakage_y\right)$$

where

Equation 2

$$PE_y = PE_{y,power} + PE_{y,ww,treated} + PE_{y,s,final} + PE_{y,fugitive} + PE_{y,dissolved}$$

and

$PE_{y,power}$ = emissions from electricity or diesel consumption in year *y*

$PE_{y,ww,treated}$ = emissions from degradable organic carbon in treated wastewater in year *y*

$PE_{y,s,final}$ = emissions from anaerobic decay of final sludge produced in year *y*

$PE_{y,fugitive}$ = emissions from methane release in capture and flare systems in year *y*

$PE_{y,dissolved}$ = emissions from dissolved methane in treated wastewater in year *y*

As the project activity does not involve the transfer of used technology to or from another activity, there are no leakage effects.

Table 5: Input values and data sources for wastewater component

Parameter	Description	Value	Source
Equation 3 $BE_y = Q_{y,ww} \times COD_{y,ww,untreated} \times B_{o,ww} \times MCF_{ww,treatment} \times GWP\_CH_4$			
$Q_{y,ww}$	Volume of wastewater treated in year *y* (m^3)	85,000	Thachana
$COD_{y,ww,untreated}$	Chemical oxygen demand of wastewater entering the anaerobic treatment system with methane capture in the year *y* (t/m^3)	0.073	Thachana
$B_{o,ww}$	Methane producing capacity of the wastewater (kg CH_4/kgCOD)	0.21	IPCC, as per AMS-III.H.
$MCF_{ww,treatment}$	Methane correction factor for the wastewater treatment system that will be equipped with methane recovery and combustion (fraction)	0.8	Lower value for anaerobic deep lagoon in AMS-III.H. table III.H.I.
GWP_CH_4	Global warming potential for methane	21	AMS-III.H.
Equation 4 $PE_{y,power} = EG_{y,consumed} \times EF_{y,consumed}$			
$EG_{y,consumed}$	Amount of electricity consumed by the project activity facilities (MWh)	-	N/A (not envisaged)
$EF_{y,consumed}$	Emission factor of electricity consumed (tCO_2/MWh)	-	N/A (not envisaged)

Equation 5 $PE_{y,ww,treated} = Q_{y,ww} \times COD_{y,ww,treated} \times B_{o,ww} \times MCF_{ww,final} \times GWP\_CH_4$			
$Q_{y,ww}$	See above	See above	See above
$COD_{y,ww,treated}$	Chemical oxygen demand of the treated wastewater in year *y* (t/m^3)	0.016	Thachana
$B_{o,ww}$	See above	See above	See above
$MCF_{ww,final}$	Methane correction factor based on type of treatment and discharge pathway of the wastewater (fraction)	0.1	Higher value for well-managed aerobic treatment in AMS-III.H. table III.H.I.
GWP_CH_4	See above	See above	See above
Equation 6 $PE_{y,s,final} = S_{y,final} \times DOC_{y,s,final} \times MCF_{s,final} \times DOC_F \times F \times \frac{16}{12} \times GWP\_CH_4$			
$S_{y,final}$	Amount of final sludge generated by the wastewater treatment in year *y* (t)	1,092	Thachana
$DOC_{y,s,final}$	Degradable organic content of the final sludge generated by the wastewater treatment in year *y* (fraction)	0.09	Ex-ante default factor for industrial sludge as per AMS-III.H.
$MCF_{s,final}$	Methane correction factor of the landfill that receives the final sludge in year *y* (fraction)	0	The sludge will be given to farmers for land application.
DOC_F	Fraction of DOC dissimilated to biogas	0.5	IPCC, as per AMS-III.H.
F	Fraction of CH_4 in landfill gas	0.5	IPCC, as per AMS-III.H.
GWP_CH_4	See above	See above	See above
Equation 7 $PE_{y,fugitive} = PE_{y,fugitive,ww} = (1 - CFE_{ww}) \times Q_{y,ww} \times COD_{y,ww,untreated} \times B_{o,ww} \times MCF_{ww,treatment} \times GWP\_CH_4$ [2]			
CFE_{ww}	Capture and flare efficiency of the methane recovery and combustion equipment in the wastewater treatement	0.5	As per AMS-III.H. for open flares
$Q_{y,ww}$	See above	See above	See above
$COD_{y,ww,untreated}$	See above	See above	See above
$B_{o,ww}$	See above	See above	See above
$MCF_{ww,treatment}$	Methane correction factor for the wastewater treatment system that will be equipped with methane recovery and combustion (fraction)	1.0	Higher value for anaerobic deep lagoon in AMS-III.H. table III.H.I.
GWP_CH_4	See above	See above	See above

[2] $PE_{y,fugitive,ww}$ is not relevant, as no sludge treatment occurs.

$PE_{y,dissolved} = Q_{y,ww} \times CH_{4\_y,ww,treated} \times GWP\_CH_4$			Equation 8
$Q_{y,ww}$	See above	See above	See above
$CH_{4\_y,ww,treated}$	Dissolved methane content in treated wastewater (t/m^3)	0	AMS-III.H. Default value for aerobic discharge. Wastewater will be discharged to water palm oil plants, rubber plants and grasses.
GWP_CH_4	See above	See above	See above

B.6.1.2 Power generation component

The baseline for power generation is the kWh produced by the renewable generating unit multiplied by an emission coefficient (measured in kg CO_2e/kWh) calculated in a transparent and conservative manner as a combined margin (CM), consisting of the combination of operating margin (OM) and build margin (BM) according to the procedures prescribed in the approved methodology ACM0002. This is consistent with paragraph 9.(a) of AMS-I.D.

Equation 9

$$ER_{y,power} = EG_{y,exported} \times EF_{y,grid}$$

where:

$ER_{y,power}$ = Emission reductions due to displacement of grid electricity (tCO_2);

$EG_{y,exported}$ = Electricity supplied to the grid by the Project in year *y* (MWh);

$EF_{y,grid}$ = Emission factor for grid electricity for year *y* (tCO_2/MWh).

and:

Equation 10

$$EF_{y,grid} = w_{OM} \cdot EF_{OM,y} + w_{BM} \cdot EF_{BM,y}$$

where:

w_{OM} = Weight of Operating Margin in the Combined Margin (fraction), 0.5 by default;

w_{BM} = Weight of Build Margin in the Combined Margin (fraction), 0.5 by default;

$EF_{OM,y}$ = Emission factor of set of plants in the Operating Margin in year *y* (tCO_2/MWh);

$EF_{BM,y}$ = Emission factor of set of plants in the Build Margin in year *y* (tCO_2/MWh).

For the Operating Margin, ACM0002 allows four methods: (a) Simple OM, (b) Simple Adjusted OM, (c) Dispatch Data Analysis OM, or (d) Average OM. The first methodological choice, Dispatch Data Analysis OM, was not carried out due to data constraints. Therefore, the second methodological choice, the Simple OM[3] is applied.

The Simple Adjusted OM ($EF_{OM,simple,y}$) is calculated according to the following formula:

[3] The Thai grid consists of less than 50% renewables

Equation 11

$$EF_{OM,y} = EF_{OM,simple,y} = \frac{\sum_{i,j} F_{i,j,y} \cdot COEF_{i,j}}{\sum_{j} GEN_{j,y}}$$

where:

$F_{i,j,y}$ = Amount of fuel consumed by relevant power sources *j* in year *y*, where *j* refers to the power sources in the grid excluding low-cost/must-run power plants and including any imports to the grid;

$COEF_{i,j}$ = CO_2 emission coefficient of fuel *i* used in power sources *j* (tCO_2/mass or volume unit);

$GEN_{j,y}$ = Electricity supplied to the grid by source *j* (MWh).

The Build Margin is calculated as the generation-weighted average emission factor of a sample of power plants *m*, as follows.

Equation 12

$$EF_{BM,y} = \frac{\sum_{i,m} F_{i,m,y} \cdot COEF_{i,m}}{\sum_{m} GEN_{m,y}}$$

where

$F_{i,m,y}$ = Amount of fuel consumed by sample group *m* in year *y*, where sample group *m* consists of either the five power plants that have been built most recently, or the power plant capacity additions in the electricity system that comprise 20% of the system generation (in MWh) and that have been built most recently;

$COEF_{i,m}$ = CO_2 emission coefficient of fuel *i* used in sample group *m* (tCO_2/mass or volume unit);

$GEN_{m,y}$ = Electricity supplied to the grid by sample group *m* (MWh).

Both the Operating Margin and Build Margin emission factors will be determined *ex ante* based on the most recent public data available in addition to the other input parameters. These are provided in the ensuing tables.

Table 6: Data for Operating Margin, sourced from EGAT PDP 2002 - 2004

Classification as per ACM0002	Type of fuel	2001		2002		2003		Unit for fuel consumption
		Generation (GWh)	Fuel Consumption	Generation (GWh)	Fuel Consumption	Generation (GWh)	Fuel Consumption	
Non-LCMR	Natural Gas	70,280	1,681	76,689	1,632	83,500	1,895	MMSCFD
	Heavy Oil	3,146	783	2,062	521	2,150	533	Mlitres
	Diesel Oil	155	46	258	67	45	12	Mlitres
	Lignite	17,307	15.24	16,890	15.20	17,134	16.22	Mtons
	Imported Coal	2,475	0.990	2,541	1.054	2,526	1.084	Mtons
Imports	EGAT-TNB	9	-	13	-	105	-	N/A
	Laos Hydro	2,885	-	2,807	-	2,438	-	N/A
LCMR	Hydro	6,311	-	6,481	-	7,742	-	N/A
	Renewable Energy	597	-	648	-	1,103	-	N/A
	Heavy Oil	3,146	783	2,062	521	2,150	533	Mlitres
Total Non-LCMR +		96,257		101,260		107,898		

Imports							
Total	103,165		108,389		116,743		

Table 7: Data for Build Margin, sourced from DEDE and EPPO

Plant name	Commission Date	Fuel type	Generation (GWh)	Efficiency	Fuel Consumption (TJ)
EPEC	25-Mar-03	Natural Gas	1,922	7,083	14,363
Glow	31-Jan-03	Natural Gas	4,298	6,850	31,062
Ratchaburi	18-Apr-02, 1-Nov-02	Natural Gas	12,315	7,262	94,355
SPP – collective	post 28-Oct-00	Renewable	1,236	-	0
SPP – collective	post 28-Oct-00	Natural Gas	1,352	-	9,386
Ratchaburi	22-Oct-00	Natural Gas	3,451	10,110	36,810
Total			24,574		185,976

Table 8: Other input parameters for the grid emission factor calculation

Type of fuel	Original Units for Fuel Consumption	Conversion Factor to Gg (kt)	NCV (TJ/Gg)	CO2 Emission Factors (kgCO2/TJ)	Oxidation Factors (fraction)
Data Source (IPCC 2006, Vol 2)			Table 1.2	Table 2.2	Table 1.4
Natural Gas	MMSCFD	8.00	48.00	56,100	1
Heavy Oil	Mlitres	0.89	40.40	77,400	1
Diesel Oil	Mlitres	0.85	43.00	74,100	1
Lignite	Mtons	1,000	11.90	101,000	1
Imported Coal	Mtons	1,000	26.70	98,300	1

As the project activity does not involve the transfer of energy generating equipment to or from another activity, there are no leakage effects.

B.6.2. Data and parameters that are available at validation:

Data / Parameter:	$MCF_{ww,treatment}$
Data unit:	Fraction
Description:	Methane correction factor for the wastewater treatment system that will be equipped with methane recovery and combustion
Source of data used:	AMS-III.H
Value applied:	0.8
Justification of the choice of data or description of measurement methods and procedures actually applied :	Lower value for anaerobic deep lagoon in AMS-III.H Table III.H.I
Any comment:	Anaerobic lagoons can be inspected by DOE.

Data / Parameter:	$EF_{y,grid} / EF_{y,consumed}$
Data unit:	tCO_2/MWh
Description:	Emission factor for grid electricity

Source of data used:	EGAT, DEDE, EPPO, IPCC
Value applied:	0.51
Justification of the choice of data or description of measurement methods and procedures actually applied :	As per AMS-I.D/ACM0002. $EF_{y,consumed}$ is equal to $EF_{y,grid}$.
Any comment:	See Sections B.6.1.2 and B.6.3.2 for details.

As per the guidance on completing SSC PDDs, data that is calculated with equations provided in the approved category and default values specified in the category is not compiled above. Such data are: $B_{o,ww}$, $MCF_{ww,final}$, GWP_CH_4, DOC_F, F, $CH_{4\_y,ww,treated}$ and CFE_{ww}.

B.6.3 Ex-ante calculation of emission reductions:

B.6.3.1 Wastewater treatment component

Baseline emission

As per Equation 3, the baseline emission from the wastewater treatment is calculated as follows.

$$BE_y = Q_{y,ww} \times COD_{y,ww,untreated} \times B_{o,ww} \times MCF_{ww,treatment} \times GWP\_CH_4$$

Using the input values listed in Table 5, BE_y is 21,891 tCO_2e per year.

Project emission

(a) Emissions from electricity or diesel consumption

No electricity or diesel consumption is expected for the Project, and is not estimated *ex ante*. However, any consumption will be monitored as they arise, and calculated as per Equation 4, reproduced below.

$$PE_{y,power} = EG_{y,consumed} \times EF_{y,consumed}$$

(b) Emissions from degradable organic carbon in treated wastewater

Emissions from DOC still remaining in the treated wastewater is estimated as per Equation 5, reproduced below.

$$PE_{y,ww,treated} = Q_{y,ww} \times COD_{y,ww,treated} \times B_{o,ww} \times MCF_{ww,final} \times GWP\_CH_4$$

Using the input values listed in Table 5, $PE_{y,ww,treated}$ is 600 tCO_2e per year.

(c) Emissions from anaerobic decay of final sludge produced

The wastewater treatment system produces a small amount of sludge, of about 1,000 tonnes per year. After dewatering, the sludge will be given away to farmers for land application. As the sludge will decompose in aerobic conditions, there will be no methane emissions from the final sludge. However, as per the methodology, the end-use of the final sludge will be monitored during the crediting period.

(d) Emissions from methane release in capture and flare systems

The emission from incomplete combustion of methane in the flare system is estimated using Equation 7 reproduced below. Using the input values listed in Table 5, $PE_{y,fugitive}$ is 521 tCO_2e per year.

$$PE_{y,fugitive} = (1 - CFE_{ww}) \times Q_{y,ww} \times COD_{y,ww,untreated} \times B_{o,ww} \times MCF_{ww,treatment} \times GWP\_CH_4$$

(e) Emissions from dissolved methane in treated wastewater

Methane emissions resulting from dissolved methane in the treated effluent is estimated using Equation 8 reproduced below. As the discharge is made to an aerobic river system, $CH_{4\_y,ww,treated}$ is zero (0) and hence $PE_{y,dissolved}$ is zero (0).

$$PE_{y,dissolved} = Q_{y,ww} \times CH_{4\_y,ww,treated} \times GWP\_CH_4$$

The total estimated project emission in a year is 1,121 tCO_2e.

Leakage

As stated in Section B.6.1.1, there is no leakage.

Emission reduction

The emission reduction is calculated as per Equation 1:

$$ER_{y,ww} = BE_y - \left(PE_y + Leakage_y\right)$$

where BE_y is 21,891 tCO_2e and PE_y is 1,121 tCO_2e. $ER_{y,ww}$ is therefore 20,770 tCO_2e.

As per the methodology AMS-III.H, the *ex post* calculation of emission reductions will be based on the monitored amount of methane recovered and used for power generation or flared, minus the project emissions calculated based on monitored variables.

B.6.3.2 Power generation component

Based on Equation 11 and values provided in Table 6 and Table 8, $EF_{OM,y}$ is 0.60 tCO_2e/MWh. Similarly, based on Equation 12 and values provided in Table 7 and Table 8 $EF_{BM,y}$ is 0.42 tCO_2e/MWh. Using Equation 10, $EF_{y,grid}$ is 0.51 tCO_2e.

The emission reduction due to the displacement of grid electricity by the Project's carbon-neutral electricity is calculated using Equation 9, reproduced below.

$$ER_{y,power} = EG_{y,exported} \times EF_{y,grid}$$

The Project is estimated to produce approximately 6,058 MWh of power for export to the grid ($EG_{y,exported}$). Therefore, $ER_{y,power}$ is 3,090 tCO_2e per year.

B.6.4 Summary of the ex-ante estimation of emission reductions:

Table 9: Ex-ante estimation of emission reductions

Year	Estimation of project activity emissions (tCO_2e)	Estimation of baseline emissions (tCO_2e)	Estimation of leakage (tCO_2e)	Estimation of overall emission reductions (tCO_2e)
Year 2007 (from Oct)	280	6,245	0	5,965
Year 2008	1,121	24,981	0	23,860
Year 2009	1,121	24,981	0	23,860
Year 2010	1,121	24,981	0	23,860
Year 2011	1,121	24,981	0	23,860
Year 2012	1,121	24,981	0	23,860
Year 2013	1,121	24,981	0	23,860
Year 2014 (to September)	841	18,736	0	17,895
Total (tonnes of CO_2e)	7,847	174,867	0	167,020

B.7 Application of a monitoring methodology and description of the monitoring plan:

B.7.1 Data and parameters monitored:

Data / Parameter:	$PE_{y,power}$
Data unit:	tCO_2
Description:	Emissions from electricity or diesel consumption in year *y*
Source of data to be used:	Calculated
Value of data	0
Description of measurement methods and procedures to be applied:	Calculated as $PE_{y,power} = EG_{y,consumed} \times EF_{y,consumed}$
QA/QC procedures to be applied:	N/A
Any comment:	This emission source is not expected, but will be monitored regardless.

Data / Parameter:	$EG_{y,consumed}$
Data unit:	MWh
Description:	Amount of electricity consumed by the project activity facilities
Source of data to be used:	Thachana / PEA
Value of data	0
Description of measurement methods and procedures to be applied:	This parameter will be measured continuously by electricity meters. Data will be kept electronically in a systematic and transparent manner.

QA/QC procedures to be applied:	The amount of electricity consumed by the Project will be monitored by an electricity meter. The electricity meter will undergo maintenance / calibration subject to appropriate industry standards. The consistency of the data will be verified through the actual purchase records between Thachana and PEA.
Any comment:	This emission source is not expected, but will be monitored regardless.

Data / Parameter:	$PE_{y,ww,treated}$
Data unit:	tCO_2e
Description:	Emissions from degradable organic carbon in treated wastewater in year *y*
Source of data to be used:	Calculated
Value of data	600
Description of measurement methods and procedures to be applied:	Calculated as $PE_{y,ww,treated} = Q_{y,ww} \times COD_{y,ww,treated} \times B_{o,ww} \times MCF_{ww,final} \times GWP\_CH_4$
QA/QC procedures to be applied:	N/A
Any comment:	N/A

Data / Parameter:	$Q_{y,ww}$
Data unit:	m^3
Description:	Volume of wastewater treated in year *y*
Source of data to be used:	Thachana
Value of data	85,000
Description of measurement methods and procedures to be applied:	This is monitored continuously through a flow meter.
QA/QC procedures to be applied:	The flow meter will undergo maintenance / calibration subject to appropriate industry standards.
Any comment:	N/A

Data / Parameter:	$COD_{y,ww,treated}$
Data unit:	t/m^3
Description:	Chemical oxygen demand of the treated wastewater in year *y*
Source of data to be used:	Thachana
Value of data	0.016
Description of measurement methods and procedures to be applied:	COD measurements will be carried out in-house daily and sent to an outside laboratory quarterly.
QA/QC procedures to be applied:	Sampling and analysis will be carried out adhering to internationally recognized procedures.
Any comment:	N/A

Data / Parameter:	$PE_{y,s,final}$

Data unit:	tCO_2e
Description:	Emissions from anaerobic decay of final sludge produced in year *y*
Source of data to be used:	Calculated
Value of data	0
Description of measurement methods and procedures to be applied:	$PE_{y,s,final} = S_{y,final} \times DOC_{y,s,final} \times MCF_{s,final} \times DOC_F \times F \times \frac{16}{12} \times GWP\_CH_4$
QA/QC procedures to be applied:	N/A
Any comment:	N/A

Data / Parameter:	$S_{y,final}$
Data unit:	T
Description:	Amount of final sludge generated by the wastewater treatment in year *y*
Source of data to be used:	Thachana
Value of data	1,092
Description of measurement methods and procedures to be applied:	The final sludge will be weighed when the anaerobic digester is emptied.
QA/QC procedures to be applied:	In the case of off-site disposal, the weighed tonnage can be compared against the records of waste contractor / end user.
Any comment:	N/A

Data / Parameter:	$DOC_{y,s,final}$
Data unit:	tC/t sludge
Description:	Degradable organic content of final sludge generated by the Project in year *y*
Source of data to be used:	AMS-III.H
Value of data	0.09
Description of measurement methods and procedures to be applied:	This parameter will be monitored in the case that the sludge is not given to the farmers and disposed on-site, or if the end use cannot be monitored.
QA/QC procedures to be applied:	N/A
Any comment:	N/A

Data / Parameter:	$MCF_{s,final}$
Data unit:	Fraction
Description:	Methane correction factor of the landfill that receives the final sludge in year *y*
Source of data to be used:	AMS-III.G/Methane tool
Value of data	0
Description of measurement methods	Visual confirmation of the landfill by the DOE. If the end use is monitored, as per the methodology, $MCF_{s,final}$ is zero (0).

and procedures to be applied:	
QA/QC procedures to be applied:	N/A
Any comment:	N/A

Data / Parameter:	$PE_{y,fugitive}$
Data unit:	tCO_2e
Description:	Emissions from methane release in capture and flare systems in year *y*
Source of data to be used:	Calculated
Value of data	104
Description of measurement methods and procedures to be applied:	Calculated as $PE_{y,fugitive} = PE_{y,fugitive,ww} = (1 - CFE_{ww}) \times Q_{y,ww} \times COD_{y,ww,untreated} \times B_{o,ww} \times MCF_{ww,treatment} \times GWP\_CH_4$
QA/QC procedures to be applied:	N/A
Any comment:	N/A

Data / Parameter:	$COD_{y,ww,untreated}$
Data unit:	t/m^3
Description:	Chemical oxygen demand of wastewater entering the anaerobic treatment system with methane capture in year *y*
Source of data to be used:	Thachana
Value of data	0.073
Description of measurement methods and procedures to be applied:	COD measurements will be carried out in-house daily and sent to an outside laboratory quarterly.
QA/QC procedures to be applied:	Sampling and analysis will be carried out adhering to internationally recognized procedures.
Any comment:	N/A

Data / Parameter:	$PE_{y,dissolved}$
Data unit:	tCO_2e
Description:	Emissions from dissolved methane in treated wastewater in year *y*
Source of data to be used:	Calculated
Value of data	0
Description of measurement methods and procedures to be applied:	Calculated as $PE_{y,dissolved} = Q_{y,ww} \times CH_{4\_y,ww,treated} \times GWP\_CH_4$
QA/QC procedures to be applied:	N/A
Any comment:	N/A

Data / Parameter:	$CH_{4\_y,ww,treated}$
Data unit:	t/m^3
Description:	Dissolved methane content in treated wastewater
Source of data to be used:	AMS-III.H
Value of data	0
Description of measurement methods and procedures to be applied:	Visual confirmation by DOE. For aerobic wastewater treatment, the default value is zero. In anaerobic treatment, it can be measure, or a default value of 0.001 can be used.
QA/QC procedures to be applied:	N/A
Any comment:	N/A

Data / Parameter:	$ER_{y,power}$
Data unit:	tCO_2
Description:	Emission reductions due to displacement of grid electricity in year *y*
Source of data to be used:	Calculated
Value of data	1,763
Description of measurement methods and procedures to be applied:	Calculated as $ER_{y,power} = EG_{y,exported} \times EF_{y,grid}$
QA/QC procedures to be applied:	N/A
Any comment:	N/A

Data / Parameter:	$EG_{y,exported}$
Data unit:	MWh
Description:	Amount of electricity supplied to the grid by the Project in year *y*
Source of data to be used:	Thachana / PEA
Value of data	6,058MWh
Description of measurement methods and procedures to be applied:	This parameter will be measured continuously by electricity meters. Data will be kept electronically in a systematic and transparent manner.
QA/QC procedures to be applied:	The amount of electricity generated by the Project will be monitored by electricity meters, which will be calibrated according to the standards set by PEA. The consistency of the data will be verified through the actual sales records between Thachana and PEA.
Any comment:	N/A

Data / Parameter:	BE_y
Data unit:	tCO_2e
Description:	Baseline emission from wastewater in year *y*
Source of data to be used:	Calculated

Value of data	21,891
Description of measurement methods and procedures to be applied:	Monitored amount of biogas recovered and fuelled or flared, adjusted for methane content in biogas ($F_{CH4\_captured}$) and density ($\rho_{CH4\_captured}$, deduced from temperature T_{biogas} and pressure P_{biogas} of gas). The amount of biogas recovered is monitored using continuous flow meters, as per AMS-III.H.
QA/QC procedures to be applied:	The flow meters will undergo maintenance / calibration subject to appropriate industry standards.
Any comment:	N/A

Data / Parameter:	$F_{CH4\_captured}$
Data unit:	Fraction (volumetric basis)
Description:	Fraction of methane in the recovered biogas
Source of data to be used:	Thachana
Value of data	N/A – this parameter is not relevant for the purpose of the *ex ante* estimation
Description of measurement methods and procedures to be applied:	The fraction of methane in the biogas will either be measured with a continuous analyzer, or with periodical measurements at a 95% confidence level, in accordance3 with AMS-III.H.
QA/QC procedures to be applied:	The analyzer will undergo maintenance / calibration subject to appropriate industry standards.
Any comment:	N/A

Data / Parameter:	$\rho_{CH4\_captured}$
Data unit:	t CH_4/m^3 biogas
Description:	Density of methane combusted
Source of data to be used:	Calculated
Value of data	N/A – this parameter is not relevant for the purpose of the *ex ante* estimation
Description of measurement methods and procedures to be applied:	Calculated from T_{biogas} and P_{biogas}.
QA/QC procedures to be applied:	N/A
Any comment:	N/A

Data / Parameter:	T_{biogas}
Data unit:	degC or degK
Description:	Temperature of biogas combusted
Source of data to be used:	Thachana
Value of data	N/A – this parameter is not relevant for the purpose of the *ex ante* estimation
Description of measurement methods and procedures to be applied:	The fraction of methane in the biogas will either be measured with a continuous analyzer, or with periodical measurements at a 95% confidence level.
QA/QC procedures to be applied:	The temperature meter will undergo maintenance / calibration subject to appropriate industry standards.

Any comment:	N/A

Data / Parameter:	P_{biogas}
Data unit:	bar
Description:	Pressure of biogas combusted
Source of data to be used:	
Value of data	N/A – this parameter is not relevant for the purpose of the *ex ante* estimation
Description of measurement methods and procedures to be applied:	The fraction of methane in the biogas will either be measured with a continuous analyzer, or with periodical measurements at a 95% confidence level.
QA/QC procedures to be applied:	The pressure gauge will undergo maintenance / calibration subject to appropriate industry standards.
Any comment:	N/A

B.7.2 Description of the monitoring plan:

All monitoring equipment will be installed by a qualified contractor and regularly calibrated for quality control according to the to the appropriate industry standards. Monitoring and recording of the required parameters will be undertaken by trained personnel under the management of a CDM Manager.

Execution of the monitoring plan will be carried out by Thachana staff, who will monitor, record and store relevant data. Such data will be made available to the DOE for verification in a transparent manner.

The operational and management structure for monitoring is summarized in the below diagram.

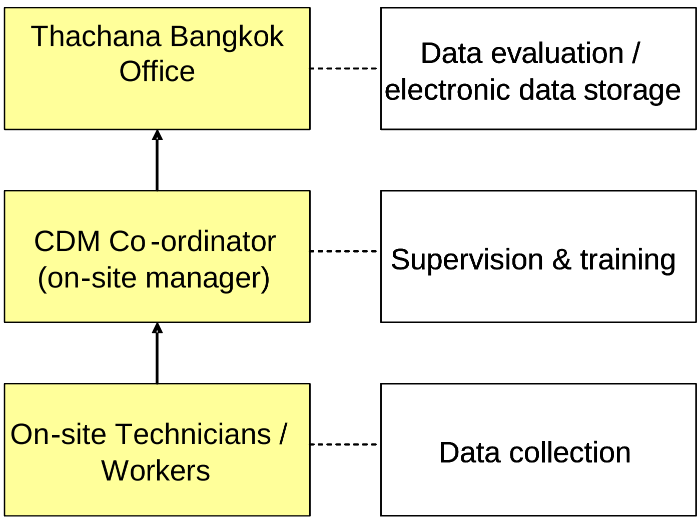

Figure 5: Reporting structure as currently planned

B.8 Date of completion of the application of the baseline and monitoring methodology and the name of the responsible person(s)/entity(ies)

The baseline study was completed in May 2007 by MUS.

Clean Energy Finance Committee
Mitsubishi UFJ Securities Co., Ltd.
Tokyo, Japan
Phone: +81-3-6213-6331
E-mail: hatano-junji@sc.mufg.jp; ktochikawa@cefconsulting.com

MUS is a project participant as defined by the CDM Executive Board. Contact details are provided in Annex 1.

SECTION C. Duration of the project activity / crediting period

C.1 Duration of the project activity:

C.1.1. Starting date of the project activity:

01/08/2005

C.1.2. Expected operational lifetime of the project activity:

21 years

C.2 Choice of the crediting period and related information:

C.2.1. Renewable crediting period

C.2.1.1. Starting date of the first crediting period:

01/10/2007

C.2.1.2. Length of the first crediting period:

7 years

C.2.2. Fixed crediting period:

C.2.2.1. Starting date:

This section is intentionally left blank.

C.2.2.2. Length:

This section is intentionally left blank.

SECTION D. Environmental impacts

D.1. If required by the host Party, documentation on the analysis of the environmental impacts of the project activity:

The Project will contribute to the following major positive environmental impacts:

- Improvement of local air quality. One of the major problems associated with wastewater treatment is the pungent odour arising from the open lagoons, during the long decomposition process. By treating the POME in an enclosed tank that allows accelerated decomposition, this will significantly improve the air quality, which is important not only beyond Thachana's borders, but also to Thachana's staff within the grounds.

- Renewable energy generation. By using the methane contained in the biogas generated from the POME, the Project taps into an unused, environmentally friendly and renewable energy source. This will reduce the consumption of fossil fuels conventionally used for power generation.

No negative impacts are identified with the Project.

D.2. If environmental impacts are considered significant by the project participants or the host Party, please provide conclusions and all references to support documentation of an environmental impact assessment undertaken in accordance with the procedures as required by the host Party:

Under the Thai laws, no EIA or similar application were required for the project activity.

SECTION E. Stakeholders' comments

E.1. Brief description how comments by local stakeholders have been invited and compiled:

The consultation meeting for comments by local stakeholders was organized on March 31, 2007 at Thachana Palm Oil mill. The invitation letters were sent to Tambon Administration Organizations[4] located within 5 kilometers radius of the Project. The Tambon Administration Organizations then informed the residents in their responsible area regarding the local stakeholders meeting. The local stakeholders who accepted the invitation included residents, workers and local authorities.

A leaflet regarding the Project and a questionnaire were distributed to the participants. The Project Owner, presented on the Project including background and rationale, biogas technology and benefits to the local community. The participants were invited to give any comments on the Project.

Table 10: Program

Time	Program
9:00 ‐ 9:30	Registration
9:30 – 10:00	Presentation of Project by Mr. Krit Yangvanitset (Thachana owner)
10:30 – 10:45	Coffee break
10:45 – 11:30	Site visit and Q&A session
11:30 – 12:00	Filling of questionnaire

[4] A Tambon consists of a several villages

Figure 6: Stakeholders listening to a presentation on the Project

E.2. Summary of the comments received:

The participants gave comments on the benefits contributed to the local community. All of the participants agreed that the Project positively influences the local environment by reducing the odor and making use of the wastewater to produce electricity. Some participants indicated that they can derive additional benefits from using the treated wastewater to water palm oil and rubber plantation. All of the participants also agreed that the Project improve the treated wastewater. 30 and 70 percent of the participants showed the most satisfaction and satisfaction on the Project, respectively. None of the participants had a negative view of the Project.

E.3. Report on how due account was taken of any comments received:

All of the participants realize the benefits the Project contributed to the local community. To give benefit on the use of the treated wastewater to water the plantation, the Project Owner decided that he will install a piping system to distribute the treated wastewater to the residents living some distance away from the Project. Moreover, the advertisement on job employment in Thachana Palm Oil mill was announced in the meeting.

Annex 1

CONTACT INFORMATION ON PARTICIPANTS IN THE PROJECT ACTIVITY

Organization:	Thachana Palm Oil Co., Ltd.
Street/P.O.Box:	182 Moo 12 Phetkasem Road, Tumbon Kuntulee,
Building:	
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State/Region:	Surat Thani Province
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Country:	
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E-Mail:	
URL:	
Represented by:	
Title:	
Salutation:	Mr.
Last Name:	Yangvanitset
Middle Name:	
First Name:	Krit
Department:	
Mobile:	
Direct FAX:	
Direct tel:	
Personal E-Mail:	

Organization:	Mitsubishi UFJ Securities Co., Ltd.
Street/P.O.Box:	2-4-1 Marunouchi,
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E-Mail:	
URL:	www.sc.mufg.jp/english/e_cefc/
Represented by:	
Title:	Chairman
Salutation:	Mr.
Last Name:	Hatano
Middle Name:	
First Name:	Junji
Department:	Clean Energy Finance Committee
Mobile:	
Direct FAX:	
Direct tel:	
Personal E-Mail:	hatano-junji@sc.mufg.jp

Annex 2

INFORMATION REGARDING PUBLIC FUNDING

The Project does not involve funding from an Annex I country.

Annex 3

BASELINE INFORMATION

Please refer to Sections B.6.1, B.6.2 and B.6.3.

Annex 4

MONITORING INFORMATION

Please refer to Sections B.7.1 and B.7.2.

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