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.

SECTION A. General description of small-scale project activity

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

Project Title: Pitak Palm Wastewater Treatment and Biogas Utilization Project

PDD Version: 1.0

Date: 09 December 2008

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

Purpose of the project activity:
The proposed project entails the installation of a Completely Stirred Tank Reactor (CSTR) and an Upflow Anaerobic Sludge Blanket technology (UASB) biogas reactor for treatment of wastewater and power generation at an existing palm oil mill in Ampher Sikao, located in the Trang Province in Southern Thailand. The major components of the project are:

a) the extraction of methane (biogas) from the wastewater stream through the biogas reactor and
b) the reuse of biogas as fuel for power generation, using an 1.063 MW_{el} gas engine.

The extraction process of palm oil generates about 0.55 m^3 of Palm Oil Mill Effluent (POME) for each ton of Fresh Fruit Bunch (FFB) processed. The proposed project will be implemented at the Pitak Palm Oil Co., Ltd production facility with a total expected wastewater flow-rate of 330 m^3/day and an average COD concentration of 75,193 mg/L.

The mill presently operates under an effluent standards regulated by the environmental authorities, which will improve substantially due to higher efficiency and improved process control of the biogas reactor as compared to open lagoons. In fact, the biogas reactor system allows the palm oil mill factory to reuse the treated effluent in the palm oil mill production process, contributing to water conservation. Further, the project will avoid odour emissions as compared to an anaerobic lagoon, thereby contributing significantly to an improved quality of life around the project site.

In order to meet above mentioned requirements, POME is currently treated in a series of seven open anaerobic lagoons, each with a depth of around 7 m and a total capacity of 143,000 m^3. The existing treatment system prior to the project activity consists of several steps including cooling, oil removal, anaerobic and aerobic treatment to reduce the COD concentrations to a level acceptable for irrigation purposes. The anaerobic decay of organic matter within the open lagoons generates biogas containing methane, which escapes in an uncontrolled manner to the atmosphere.

The new treatment system to be introduced as a sequential stage prior to the existing lagoon system (see Figure 1 below) will account for 98% of COD removal, producing and capturing biogas for electricity generation, which will be used by the palm oil mill facility, displacing grid electricity from fossil fuel based electricity generation sources. Therefore, the project activity reduces greenhouse gas emissions in a twofold manner; one by avoiding the release of methane to the atmosphere from the COD removal in the existing lagoon system and second by generating renewable electricity which in turn replaces grid electricity.

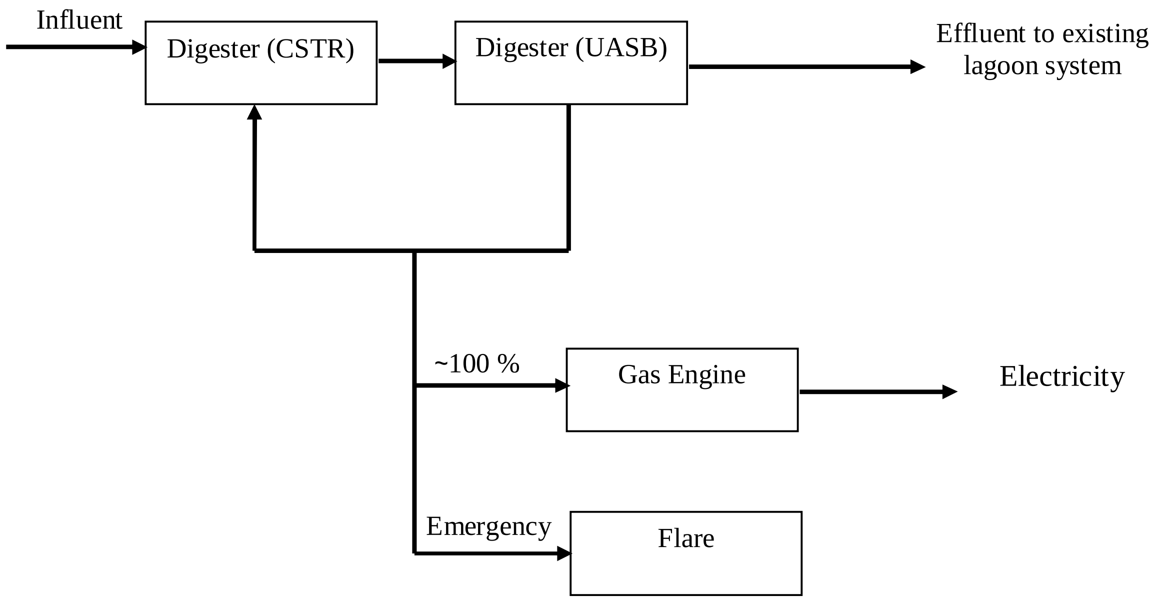

Figure 1: Biogas generation and utilization diagram

Sustainable Development Benefits of the Project

According to the definition of sustainable development criteria for CDM projects by the Thai DNA[1], the project will directly contribute to sustainable development in Thailand in several ways as shown below:

Natural Resources and Environment benefits

- Reduction of greenhouse gas emissions by avoiding methane emissions from open anaerobic lagoons to the atmosphere and by displacing electricity from grid connected fossil fuel based power plants;
- Reduction of odor emissions;
- Reduction in usage of non-renewable energy, i.e. fossil fuel for grid electricity generation;
- Improvement of the quality of water discharged into the environment;

Social benefits

- Involvement of local communities through a public participation meeting, in which people accepted the project;
- Increase in employment by creating 12 full time jobs to operate the system and several temporary ones during the construction of the project activity;
- The project activity will provide opportunities for management and operators to acquire new technological knowledge and skills.

Technology transfer benefits

[1] http://www.tgo.or.th/english/index.php?option=com_content&task=view&id=15&Itemid=1

- Promotion of technological in Thailand, which could be replicated across Thailand and the region;
- Provision of necessary training on the management of the power plant to staff;

Economic benefits

- Reduction in dependency on fossil fuel for electricity generation while at the same time enhancing energy security by increasing diversity of supply;
- The utilization of the methane captured to generate electricity contributes to economic returns in supporting the capital, operational and maintenance costs of the more efficient closed-tank anaerobic digester plant;
- Generation of income for the local community through additional local employment opportunities;
- Demonstration of the use of CDM as a financial incentive for implementation of effective waste to energy projects.

ADDITIONAL REQUIREMENTS FOR THE GOLD STANDARD:
Sustainable Development Screen:

The project shows mainly positive scores according to the Gold Standard sustainability screen. For details please refer to the Annex 5.

A.3. Project participants:

Name of Party involved (*) ((host) indicates a host Party)	Private and/or public entity(ies) project participants (*) (as applicable)	Kindly indicate if the Party involved wishes to be considered as project participant (Yes/No)
Thailand (host)	Pitak Palm Oil Co., Ltd. (private entity)	No
Switzerland	South Pole Carbon Asset Management Ltd. (private entity)	No
(*) In accordance with the CDM modalities and procedures, at the time of making the CDM-PDD public at the stage of validation, a Party involved may or may not have provided its approval. At the time of requesting registration, the approval by the Party(ies) involved is required.		

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.:

Trang Province

A.4.1.3. City/Town/Community etc:

Amphoe Sikao

A.4.1.4. Detail of physical location, including information allowing the unique identification of this project activity (maximum one page):

The address of the project is: 99 Moo 3, Tumbol Kalasae, Ampher Sikao, Trang 92150.
The coordinates of project, are: Latitude 7°34"3'N and Longitude 99°20"29'E.

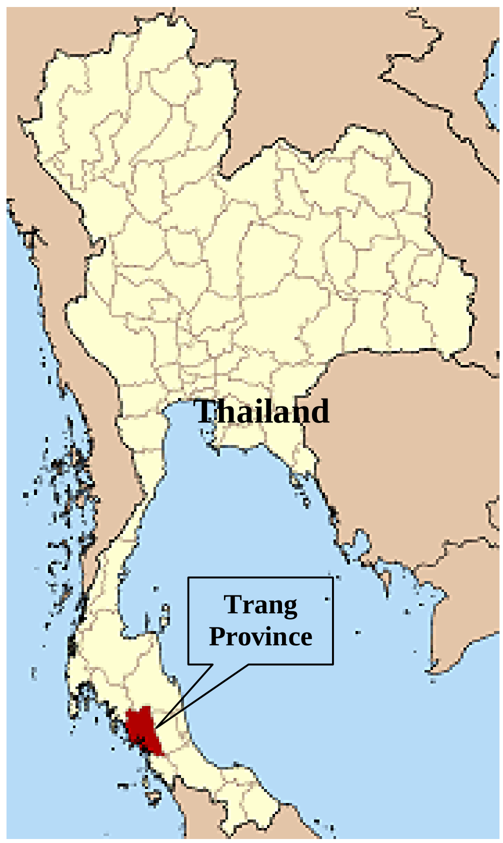

Figure 2: Project location

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

Type and category:

According to Appendix B to the *Simplified Modalities and Procedures for Small-Scale CDM Project Activities*, the Project type and category are defined as follows:

Methane avoidance component:

Type III:	Other project activities
Category III.H:	Methane Recovery in Wastewater Treatment
Sectoral Scope 13:	Waste handling and disposal

Electricity generation component:

Type I:	Renewable energy projects
Category I.D:	Grid connected renewable electricity generation
Sectoral Scope 1:	Energy industries (renewable /non-renewable sources)

ADDITIONAL REQUIREMENTS FOR THE GOLD STANDARD:
Project activities eligible under the Gold Standard

Please refer to Annex 5 for Gold Standard information.

Process and technology description
The influent first passes through a new screen extractor, in order to remove coarse particles (roots, pulp, peels). After the screening, the wastewater flows into an equalization and settling lagoon (in concrete, sloped) for removal of settleable solids. This lagoon is divided in two parts, one in operation, one in standby or cleaning modus.

Water from the equalization lagoon flows into an adjacent pump pit, equipped with submerged pumps, pumping the wastewater continuously to the next stage. The acidic wastewater has to be neutralized with lime and/or caustic soda (for fine tuning on a standby basis). Lime powder is directly added in a lime mixing basin, which receives the wastewater from the pre-treatment.

In a third adjacent basin, grit (including impurities present in the lime) is trapped and removed periodically. There are two grit traps. One is in operation, while the other one is being cleaned or on stand-by. From the grit trap the effluent flows into a pump sump.

The wastewater is then pumped into the methane reactors through an influent distribution system at the bottom of the reactor. The methane reactors consist of two different units: the CSTR (Completely (or Continuous flow) Stirred Tank Reactor) and the UASB (Upflow Anaerobic Sludge Blanket) type, with a special "3 phase separator" device at the top of the reactor.

In the CSTR, the wastewater is continuously pumped into the reactor at the same time as the treated water is removed. The CSTR is a versatile reactor, which allows simple catalyst charging and replacement. Its well-mixed nature (due to stirring) permits straightforward control over temperature and pH of the reaction and the supply or removal of gases.

In the UASB, the wastewater rises through an expanded bed of anaerobic active methanogenic sludge (the so called "sludge blanket") undergoing an anaerobic biological process, where organic matter is converted into biogas and sludge. An internal device at the top of the reactor separates the mixed liquor into clarified wastewater, biogas and sludge streams.

Excess sludge can eventually, from time to time, be withdrawn from the bottom of the reactor. This excess sludge is extremely thick (5-10% DS), stable, and can be used for soil application without any problems. The effluent of the UASB reactor will be further treated in some of the existing lagoons, receiving only 2% of the original load COD load.

The biogas will be used as fuel in a power generator (genset) consisting of a biogas fired engine and an alternator, with an installed capacity of 1,063 kWe. Before use in the power generator, the biogas has to be treated to reduce the sulphur content of the biogas from palm oil mill factory effluent using a Biogas Scrubber (1250 Bio-scrubber), based on a proprietary sulphur removal system, which does not use chemicals (except for pH control in the oxidation phase). In practice min. 90% removal is obtained. The scrubber is placed on top of the aeration basin, so as to allow gravitational flow of the washing water back into the inlet of the aeration basin. From the aeration basin, water is continuously pumped into the scrubber tower.

The effluent of the scrubber is treated by intense aeration in an aeration basin, in order to reduce the sulfide concentration. Intense aeration reduces the sulfide concentration by chemical + biological oxidation. The sulfides are slowly oxidised (mainly chemically) by dissolved oxygen, resulting in a mixture of elementary sulphur, thiosulphate, sulfite and sulfate. A small part is also stripped out of the wastewater. Due to the high pH of the wastewater (8-8.5), the amount stripped out is quite low. Only very small amounts of sulfide are left in the aerated effluent at concentrations (0-10 mg/l) low enough to be reused as scrubber inlet liquid.

The aeration of the anaerobic effluent is done in a rectangular tank by means of a floating surface aerator. As make-up water for the aeration tank a stream from the final aerobic lagoon of the existing effluent lagoon system is used, pumped up from a new pump sump.

After the scrubber the biogas goes to an optional proprietary biogas drier (Absolute: Gas Dryer Unit), to reduce most of the moisture content of the biogas, because some generator engine suppliers impose limits on the % humidity of the biogas, whereas when it comes from the anaerobic reactor it is (over) saturated with water vapour.

After the biogas drier the biogas is sent to the power generators with biogas blowers. H_2S and CH_4 content of the biogas are continuously measured in line. For safety, start-up and green house gas avoidance reasons an enclosed flare is also foreseen.

ADDITIONAL REQUIREMENTS FOR THE GOLD STANDARD:

Gold Standard projects must result in technology transfer and/or knowledge innovation. Please refer to Annex 5 for Gold Standard information.

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

The estimated amount of emission reductions over the crediting period of 7 years is summarized in the Table 1 below.

Table 1: Estimated amount of emissions reductions

Years	Annual estimation of emission reductions in tonnes of CO2e
2009	17,328
2010	17,328
2011	17,328
2012	17,328
2013	17,328
2014	17,328
2015	17,328
Total emission reductions (tonnes of CO2e)	**121,293**
Total number of crediting years	**7**
Annual average over the crediting period of estimated reductions (tonnes of CO2e)	**17,328**

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

No public funding is involved in the project.

ADDITIONAL REQUIREMENTS FOR THE GOLD STANDARD:
ODA Additionality Screen:

Please refer to Annex 5 for Gold Standard information.

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

The project participants confirm that there is no registered small-scale CDM project activity or an application to register another small-scale CDM project activity with the same project participants and whose project boundary is within 1 km of the project boundary of the proposed small-scale activity at the closest point. According to Appendix C to the *Simplified Modalities and Procedures for Small-scale CDM Project Activities*, the Project is not a debundled component of a large-scale project activity.

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:

Methane avoidance component:

The approved CDM small-scale baseline and monitoring methodology AMS III.H "Methane Recovery in Wastewater Treatment" (Version 10) is applied to the methane avoidance component of the project activity.

Electricity generation component:

The approved CDM small-scale baseline and monitoring methodology AMS-I.D "Grid connected renewable electricity generation" (Version 13) is applied to the electricity generation component of the project activity.

For more information on both methodologies, please refer to the link:
http://cdm.unfccc.int/methodologies/SSCmethodologies/approved.html

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

Methane avoidance component:

The project satisfies the following applicability conditions of the approved small-scale CDM methodology AMS-III.H:

- the project activity recovers methane from biogenic organic matter in wastewater
- the estimated emission reductions of the project activity will not exceed 60kt CO_2e in any year of the crediting period

As demonstrated in Section B.4, the wastewater would have been treated in open anaerobic lagoons in the absence of the Project. The project activity refers thus to case (vi) described in Paragraph 1 of AMS.III.H and fulfils the applicability conditions of the respective project type.

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).

Furthermore, the project also falls under paragraph 2(a); the recovered methane is utilized for thermal or electrical energy generation applications.

Electricity generation component:

The project activity also conforms to small-scale CDM project category AMS I.D since:

- The Project comprises the use of energy derived from renewable biomass (biogas) to supply electricity that displaces electricity from the national grid.

- The electricity generation capacity of the Project is less than 15 MW_{el}

B.3. Description of the project boundary:

The project boundary is defined as the physical, geographical site where the wastewater and sludge treatment takes place and the site where the renewable energy generation is located.

The following emission sources and gases are considered in the emission reduction calculations as Table 2.

Table 2: The considered emission sources and gases for emissions reduction calculation

	Source	Gas	Justification / Explanation
Baseline	Lagoon	CH_4	Emission from decay of organic matter
	Electricity grid	CO_2	CO_2 emissions from fossil fuel based electricity generation plants connected to the electricity grid
Project activity	Anaerobic reactor	CH_4	Fugitive emissions on account of inefficiencies in capture systems
	Anaerobic lagoon	CH_4	Emissions from decay of organic matter in the WWT system not equipped with biogas recovery
	Close-flare	CH_4	Emissions due to incomplete flaring
	Electricity consumption	CO_2	Emissions on account of use of electricity to run equipments used in anaerobic treatment

The project boundary is shown in the schematic diagram provided below (Figure 3). The raw effluent after the pretreatment is fed to the anaerobic digester tank system composed of the CSTR and UASB reactors. The treated effluent will be directed to the existing open cascading lagoon system for removal of the remaining 2% COD load. The effluent will be discharged after the last lagoon in accordance with the requirements of Thailand’s Department of Environment. Biogas captured will be used in gas engines for power generation and supplied to the user at the project site. The residual effluent from anaerobic digesters (CSTR and UASB) will go through a sludge dewatering facility, consisting of a settling tank and sand drying beds. The dried sludge recovered will be disposed off in plantations close to the project site as fertilizer.

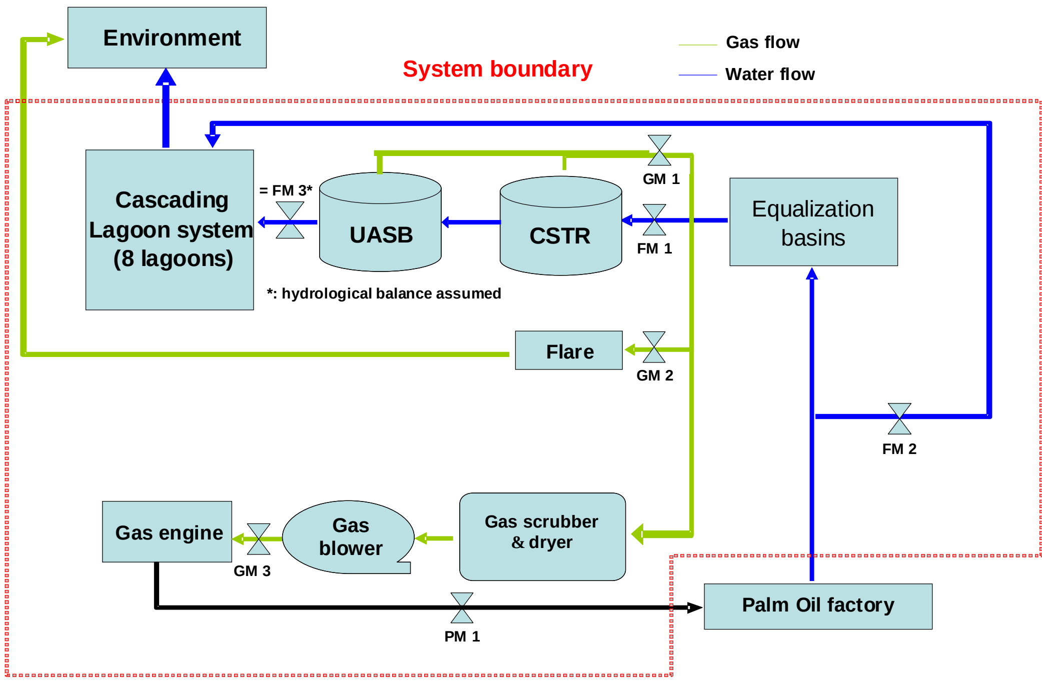

Figure 3: System boundary

B.4.	**Description of baseline and its development:**

Determination of the baseline

At the project location, the baseline scenario is a wastewater treatment system designed as open anaerobic lagoons without methane recovery and electricity use by the palm oil mill imported from the national grid.

The new biogas reactor system is being introduced as a sequential stage with methane recovery to the existing lagoon system (as defined under applicability conditions for project activity measures under Paragraph 1 (vi) of the applied methodology, see Section B.2 above). The produced electricity replaces electricity from the national grid.

Therefore, according to Paragraph 23 of AMS.III.H, the baseline scenario to the project activity is defined as follows:

1. The existing anaerobic wastewater treatment system without methane recovery for the case of introduction of a sequential anaerobic wastewater treatment system with methane recovery

According to Paragraph 7 of AMS I.D, the baseline scenario is defined according to a type III category that is in this case AMS.III.H as above. In the baseline scenario according to AMS.III.H, there is no on-site electricity generation. Therefore, the produced electricity by the project activity displaces electricity from the national grid.

Determination of the baseline emissions

The major parameters and assumptions for calculation of baseline emissions are provided in the Table 3 below:

Table 3: All assumptions for calculation of baseline emissions

Methodology: AMS III H (Methane avoidance component)	
$BE_{ww,treatment,y} = \sum_i Q_{ww,i,y} * COD_{removed,i,y} * MCF_{ww,treatment,BL,i} * B_{o,ww} * UF_{BL} * GWP_{CH_4}$	
BE $_{\textbf{ww, treatment}}$ **:** Baseline emissions in year y for waste water treatment(tCO_2 e)	Calculated
Q $_{\textbf{ww, i, y}}$: Quantity of waste water treated anaerobic process in baseline (Based on the previous palm production and waste water generation data)	Monitored for ex post estimations
COD $_{\textbf{removed, i, y}}$: COD removed by the anaerobic wastewater treatment system in baseline (Lagoon system had a removal efficiency of 98%, but the baseline emissions are for the removal which is prevented by the project activity i.e. about 98% removal of COD intake[2].)	98% of inlet value
UF $_{\textbf{BL}}$ **:** Model correction factor to account for model uncertainties	0.94
B $_{\textbf{o, ww}}$: Methane producing capacity of the wastewater. (IPCC default value, corrected as per methodology AMS III-H page – 4, is used for estimation)	0.21kg CH_4/kg COD
MCF $_{\textbf{ww, treatment, BL, i}}$: Methane correction factor for the existing anaerobic wastewater treatment systems (Based on IPCC default value, Volume 5 Chapter 6, page 6.21. The lower value is used for conservative estimation of baseline emissions)	0.8
GWP $_{\textbf{CH4}}$: Global warming potential of methane gas	21

Methodology: AMS I D (electricity generation component)	
$BE_{y,el} = EF_y \cdot EG_y$	
BE $_{\textbf{y, el}}$: Baseline emissions from power generation in year y	Calculated
EG $_{\textbf{y}}$: Electricity generated during year y by power generation facility	Monitored for ex post estimation
EF $_{\textbf{y}}$: Emission Factor of replaced power (Tool to calculate emission factor of an electricity system)	Calculated – Fixed ex-ante

Please see B.6 for detailed justification of the key assumptions and rationale of the baseline emissions. Detailed explanation and calculation to obation EF_y is provided in Annex 3.

[2] The COD $_{in}$ and COD $_{out}$ for the waste water treatment system installed before the lagoon. In this case baseline emissions are estimated for the 98%COD removal based on the monthly COD measurement prior the project implementation.

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:

The project activity, as explained, tries to reduce GHG emissions by capturing the methane that would have escaped into environment from anaerobic reduction of COD in lagoons and also use the captured methane to generate power and replace grid electricity. The carbon credit incomes were well taken into account before the project initiation. The following table gives an overview of the timeline of the key milestones in project implementation so far.

Table 4: The schedule and the main events for project

Date	Event	Comment
29 July 2004	Pitak Palm Company is registered as the palm oil mill company	Company affidavit
29 July 2005	Pitak Palm Company is received the operating licence	Operating licence
April 2007	Palm oil mill starts its production	Summary record of palm oil mill production
15 October 2007	Board Meeting to discuss the biogas project and take decision on same.	Minutes of Meeting
December 2007	Pitak Palm Company considered to get the revenues from carbon credit (CERs) through CDM	Technical proposal (conducted by Papop company)
8 December 2007	Pitak Palm Company signed the construction contract with Papop company (technology provider) as turn key	Construction contract
26 March 2008	Pitak Palm Company requested for the supporting money from BOI	BOI request
9 May 2008	Site preparation for biogas plant	Invoices
11 June 2008	Loan approval from Thai Kasikorn Bank (38,000,000 THB)	Loan approval
12 June 2008	Pitak Palm Company signed the 2.05 Mw electricity selling contract with PEA	PEA contract
2 July 2008	Pitak Palm Company received the supporting money from BOI	BOI Permit
4 August 2008	Initial CDM Gold Standard stakeholder consultation	Cooperation between Pitak Palm Oil Company and South Pole Carbon company
17 September 2008	Measure the background noise level (24 hours) at the site (during the plant's running) by the ISO tested Lab	The noise measurement report
28 September 2008	Finishing Initial Environmental Evaluation (IEE) and draft PDD	
1 October 2008	Submission the Letter of Approval (LoA) request to Thai DNA (Host)	
15 October 2008	Submission the requesting of Letter of Intense (LoI) to Thai DNA	
5 November 2008	Receive the acceptance LoI letter from Thai DNA	

February 2009	Expected start-up of the plant	

The proof for CDM consideration is evident from the technical proposal, i.e. contract between project owner and the technology provider. The documents related to Letter of Intent to Thai DNA for LoA Host approval are also available. These documents show that project owner expects to get revenues from the sale of the carbon credits after the registration of the CDM project activity.

As discussed in section B.4, the most plausible scenario in absence of project activity would be *"continuation of the use of open anaerobic lagoons for the treatment of the wastewater throughout the crediting period"* since existing lagoons are sufficient to meet wastewater treatment needs of the facility, no additional capacity expansion is planned and there is no incentive to change to a more costly technology nor does the facility need to comply with stricter discharge limits. The only rationale for the investment is the availability of additional incentives from carbon credits as well as reduction of energy costs.

According to *Attachment A* of *Appendix B* of the *Simplified Modalities and Procedures for Small-Scale CDM Project Activities*, additionality of the project shall be demonstrated by showing that the project activity would not have occurred anyway due to at least one barrier. Since the decision by project proponent to implement the project activity is dependent on economic returns from the project activity, investment analysis is undertaken to compare the returns from project activity vis-à-vis available benchmark. The investment analysis is further followed by a sensitivity analysis.

Investment analysis:

At the project location, the existing lagoons are sufficient to meet wastewater treatment needs of the facility and comply with national environmental regulations. No additional capacity expansion is planned and there is no incentive to change to a more costly technology nor does the facility need to comply with stricter discharge limits. As compared to the project activity, the existing anaerobic lagoon system requires no additional investment and their operation and maintenance costs are much lower than for the anaerobic reactor system.

The economic key indicators of the project activity (IRR, NPV) are based on information available at the date of investment decision on 11 June 2008. The basic financial parameters of the project are listed in Table 5 and 6 below.

Table 5: The Basic Financial Parameter of the project

Parameter	Value	Reference
Total Investment (Euro)	1,778,335	Proposal of supplier
Operating and maintenance costs (Euro/year)	128,455	Proposal of supplier
Manpower cost WWTP and Gas engine	17,573	Proposal of supplier
Annual Biogas generated (Nm3/yr)	2,026,451	As per ER calculation sheet
Annual Power supplied to the Grid (MWh/yr)	5,197	As per ER calculation sheet
Price of electricity sold (THB/kWh)	2.8	Average price of electricity bought in the last years
Expected emission reduction (tCO2 e/yr)	17,328	As per ER calculation sheet
Price of ERs (Euro/tCO2 e)	10.0	Benefit sharing
Operation period (years)	15	Proposal of supplier
Crediting years	7	
VAT	7.00%	
Exchange rate (THB/Euro)	47.80	Rate at the date of investment decision

As per the agreement with the technology provider is valid for 15 years, the investment analysis is bounded to its duration. The wastewater treatment system with its electricity generator will be transferred to the effluent producer at the end of the contract. The project should generate a positive profitability for the operator within those 15 years.

The economic indicator most suitable for the project type and decision context is the Project IRR.

Table 6: Comparative financial indicators with and without CDM revenues

Develop project activity with electricity revenues	Project IRR (%)	4.7%
Develop project activity with electricity and CDM revenues	Project IRR (%)	13.8%

Benchmark Establishment:

Benchmark for project activity is chosen from available public information. For ease of comparison, project proponent has considered Minimum Lending Rate (MLR) from the banking institutions as the project IRR benchmark. A project shall be able to service its debt component to remain functional and be able to make some profit. Minimum Lending rate on the date of investment decision i.e. 15th October 2007 is 7.25%[3].

[3] http://www.bot.or.th/English/Statistics/FinancialMarkets/Interestrate/_layouts/application/interest_rate/IN_Rate.aspx

Based on the financial parameters listed above the IRR is not enough to motivate project proponent to invest in the same. Through additional CDM revenues the proponent is able to achieve higher financial returns covering his risks. For the baseline scenario no additional investment would be required, thereby not hindering the continuation of same.

The figures in the table above show that developing the project without CDM revenue will end up with significantly lower financial indicators than usually demanded for this project type in Thailand. Also, the IRR of the project without CDM revenues remains under the Minimum Lending Rate (MLR) of commercial banks in Thailand of 7.25%. The project owner would not invest in a project with an IRR below the MLR.

Sensitivity analysis:

In order to test the robustness of the IRR analysis, a sensitivity analysis is carried out, varying the main parameters of the calculation as presented in the figure below. Indeed, the project IRR could significantly vary when certain parameters fluctuate. The parameters most likely to vary are: the price of electricity and the operating and management costs. These parameters are thus increased and decreased by 10%. The IRR always remains below the benchmark when varying these parameters, disabling thus any investment in this project without CDM revenues.

Table 7: IRR sensitivity analysis

Variation	Electricity price	Operating and management costs
	(IRR %)	(IRR %)
-10%	2.40%	5.60%
-5%	3.58%	5.14%
0%	4.68%	4.68%
5%	5.72%	4.20%
10%	6.71%	3.72%

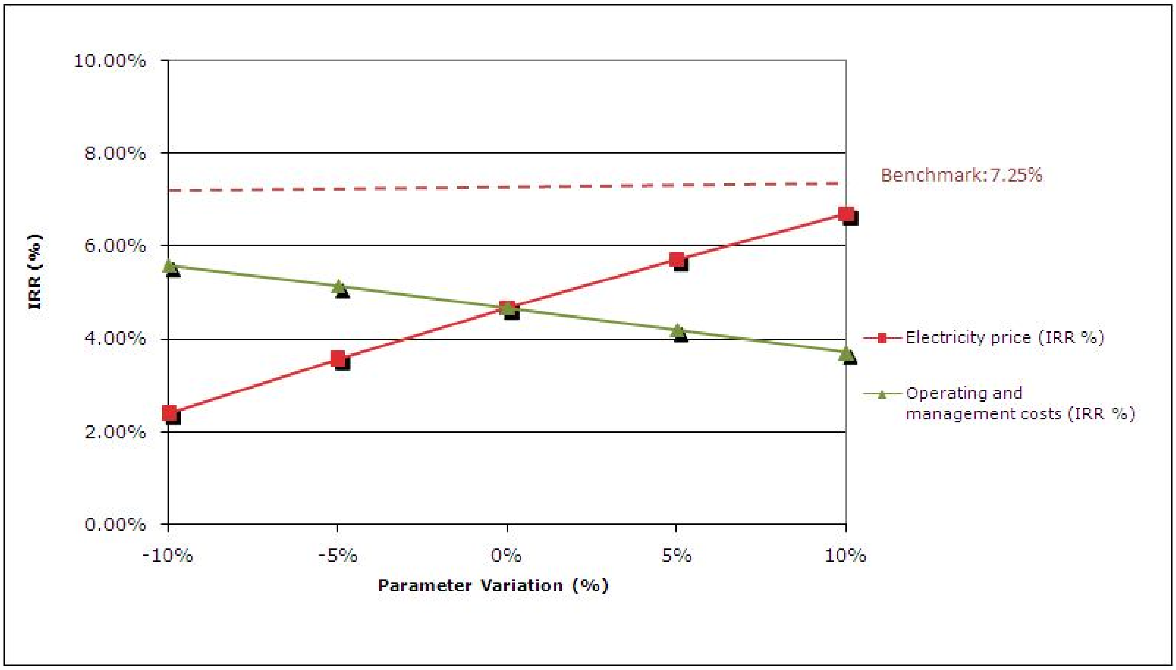

Figure 4: IRR sensitivity analysis

The implementation of a biodigester and gas engine entails high investment and O&M costs and uncertain commercial returns (from the production and use of biogas). The only rationale for the investment in a costly CSTR and UASB technology is the availability of additional incentives from carbon credits and revenues from electricity sales. CDM revenues play a key role in overcoming investment barriers to the project, making it financially more attractive and less risky for potential investors. CDM revenues have been considered since the beginning of the project; the project owner was aware of CDM as CDM revenues were already taken into account in its feasibility study before the implementation of the first line.

Conclusion:

It is clear that the carbon credit revenues play a significant role in the financial viability of the project and that the project owner would not have invested in such a project without the consideration of carbon credits revenues. In absence of the project activity, the existing lagoons would lead to higher green house emissions due to methane release from the lagoons to the atmosphere and CO_2 emissions related to fossil fuel fired power plants connected to the grid. Hence, according to Attachment A of Appendix B of the *Simplified Modalities and Procedures for Small-Scale CDM Project Activities*, Paragraph 1(a), a financially more viable alternative to the project activity would have led to higher emissions and does not face the barrier described above. Therefore, the project activity is considered to be additional.

ADDITIONAL REQUIREMENTS FOR THE GOLD STANDARD:
Gold Standard Additionality Screen

In addition to the UNFCCC Additionality Tool, the Gold Standard Additionality Screen includes an Previous Announcement Check and ODA Additionality.

Please refer to Annex 5 for Gold Standard information.

B.6. Emission reductions:

Year	Emission of project activity emissions (tCO2e)	Estimation of baseline emissions (tCO2e)	Estimation of leakage (tCO2e)	Estimation of overall emission reductions (tCO2e)
1	2,378	19,706	0	17,328
2	2,378	19,706	0	17,328
3	2,378	19,706	0	17,328
4	2,378	19,706	0	17,328
5	2,378	19,706	0	17,328
6	2,378	19,706	0	17,328
7	2,378	19,706	0	17,328
Total (tonnes CO2e)	16,647	137,940	0	121,293

B.6.1. Explanation of methodological choices:

The amount of methane that would be emitted to the atmosphere in the absence of the project activity is estimated according to AMS III.H, Version 10.

The baseline for this project activity corresponds to Paragraph 1, option (vi), of the methodology, defining the baseline scenario as an anaerobic wastewater treatment system without methane recovery and combustion.
The amount of CO_2 that would have been emitted to the atmosphere from grid connected fossil fuel based power plants in the absence of the project activity is estimated according to methodology AMS I.D, Version 13.

This section details the applicable formulas from the methodologies applied to the project activity.

Project emissions

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

AMS III-H
The project activity emissions are calculated as follows:

$$\mathbf{PE_{y} = PE_{y,\,power} + PE_{ww,\,treatment,\,y} + PE_{s,\,treatment,\,y} + PE_{ww,\,discharge,\,y} + PE_{s,\,final,\,y} + PE_{fugitive,\,y} + PE_{biomass,\,y} + PE_{flaring,\,y}} \quad \textbf{(1)}$$

Where:

PE_{y}	Project activity emissions in the year y (tCO_2e)
$PE_{y,\,power}$	Emissions from electricity or fossil fuel consumption in the year y
$PE_{ww,\,treatment,\,y}$	Methane emissions from wastewater treatment systems not equipped with biogas recovery in year y
$PE_{s,\,treatment,\,y}$	Emissions from sludge treatment systems not equipped with biogas recovery in year y
$PE_{ww,\,discharge,\,y}$	Emissions from degradable organic carbon in treated wastewater in year y
$PE_{s,\,final,\,y}$	Emissions from anaerobic decay of the final sludge produced in the year y
$PE_{fugitive,\,y}$	Emissions from biogas release in capture systems in year y
$PE_{biomass,\,y}$	Emissions from biomass stored under anaerobic condition
$PE_{flaring,\,y}$	Emissions from incomplete flaring in year y

$PE_{y,\,power}$: All the equipments that are involved in operation of biogas generation and consumption are to be included in estimation of power consumption.

$PE_{ww,\,treatment,\,y}$: This accounts for project emissions in wastewater not equipped with biogas recovery system and are calculated as follows:

$$\mathbf{PE_{ww,\,treatment,\,y} = \sum Q_{ww,j,y} * COD_{removed,\,PJ,\,i,\,y} * MCF_{ww,\,treatment,\,PJ,\,j} * UF_{PJ} * GWP_{CH4} * B_{o,\,ww}} \quad \textbf{(2)}$$

Where:

$Q_{ww,\,j,\,y}$	Volume of wastewater treated in the year “y” (m3/yr)
GWP_{CH4}	Global Warming Potential for methane (value of 21 is used)
$B_{o,\,ww}$	Methane producing capacity of the wastewater (IPCC default value of 0.21 kg CH4/kg COD)[4]
$COD_{removed,\,PJ,\,y}$	Chemical oxygen demand removed by project wastewater treatment system in the year “y” (tonnes/m3). It will be estimated as the difference between the inlet and outlet of the lagoon system
$MCF_{ww,\,treatment,\,PJ,\,j}$	Methane correction factor for project wastewater treatment system without biogas recovery.
UF_{PJ}	Model correction for uncertainties (1.06)

[4] As per AMS.III.H, the IPCC default value of 0.25 kg CH4/kg COD was corrected to take into account the uncertainties.

$PE_{fugitive, y}$: These emissions account for methane release in capture system.

$$PE_{fugitive, y} = PE_{fugitive, ww, y} + PE_{fugitive, s, y} \quad (3)$$

Where;

$PE_{fugitive, ww, y}$	Fugitive emissions through capture inefficiencies in the anaerobic wastewater treatment systems equipped with biogas recovery in year "y" (tCO2e);
$PE_{fugitive, s,y}$	Fugitive emissions through capture inefficiencies in the anaerobic sludge treatment in the year "y" (tCO2e)

$$PE_{fugitive, ww,y} = (1 - CFE_{ww}) * MEP_{ww, treatment,y} * GWP_{CH4} \quad (4)$$

Where:

CFE_{ww}	Capture efficiency of the biogas recovery equipment in the wastewater treatment (a default value of 0.9 shall be used, given no other appropriate value)
$MEP_{ww, treatment,y}$	Methane emission potential of wastewater treatment system equipped with biogas recovery in the year "y" (tonnes)

$$MEP_{ww, treatment,y} = Q_{y, ww} * B_{o, ww} * UF_{PJ} \sum COD_{y, removed, j} * MCF_{ww, treatment,pj,k} \quad (5)$$

Where;

$COD_{y, removed, j}$	The chemical oxygen demand removed by the treatment system "j" of the project activity equipped with methane recovery in the year "y" (tonnes/m^3)
$MCF_{ww, treatment, j}$	Methane correction factor for the wastewater treatment system "j" equipped with methane recovery
$B_{o, ww}$	Methane producing capacity of the wastewater (IPCC default value for domestic wastewater of 0.21 kg CH4/kg COD)
UF_{PJ}	Model correction factor to account for model uncertainties (1.06)

For this project we shall consider the CSTR and the UASB digester. $COD_{y, removed,}$ will be estimated as the difference of the COD values between the inlet and outlet of the system.

$$PE_{fugitive, s,y} = (1 - CFE_{s}) * MEP_{s, treatment, y} * GWP_{CH4} \quad (6)$$

Where;

CFE_{s}	Capture efficiency of the methane recovery in the sludge treatment (a default value of 0.9 shall be used, given no other appropriate value)
$MEP_{s, treatment, y}$	Methane emission potential of sludge treatment plant in the year "y" (tonnes)

$$MEP_{s, treatment, y} = S_{I,PJ,y} * DOC_{s} * MCF_{s, treatment, PJI} * DOC_{F} * F * 16/12 * UF_{pj} \quad (7)$$

Where;

$S_{I, PJ, y}$	Amount of untreated sludge generated in the year y (tonnes)
DOC_{F}	Degradable organic content of the final sludge generated by the wastewater treatment in the year "y" (fraction). IPCC default value of 0.09 for industrial sludge (wet basis, assuming dry matter content of 35 percent) will be used
$MCF_{s, treatment, PJI}$	Methane correction factor for the sludge treatment system that will be equipped

	with methane recovery and combustion/utilization/flare equipment (MCF Higher value of 1.0 as per table III.H.1)
UF_{pj}	Model correction for factor to account for model uncertainties (1.06)

However, no untreated sludge shall be generated from the project activity. Nevertheless this is a part of monitoring methodology and shall be monitored for any sludge generated during the year and be used for conservative estimation of project emissions.

$PE_{flaring,\ y}$: Methane emission due to incomplete flaring in year y as per "Tool to determine project emission s from flaring gases containing methane" (tCO_2e).

The calculation steps for project emissions are as follows:

STEP 1. Determination of the mass flow rate of the residual gas that is flared
This step calculates the residual gas mass flow rate in each hour h, based on the volumetric flow rate and the density of the residual gas. The density of the residual gas is determined based on the volumetric fraction of all components in the gas.

STEP 2 though STEP 4 are not applicable for this project.

STEP 5: Determination of methane mass flow rate in the residual gas on a dry basis
The quantity of methane in the residual gas flowing into the flare is the product of the volumetric flow rate of the residual gas ($FV_{RG,h}$), the volumetric fraction of methane in the residual gas ($fv_{CH4,RG,h}$) and the density of methane ($\rho_{CH\ 4,n,h}$) in the same reference conditions (normal conditions and dry or wet basis). Considering that the gas is cooler than 60 degrees Celsius, the reported density is expressed on dry basis already.

$$TM_{RG,h} = FV_{RG,\ h} * fv_{CH4,\ RG,\ h} * \rho_{CH4,\ n,\ h} \qquad (8)$$

Where:

$FV_{RG,\ h}$	Volumetric flow rate of the residual gas in dry basis at normal conditions in hour h (Nm^3/h)
$fv_{CH4,\ RG,\ h}$	Volumetric fraction of methane in the residual gas on dry basis in hour h
$\rho_{CH4,\ n,\ h}$	Density of methane at normal condition (kg/m)

STEP 6: Determination of the hourly flare efficiency
The determination of the hourly flare efficiency depends on the operation of the flare (e.g. temperature), the type of flare used (open or enclosed) and, in case of enclosed flares, the approach selected by project participants to determine the flare efficiency (default value or continuous monitoring).
In case of open flares and use of the default value for the flare efficiency, the flare efficiency in the hour h ($\eta_{flare,\ h}$) is 50%, if the flare is detected for more than 20 minutes during the hour h

As the temperature will be 850°C for more than 40 minutes during the hour h, the 50% default was selected.

STEP 7: Calculation of annual project emissions from flaring
Project emissions from flaring are calculated as the sum of emissions from each hour h, based on the methane flow rate in the residual gas ($TM_{RG,h}$) and the flare efficiency during each hour h ($\eta_{flare,h}$), as follows:

$$PE_{flare,y} = \Sigma TM_{RG,h} * (1- \eta_{flare,h}) * GWP_{CH4}/1000 \quad (9)$$

Where:

$TM_{RG,h}$	Mass flow rate of methane in the residual gas in hour h
$\eta_{flare,h}$	Flare efficiency in hour h
GWP_{CH4}	Global Warming Potential of methane valid for the commitment period

Considering that some parameters are not measured on an hourly basis, the figures in these equations are based on hourly averages using annual reported data and using the simplifications and default values provided by the flaring tool.

The project activity will use the flare system only in case of emergency. Therefore, for ex-ante calculations, this term will be neglected.

AMS I-D

The project emissions due to the electricity consumed by the project activity are calculated as follows (AMS I-D):

$$PE_{power} = EC_y * EF_y \quad (10)$$

Where:

EC_y	Electricity consumed by the project activity during year y
EF_y	Grid emission factor of Thailand.

Leakage emissions

The used technology is not equipment transferred from another activity and the existing equipment is not transferred to another activity, therefore according to the AMS.III.H, there is no leakage to be considered.

Baseline emissions

Baseline emissions are the sum of emissions from the degradable organic matter in the treated wastewater (calculated according to AMS.III.H version 10) and from the displacement of grid electricity (calculated according to AMS.I.D version 13).

AMS.III.H

$$BE_y = BE_{power,y} + BE_{ww,treatment,y} + BE_{s,treatment,y} + BE_{ww,discharge,y} + BE_{s,final,y} \quad (11)$$

Where:

BE_y	Baseline emissions in the year y (tCO_2e).
$BE_{power,y}$	Baseline emissions from electricity or fuel consumption in year y (tCO_2e).
$BE_{ww,treatment,y}$	Baseline emissions of the wastewater treatment systems affected by the project activity in year y (tCO_2e).
$BE_{s,treatment,y}$	Baseline emissions of the sludge treatment systems affected by the project activity in year y (tCO_2e).
$BE_{ww,discharge,y}$	Baseline methane emissions from degradable organic carbon in treated wastewater discharge into sea/river/lake in year y (tCO_2e). The value of this term is zero for the

case 1 (ii).

$BE_{s, final, y}$ Baseline methane emissions from anaerobic decay of the final sludge produced in year y (tCO_2e). If the sludge is controlled combusted, disposed in a landfill with biogas recovery, or used for soil application in the baseline scenario, this term shall be neglected.

Methane emissions from the baseline wastewater treatment systems affected by the project ($BE_{ww,treatment,y}$) are determined using the methane generation potential of the wastewater treatment systems:

$$\mathbf{BE_{ww, treatment, y} = \sum Q_{ww, j, y} * COD_{removed, i, y} * MCF_{ww, treatment, BL, j} * UF_{BL} * GWP_{CH4} * B_{o, ww}} \quad \mathbf{(12)}$$

Where:

$Q_{ww, i, y}$	Volume of wastewater treated in baseline wastewater treatment system i in year y (m^3).
$COD_{removed, i, y}$	Chemical oxygen demand removed by baseline treatment system i in year y (tonnes/m3).
$MCF_{ww, treatment, BL, i}$	Methane correction factor for baseline wastewater treatment system i (MCF value as per table III.H.l).
i	Index for baseline wastewater treatment system.
$B_{o, ww}$	Methane producing capacity of the wastewater (IPCC lower value for domestic wastewater of 0.21 kg CH_4/kg COD)[5]
UF_{BL}	Model correction factor to account for model uncertainties (0.94)[6]
GWP_{CH4}	Global Warming Potential for methane (value of 21).

In the proposed project activity, there is no sludge treatment and the treated wastewater is not discharged into sea/lake/river. Therefore:

$BE_{s, treatment,y} = 0$

$BE_{ww, discharge, y} = 0$

$BE_{s, final, y} = 0$

Baseline emissions from electricity consumption ($BE_{power,y}$) are determined as per the procedures described in AMS-I.D.

AMS-I.D

For the electricity displaced by the project activity, the baseline emissions are calculated as follows:

$$\mathbf{BE_y = EG_y * EF_y} \quad \mathbf{(13)}$$

BE_y	the baseline emissions from electricity displaced by the project activity during the year y in tCO_2e.
EG_y	the net quantity of electricity generated by the project activity during the year y in TJ.
EF_y	Grid emission factor of Thailand, calculated with the tool to calculate the emission factor of an electricity system, in TCO_2/MWh

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[5] The IPCC default value of 0.25 kg CH_4/kg COD was corrected to take into account the uncertainties. For domestic waste water, a COD based value of $B_{o,ww}$ can be converted to BOD_5 based value by dividing it by 2.4 i.e. a default value of 0.504 kg CH_4/kg COD can be used.

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

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

All data and parameters used for the emission reductions calculations but not monitored during the crediting period are provided in the following tables.

Data / Parameter :	GWP_{CH4}
Data unit	
Description	Global warning potential
Source of data used	Intergovernmental Panel on Climate Change, Climate Change 1995: The Science of Climate Change (Cambridge, UK: Cambridge University Press, 1996)
Value applied	GWP_{CH4} 21
Justification of the choice of data or description of measurements methods and procedures actually applied	IPCC default value
Any comments :	

Data / Parameter :	$B_{o,ww}$
Data unit	kg CH_4/kg COD
Description	IPCC default value, corrected as per methodology AMS III-H page – 4, is used for estimation
Source of data used	IPCC default value
Value applied	0.21
Justification of the choice of data or description of measurements methods and procedures actually applied	IPCC default value
Any comments :	As per AMS.III.H Version 10, the IPCC default value of 0.25 kg CH4/kg COD was corrected to take into account the uncertainties.

Data / Parameter:	UF_{BL}
Data unit:	-
Description:	Model correction factor to account of model uncertainties
Source of data used:	AMS.III.H
Value applied:	0.94
Justification of the choice of data or description of measurement methods and procedures actually applied :	Value for the baseline emissions calculation.
Any comment:	The original source of data is: FCCC/SBSTA/2003/Add.2,

	page 25

Data / Parameter:	UF_{PJ}
Data unit:	-
Description:	Model correction factor to account of model uncertainties
Source of data used:	AMS.III.H
Value applied:	1.06
Justification of the choice of data or description of measurement methods and procedures actually applied :	Value for the project emissions calculation.
Any comment:	The original source of data is: FCCC/SBSTA/2003/Add.2, page 25

Data / Parameter:	$MCF_{ww, treatment, BL, i}$
Data unit:	Fraction
Description:	Methane correction factor for the baseline anaerobic wastewater treatment systems
Source of data used:	Table III.H.1 from AMS-III.H, Version 10 methodology
Value applied:	$MCF_{ww, treatment, BL, i} = 0.8$
Justification of the choice of data or description of measurement methods and procedures actually applied :	All MCF values have been chosen in a conservative manner according to table III.H.1 from methodology AMS-III.H, Version 10. The baseline wastewater treatment system consists in a succession of deep lagoons, with depth more than 2 metres, so the value of 0.8 has been chosen.
Any comment:	The original source of data can be checked for IPCC default value, Volume 5 Chapter 6, page 6.21. The lower value is used for conservative estimation of baseline emissions

Data / Parameter:	$MCF_{ww, treatment, PJ, i}$
Data unit:	Fraction
Description:	Methane correction factor for project wastewater treatment system not equipped with biogas recovery
Source of data used:	Table III.H.1 from AMS-III.H, Version 10 methodology
Value applied:	$MCF_{ww, treatment, PJ, i} = 0.8$
Justification of the choice of data or description of measurement methods and procedures actually applied :	All MCF values have been chosen in a conservative manner according to table III.H.1 from methodology AMS-III.H, Version 10. The project wastewater treatment system without biogas recovery (secondary treatment) consists in a succession of deep lagoons, with depth more than 2 metres, so the value of 0.8 has been chosen.
Any comment:	The original source of data can be checked for IPCC default value, Volume 5 Chapter 6, page 6.21. The lower value is used for conservative estimation of baseline emissions

Data / Parameter:	CFE_{ww}
Data unit:	Fraction
Description:	Capture efficiency of the biogas recovery equipment in the

	wastewater treatment
Source of data used:	IPCC
Value applied:	0.9
Justification of the choice of data or description of measurement methods and procedures actually applied :	In absence of an appropriate value the methodology describes to use an IPCC default value of 0.9
Any comment:	

Data and parameters from the AMS.I.D

Data / Parameter:	EF_y
Data unit:	tCO_2/MWh
Description:	Grid emission factor of Thailand
Source of data used:	"Tool to calculate the emission factor for an electricity system".
Value applied:	0.521
Justification of the choice of data or description of measurement methods and procedures actually applied :	Calculation provided in Annex 3 with the "Tool to calculate the emission factor for an electricity system".
Any comment:	

B.6.3 Ex-ante calculation of emission reductions:

The following section gives details of ex – ante estimation of CERs for the project activity.
The data sheet of calculations shall be provided to the DOE.
The excel datasheet where the ER calculations were estimated has been provided to the DOE. How the equations have been applied is described in section B.6.1. The main calculation parameters and results are provided below:

Project emissions

Methodology: AMS III H (Methane avoidance component)		
Emissions in wastewater treatment system without biogas recovery		
Formula: $PE_{ww,treatment,y} = Q_{y,ww} * \sum(COD_{y,removed} * B_{o,ww} * MCF_{ww,treatment,i} * GWP_{CH4}*UF_{PJ})$		
$Q_{y,ww}$ =	68,750 Nm^3/y	Based on designed value of wastewater treated: 275 m^3/day, operation of 250 days (sourced from technical proposal)
$COD_{y,removed}$ =	98% of inlet value	Test reports available
$COD_{in,treatment}$ =	925 mg/l	Assuming 98.8% of UASB + CSTR efficiency
$B_{o,ww}$ =	0.21kg CH_4/kg COD	Default value
$MCF_{ww,treatment,i}$ =	0.8	Default value for anaerobic deep lagoons
GWP_{CH4} =	21	Default value
UF_{PJ}	1.06	Default value
Calculation:		

$PE_{ww, treatment, y}$ = 68,750 X (71,013 X 0.988 / 1,000,000) X 0.21 X 0.8 X 21 X 1.06 = **235 tCO_2 e**		
Fugitive emissions in wastewater treatment system with biogas recovery		
Formula: $PE_{fugitive, ww, y} = (1 – CFE_{ww}) * MEP_{ww, treatment, y} * GWP_{CH4}$		
CFE_{ww}	0.9	Default value
$MEP_{ww, treatment, y}$	19,095 t	Methane emission potential of wastewater treatment systems equipped with biogas recovery : $MEP_{ww, treatment, y} = Q_{y, ww} * B_{o, ww} * UF_{PJ} * \sum COD_{y, removed} * MCF_{ww, treatment, PJ}$ Where $COD_{y, removed} = COD_{y, in} * \eta_{(UASB + CSTR) v} = COD_{y, in} * 0.98$
Calculation: $PE_{fugitive, ww,y}$ = 19,095 X (1-0.9) = **1,909 tCO_2 e**		
Methane emissions due to incomplete flaring		
Formula: $PE_{flare, y} = \Sigma TM_{RG, h} * (1- \eta_{flare, h}) * GWP_{CH4} / 1000$		
$\eta_{flare,h}$	0.9	Efficiency of the closed flare
$\Sigma TM_{RG, h}$	0t	Based on estimated methane production and on flare percentage (0% of total amount).
Calculation: $PE_{flare, y}$ = 0*(1-0.9)*21= **0 tCO_2e**		
Methodology: AMS I D (Power generation component)		
Formula: $PE_{power} = EC_y * EF_y$		
EC_y	449 MWh	Based on power capacity installed (68kW), and number of operating days (250).
EF_y	0.521 tCO2/MWh	Grid emission factor of Thailand (Annex 3)
Calculation: PE_{power} = 449*0.521= **234 tCO_2e**		

Baseline emissions:

Methodology: AMS III H (Methane avoidance component)		
Formula: $BE_{ww, treatment, y} = Q_{y, ww} * \sum(COD_{y, removed} * B_{o, ww} * MCF_{ww, treatment, i} * GWP_{CH4} * UF_{BL})$		
$Q_{y, ww}$ =	68,750 Nm^3/y	Based on designed value of wastewater treated: 275 m^3/day, operation of 250 days (sourced from technical proposal)
$COD_{y, removed}$ =	98.8% of inlet value	Test reports available
$COD_{in, treatment}$ =	75,193 mg/l	Sample test reports
$B_{o, ww}$ =	0.21kg CH_4/kg COD	Default value
$MCF_{ww, treatment, i}$ =	0.8	Default value for anaerobic deep lagoons
GWP_{CH4} =	21	Default value
UF_{BL}	0.94	Default value

Calculation: $BE_{ww,treatment,y}$ = 68,750 X (75,193 X 0.98 / 1,000,000) X 0.21 X 0.8 X 21 X0.94= **16,933tCO$_2$e**		
Methodology: AMS I D (Power generation component) – only after gas engine installation		
Formula: $BE_y = EG_y * EF_y$		
EG_y =	5,196.8 MWh 125.3 MWh	Based on info available for gas engine and biogas used for generation process. Efficiency of gas engine and NCV of biogas from NCV of natural gas and methane percentage in biogas = $V_{biogas\ elec}$ Nm^3 (= 1,871,034 Nm^3) X 22,034 KJ/ m3 X 0.419/3600/1000
EF_y =	0.521 tCO2/MWh	Grid emission factor – Annex 3
Calculation: BE_y = 5322.1 X 0.521 = **2773 tCO$_2$e**		

Summary

Project emissions

Year	1	2	3	4	5	6	7
Project Emissions	2378	2378	2378	2378	2378	2378	2378
Emissions due to power consumption in treatment process ($PE_{power, y}$)	234	234	234	234	234	234	234
Emissions in anaerobic plant ($PE_{ww, treatment, y}$)	235	235	235	235	235	235	235
Emissions from decay of final sludge ($PE_{S, final, y}$)	0	0	0	0	0	0	0
Fugitive emissions from use of waste water ($PE_{fugitive, ww, y}$)	1909	1909	1909	1909	1909	1909	1909
Fugitive emissions from use of sludge ($PE_{fugitive, s, y}$)	0	0	0	0	0	0	0
Project Emissions due to discharged treated waste water ($PE_{ww, discharge, y}$)	0	0	0	0	0	0	0
Emissions from flaring ($PE_{flaring, y}$)	0	0	0	0	0	0	0
Emissions from Biomass ($PE_{biomass, y}$)	0	0	0	0	0	0	0
Leakage	0	0	0	0	0	0	0

Baseline emissions

Year	1	2	3	4	5	6	7
Baseline Emissions	19706	19706	19706	19706	19706	19706	19706
from WWT system	16933	16933	16933	16933	16933	16933	16933
from sludge treatment system	0	0	0	0	0	0	0

from WW discharge	0	0	0	0	0	0	0
from final sludge	0	0	0	0	0	0	0
from fossil replacement - AMS IC	0	0	0	0	0	0	0
from disp of grid power - AMS ID	2773	2773	2773	2773	2773	2773	2773

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

The expected emission reductions for the first 7 year crediting period are provided below:

year	Emission of project activity emissions (tCO2e)	Estimation of baseline emissions (tCO2e)	Estimation of leakage (tCO2e)	Estimation of overall emission reductions (tCO2e)
1	2,378	19,706	0	17,328
2	2,378	19,706	0	17,328
3	2,378	19,706	0	17,328
4	2,378	19,706	0	17,328
5	2,378	19,706	0	17,328
6	2,378	19,706	0	17,328
7	2,378	19,706	0	17,328
Total (tonnes CO2e)	16,647	137,940	0	121,293

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

B.7.1 Data and parameters monitored:

Following data and parameters will be monitored after the implementation of the project activity. The values provided in this section are the ones used for the ER estimations provided in this PDD.

Data / Parameter:	$Q_{ww,y}$
Data unit:	m^3
Description:	Flow of wastewater treated in the year y
Source of data to be used:	Measured - Volumetric flow meters
Value of data applied for the purpose of calculating expected emission reductions in section B.5	68,750
Description of measurement methods and procedures to be applied:	The volumetric flow meters with an accepted level of accuracy are installed and integrated with SCADA (Supervisory Control And Data Acquisition system) at the plant. Data are registered daily.
QA/QC procedures to be	Periodic calibrations of flow meter are ensured via an external agency.

applied:	This calibration is usually undertaken in off season to ensure data accuracy and sufficiency in operation days.
Any comment:	

Data / Parameter:	$COD_{ww, untreated,y}$
Data unit:	mg/l
Description:	Chemical oxygen demand of the untreated wastewater in the year y
Source of data to be used:	Measured – COD of water entering the waste water treatment facility
Value of data applied for the purpose of calculating expected emission reductions in section B.5	75,193
Description of measurement methods and procedures to be applied:	The COD content will be analyzed using a colorimetric method in the on-site laboratory of the treatment plant. The results will be logged in the plant operation report on a daily basis.
QA/QC procedures to be applied:	The calorimetric method is well documented and well accepted either by national or international standards.
Any comment:	

Data / Parameter:	$COD_{out,UASB ,y}$
Data unit:	mg/l
Description:	COD of water exiting the UASB treatment process.
Source of data to be used:	Measured – Calorimetric analysis.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	925
Description of measurement methods and procedures to be applied:	The COD content will be analyzed using a colorimetric method in the on-site laboratory of the treatment plant. The results will be logged in the plant operation report on a daily basis.
QA/QC procedures to be applied:	The calorimetric method is well documented and well accepted either by national or international standards.
Any comment:	

Data / Parameter:	$COD_{ww,treated,y}$
Data unit:	mg/l
Description:	COD of water after the secondary treatment process, before being reused.
Source of data to be used:	Measured – Calorimetric analysis.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	0 We assumed everything is degraded.
Description of measurement methods and procedures to be applied:	The COD content will be analyzed using a colorimetric method in the on-site laboratory of the treatment plant. The results will be logged in the plant operation report on a daily basis.
QA/QC procedures to be applied:	The calorimetric method is well documented and well accepted either by national or international standards.
Any comment:	

Data / Parameter:	$S_{y, final}$
Data unit:	Tonnes
Description:	Amount of final sludge generated by the wastewater treatment in the year y
Source of data to be used:	Measured – all the sludge quantity produced during a monitoring period is measured before final disposal / treatment
Value of data applied for the purpose of calculating expected emission reductions in section B.5	0
Description of measurement methods and procedures to be applied:	The project proponent doesn't envisage the generation of any sludge, which would be required to treat an-aerobically.
QA/QC procedures to be applied:	The measurement equipment shall be calibrated on regular basis.
Any comment:	

Data / Parameter:	$COD_{y, removed, j}$ (here j represents UASB and CSTR treatments)
Data unit:	mg/l
Description:	COD removed by waste water treatment facility equipped with biogas recovery
Source of data to be used:	Measured – Using the above two measurements
Value of data applied for the purpose of calculating expected emission reductions in section B.5	69,592
Description of measurement methods and procedures to be applied:	The difference between $COD_{y, ww,untreated}$ & $COD_{y, out, UASB}$ gives the amount of COD removed by the UASB - CSTR process.
QA/QC procedures to be applied:	The quality assurance of COD measurement at inlet and outlet point assures the Quality of this parameter.
Any comment:	

Data / Parameter:	$COD_{y, removed, j}$ (here j represents open lagoons)
Data unit:	mg/l
Description:	COD removed by waste water treatment facility
Source of data to be used:	Measured
Value of data applied for the purpose of calculating expected emission reductions in section B.5	925
Description of measurement methods and procedures to be applied:	The difference between $COD_{out,UASB,y}$ & $COD_{ww,treated,y}$ gives the amount of COD removed by the lagoons.
QA/QC procedures to be applied:	The quality assurance of COD measurement at inlet and outlet point assures the Quality of this parameter.
Any comment:	

Data / Parameter:	Q_{biogas}
Data unit:	Nm^3
Description:	Quantity of biogas generated by the anaerobic treatment process.
Source of data to be used:	Measured – Gas flow meter
Value of data applied for the purpose of calculating expected emission reductions in section B.5	2,026,451 Based on assumption that biogas contains about 60% of methane.
Description of measurement methods and procedures to be applied:	The gas flow meters with an accepted level of accuracy are installed and integrated with SCADA (Supervisory Control And Data Acquisition system) at the plant.
QA/QC procedures to be applied:	The gas flow meter is calibrated on regular basis from a certified testing agency or institution.
Any comment:	

Data / Parameter:	$Q_{biogas, flare, y}$
Data unit:	Nm^3
Description:	Total quantity of biogas flare
Source of data to be used:	Measured **-** Gas Flow meter provided at the inlet of flare system.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	0 after the installation of the gas engine
Description of measurement methods and procedures to be applied:	Gas flow meter
QA/QC procedures to be applied:	
Any comment:	

Data / Parameter:	$EG_{y, gas engine}$
Data unit:	MWh
Description:	Electricity generated from the biogas collected In the anaerobic treatment facility and sent to the grid
Source of data to be used:	Measured
Value of data applied for the purpose of calculating expected emission reductions in section B.5	5196.8 after the operation of the gas engine Based on same assumptions as the total biogas production parameter, and 0%, used for power generation.
Description of measurement methods and procedures to be applied:	Meter readings, continuous measurement using calibrated meter.
QA/QC procedures to be applied:	Electricity meters will undergo maintenance / calibration subject to appropriate industry standards.
Any comment:	

Data / Parameter:	$Q_{biogas, gas engine, y}$

Data unit:	Nm^3
Description:	Amount of biogas used for power generation in gas engine
Source of data to be used:	Measured **-** Flow meters provided at the inlet of gas engine to monitor the biogas supplied to gas engine
Value of data applied for the purpose of calculating expected emission reductions in section B.5	2,026,451 Based on same assumptions as the total biogas production parameter, and 100% used for power generation.
Description of measurement methods and procedures to be applied:	The flow meters are integrated with Supervisory Control And Data Acquisition system (SCADA).
QA/QC procedures to be applied:	Periodic pressure loss tests shall ensure that there is no biogas leakage between the reactor outlet and both points of biogas flow measurements.
Any comment:	

Data / Parameter:	%CH4
Data unit:	%
Description:	Methane content in biogas
Source of data to be used:	Measured – Online system to monitor % of methane in biogas.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	60%
Description of measurement methods and procedures to be applied:	
QA/QC procedures to be applied:	
Any comment:	

Parameter:	T_{flame}
Unit:	°C
Description:	Flame temperature of the flare
Source of data:	Supervisory Control And Data Acquisition system (SCADA)
Value of data:	>500°C
Brief description of measurement methods and procedures to be applied:	The flame temperature will be continuously measured. Data will be recorded and stored electronically on a continuous basis.
QA/QC procedures to be applied (if any):	The temperature meter shall be subject to periodic calibration according to the equipment's specifications and applicable industrial standards.
Any comment:	If there is no record of the temperature of the exhaust gas of the flare or if the recorded temperature is less than 500 °C for any particular hour, it shall be assumed that during that hour the flare efficiency is zero.

ADDITIONAL REQUIREMENTS FOR THE GOLD STANDARD:

Data to be collected in order to monitor the project's performance on the sustainable development indicators:

The actual project performance must be assessed against the projected outcomes of the sustainable development assessment as defined in Section 3.4 of the Gold Standard Project Developer's Manual, on an annual basis.

Please refer to Annex 5 for Gold Standard information.

B.7.2 Description of the monitoring plan:

1. Monitoring Management

The required monitoring equipment is installed by the plant operator. Flow meters are regularly calibrated to recognize procedures by the operator (who is also the turn-key supplier of technology) and sampling is carried out by the onsite Biogas Lab Manager according to appropriate industrial standards.
Data acquisition for the gas and wastewater flow meters is executed through the process control unit of the biogas plant and the plant operations software. Lab data is fed into the operations software through a manual data entry user interface. The plant is operated by two trained operators who also collect data under the supervision of the Assistant Plant Manager who is in charge of filing and processing data.

2. Quality Assurance and Quality Control

The Plant Manager monitors overall performance of the plant, ensures proper and timely calibration, data acquisition and storage.

3. On-site Procedures

The operations software creates daily logs of plant performance which are printed out and recorded electronically for periodic download onsite or remote transfer for further processing.
Procedures for Calibration of Equipment
The plant operator carries out calibration according to international standards.

4. Data Storage and Filing – Electric Workbook

All relevant data is stored electronically with the process control computer unit, external storage media and transferred. A daily log is printed.

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

Completion date: 31/10/2008

by
Patrick Bürgi
South Pole Carbon Asset Management Ltd.
Technoparkstrasse 1
CH-8005 Zurich

Switzerland

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:

01/04/2008

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

15 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:

01/07/2009 (CDM registration date)

C.2.1.2. Length of the first crediting period:

7 years

C.2.2. Fixed crediting period:

C.2.2.1. Starting date:

Not applicable.

C.2.2.2. Length:

Not applicable.

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 activity basically involves the replacement of the existing open lagoons for palm oil mill effluent (POME) treatment by the installation of closed tank anaerobic digesters. The biogas produced will be captured and utilized for electricity generation using gas engines. The project activity will contribute to the following environmental improvements:

- Reducing the emissions of methane, a potent greenhouse gas.

- Avoiding the odour in the emissions of biogas from the open lagoons.
- Land area required will be smaller. Some of the open lagoons can be reclaimed.
- The project contributes to renewable energy development in Thailand. The biogas-generated electricity will displace electricity from the use of fossil fuel generator.

The proposed project is not required to undertake an Environmental Impact Assessment according to Thailand regulations (http://www.onep.go.th/eia/).

However, under the rules of the Thai DNA an initial environmental evaluation (IEE) has to be conducted and is to be submitted together with the PDD for approval. Based on project particulars and existing environmental conditions, potential impacts have been indentified that are likely to result from the proposed project activity, and where possible, these have been quantified. The positive and negative impacts are listed below:

Positive Environmental Impacts

- Wastewater is treated in a more efficient and robust way.
- Water resources are unlikely to be contaminated due to the proposed wastewater treatment structures and foundation.
- The project reduces GHG emissions that would otherwise be released into the atmosphere, and reduces undesirable odors by collecting and combusting biogas.
- Incomes are generated to the local community through additional local employment.
- Usage of non-renewable energy is reduced.

Negative Environmental Impacts

- Noise: the main source of noise from the operation is the engine noise, 55 dB(A) which much below than the standard. However, due to the project being located far away from the community and the installed of exhausted gas silencer in the gas engine, the noise level at the closest community will be below the standard of the Department of Industrial Works (DIW).
- Accidental Hazards: in view of the potential hazards involved due to system failure or accident, on- and off-site emergency measures have been formulated and will be implemented.

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:

The proposed project is not required to undertake an Environmental Impact Assessment according to the Thailand regulations (http://www.onep.go.th/eia/). No relevant negative environmental effects are expected from the implementation of the project. According to the initial environmental evaluation (IEE) described above, no significant environmental impacts are expected as a consequence of the project activity.

ADDITIONAL REQUIREMENTS FOR THE GOLD STANDARD:
EIA Requirements

The Gold Standard prescribes an elaborate process in order to determine whether an Environmental Impact Assessment (EIA) needs to be undertaken.

Please refer to Annex 5 for Gold Standard information.

SECTION E. Stakeholders' comments

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

ADDITIONAL REQUIREMENTS FOR THE GOLD STANDARD:
Public Consultation Process

In addition to the CDM stakeholder consultation requirements, the Gold Standard Public Consultation Process requires at least two public consultations and gives additional minimum requirements for the consultation process.
Please refer to Annex 5 for Gold Standard information.

Procedure followed to invite stakeholder comments

A. Public hearing for local stakeholders:

Invitation procedure
The Gold Standard Initial Stakeholder Consultation has been conducted by the project owner Nantana Panapitakkul with assistance from South Pole Carbon Asset Management Limited (Switzerland based company responsible for CDM project development) and PAPOP (Thailand engineering company responsible for implementation of the wastewater treatment plant).

Stakeholder groups as defined in the Gold Standard procedures have been identified and informed through oral and written means about the meetings. The invitation letter was sent by fax to participants located a long distance from the project, by regular mail to participants without access to a fax and there was an announcement of this meeting published in the local newspaper in Trang province. This invitation process was done within 2 weeks before the meeting date. The local newspaper and the invitation letters were collected for evidence (see annex I).

Place and date of the meetings
The initial stakeholder consultation was held at a meeting room of the local government office of the Sikao District, which is located in Trang province, on 4th of August 2008. As this meeting room is close to the project site, all participants were able to examine the location where the proposed project will take place.

Meeting Participants
The meeting was attended by local residents who lived nearby the project around 3-5 kilometers and representatives from the following stakeholder categories:

1. Local residents
2. Local government representatives
3. Delegates from political parties
4. Local entrepreneurs
5. Employees

There were total 43 people who accepted the invitation, but only 35 participants who attended the meeting. However, the participants comprised of the government people and local residents who can directly impacted from the project activity.

Language
Documentation and meeting was held in Thai (local language).

Meetings procedure

- Opening the meeting ceremony by Sa-nguan Unteng (Member of Trang Province Administration Organization) (10 min)
- Purpose of the consultation by Nantana Panapitakkul (Director of company) (15 min)
- Description of the project and environmental impacts by PAPOP company (30 min)
- Questions and Answers session (10 min)
- Description of Clean Development Mechanism (CDM) session (30 min)
- Completing checklists (Appendix E to the Gold Standard Project Developer's Manual) (30 min)
- General feedback (15 min)
- Closing the meeting ceremony (10 min)
- Dinner (40 min)

Meeting documents and protocols
Prior to the meeting, registration was held in order to clarify who attended this consultation meeting. During the meeting, documentation was delivered to participants in order to explain the description of the project, the environmental impact of the project and the checklist form by Gold Standard. On completion of the meetings, the following documentation was collected and attested by the signatures of the stakeholders that were present:

1. Presence list with name, address and occupation
2. Non-technical description of the project
3. Documentation on environmental impacts of the project
4. Filled out Appendix E of Gold Standard (checklist)

These documents were available as hardcopies and will be handed over to the Designated Operational Entity (DOE) conducting the Gold Standard validation process. The example of scanned document was indicated in the Annex I.

B. Email consultation for Gold Standard supporting organizations in Thailand:

Invitation procedure
An invitation was sent to representatives of Gold Standard supporting organizations in Thailand on July 24th 2008. At the time of the meeting, the only Gold Standard supporting NGO in Thailand was the local branch of Greenpeace. The invitation included a short introduction of the project and the date and location of the scheduled initial stakeholder consultation. No reply was received.

Period of email consultation
24 July 2008 to 4 August 2008.

E.2.	**Summary of the comments received:**

A. Public hearing for local stakeholders:

The overall response to the Wastewater Treatment and Biogas Utilization Project from participating local stakeholders was encouraging and positive. The greatest asset achieved by the project appears to be the environmental friendly aspect of the project. Stakeholders recognized that the project activity has zero discharge to the river or other natural sources such as soils and groundwater. The treated water which contains plant nutrients such as Nitrogen, Phosphorus and Potassium will be stored in the holding ponds, the last pond in the wastewater treatment series. The project participant aims to use the final treated water for irrigation on the company's oil palm plantations. The benefits are the water saving and fertilizer saving.

Two concerns arose from stakeholder comments on groundwater consumption and wastewater leakage by the project activity. Since the project owner had their water storage from precipitation for their utilization in manufacturing process, the problem of groundwater shortage should not happen to the local community. Also as a special lining (HDPE lining) will prevent the groundwater from wastewater contamination. Thus, it is unlikely that wastewater leakage should happen.

Another benefit is that odour was eliminated by the new closed wastewater treatment. Consequently, the local people health was put less at risk through the reduction of the odour from the open lagoon wastewater treatment system.

This project is believed to be sustainable since it will decrease environmental problems by replacing the old style technology with higher quality equipment, and increasing the quality of life of local people by increasing employment and providing financial supports and donations in local events such as temple fair, sport competition for the local community. To sum up the sustainability of the project, the various benefits (as reported by local stakeholders) are listed below.

1. The installed technology contributes to clean soil and water and reduced air pollution (methane and hydrogen sulfide which are the potential Greenhouse gaseous).
2. The use of biogas represents a sustainable method of generating energy.
3. The project leads to a reduction in the dependency on oil while at the same it enhances energy security by increasing diversity of fuel supply
4. As the system operates within strict environmental standards there will be no negative impacts to the environment due to the plant.
5. The project is well designed, returning clean water to the environment and not producing additional pollution.
6. The plant will create new jobs at the plant. It increases the total income of local communities from employing the local labours for construction and civil work.

Nine persons did not express any comments or reactions. No negative comments or reactions to the project have been received during the public hearing.

Five participants left general comments related to the project:

1. The Mayor of Tumbol Kuankul asked for common quality control procedures to make sure that there are less environmental impacts for the long term during the commissioning period.
   Comment by the project owner: "To operate the plant in the most effective way, quality control is a major part of the process and trained people are required in order to reduce human failure. Moreover the standard inspection by qualified validators is done during the commissioning stage for safety standards."

2. Village headman of Tumbol Kalasae asked the capacity of the wastewater treatment system in case of an increased amount of wastewater from higher operations in the future.
   Answer by the project developer: "This wastewater treatment is designed to support a high amount of wastewater. Otherwise, in case of an emergency situation, the existing open lagoon is used for wastewater storage prior to other treatment processes."
3. The Local resident of Tambol Kalasae[1st] asked about the species of microorganisms (bacteria) which will be used in the UASB system. Should these microorganisms come from the native species in the area, not from outside?
   Comment by the project owner: "Absolutely, the microorganisms are selected from the native site in order to survive and work effectively since they have already adapted in the real environment."

4. The Local resident of Tambol Kalasae[2nd] asked for the amount of electricity generation by the biogas plant.
   Answer by the project developer: "The capacity of the biogas plant depends on the quantity and quality of the wastewater which is the raw material for biogas. The generated electricity is sold to the Provincial Electricity Authority and used on-site."

5. The Secretary of Kalasae Subdistrict Administration Organization commented about the treated wastewater: Is the treated wastewater discharged or does it have another optimal use?
   Answer by the project developer: "Because of the high nutrition content of treated wastewater, this water is used for nourishing the palm trees which are the buffer zone within the plant area."

The Gold Standard questionnaire (Appendix E to the Gold Standard Manual for CDM Project Developers) has been presented in the local language (Thai). It consisted of 23 questions that were to be answered.
From the result of the questionnaire, there were no "yes" answers to these questions. This means that everyone approved of this project, which will lead to sustainable development for the local residents and the environment.

B. Email consultation for Gold Standard supporting organizations in Thailand:

Regarding to this consultation meeting, the consultation document was sent two weeks prior to meeting to many Gold Standard supporting organizations in Thailand such as the Appropriate Technology Association (ATA), Dhammanart Foundation and Renewable Energy Institute of Thailand (REIT). No comments were received.

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

No major environmental or social concerns, which were already studied and addressed in the Initial Environment Evaluation (IEE), were stated during the initial stakeholder consultation process. The IEE was studied in order to understand all of the possible impacts (i.e. environmental and social impacts) from the project and to set the plan for the project. There was some feedback from participants about the impacts, as already stated in section A, the project owner and project developer answered all the questions and comments. Participants reported that there were only positive impacts from this project for both environmental and social aspects. For environmental aspects, there will be a higher quality of wastewater treatment, a high standard of technology for pollution control (i.e. noise pollution, odour pollution and air pollution) during the project construction and the commissioning. For social aspects, there will be no changes in local tradition from the project and there will be more employment opportunities with the local people considered first. According to the IEE study, which will be approved by the Thailand Greenhouse Gas Management Organization, it was neither necessary to make any changes to the Project design nor to incorporate any additional measures to limit or avoid negative environmental impacts. The same applies to socio-economic concerns, which have not been stated at all.

It is evident from the stakeholder consultation process that the project is perceived as a positive example in Thailand and that it contributes to sustainable development in the region.

Annex 1

CONTACT INFORMATION ON PARTICIPANTS IN THE PROJECT ACTIVITY

Organization:	Pitak Palm Oil Company Limited
Street/P.O.Box:	99 Moo3
Building:	
City:	Trang
State/Region:	
Postfix/ZIP:	92150
Country:	Thailand
Telephone:	+66 075 267278-9
FAX:	+66 075 267277
E-Mail:	pitakpalm@yahoo.com
URL:	
Represented by:	
Title:	Managing Director
Salutation:	Mrs.
Last Name:	Panapitakkul
Middle Name:	
First Name:	Nantana
Department:	
Mobile:	
Direct FAX:	
Direct tel:	
Personal E-Mail:	pitakpalm@yahoo.com

Organization:	South Pole Carbon Asset Management Ltd.
Street/P.O.Box:	Technoparkstrasse 1
Building:	
City:	Zurich
State/Region:	
Postfix/ZIP:	8005
Country:	Switzerland
Telephone:	
FAX:	
E-Mail:	p.buergi@southpolecarbon.com
URL:	
Represented by:	
Title:	Managing Partner
Salutation:	Mr.
Last Name:	Bürgi
Middle Name:	
First Name:	Patrick
Department:	-
Mobile:	
Direct FAX:	

Direct tel:	+ 41 44 633 78 70
Personal E-Mail:	

Annex 2

INFORMATION REGARDING PUBLIC FUNDING

No public funding is involved in the project

Annex 3

BASELINE INFORMATION

Detail of calculation for grid emission factor

According to the methodology selected, AMS-I.D v.13 Grid connected renewable electricity generation, the baseline case regarding the electricity displacement will be the GHG emitted by the Electricity grid of Thailand to generate the electricity. The method of option (A) of item 9 of AMS-I.D v.13, the combined margin (in kg CO_2e/kWh) of the weighted average of the operating margin (OM) and build margin (BM) according to the procedures prescribed in the 'Tool to calculate the emission factor for an electricity system', is chosen for this purpose and its value was calculated by the following steps:

Identifying the relevant electric power system

As mention in section A.2.1, the electricity generated by the project activity will be sold to the Provincial Electric Authority (PEA) under "the Very Small Power Producer scheme" of Thailand. Hence, the project activity can be classified as a 'project electricity system', and a 'connected electricity system' is the 'national electricity system', where the Thai DNA does not provide information on an emission of national electricity system.

Selecting an operating margin (OM) method

For the Operating Margin, 'Tool to calculate the emission factor for an electricity system' allows to choose four different methods:
(a) Simple OM,
(b) Simple Adjusted OM,
(c) Dispatch Data Analysis OM,
or (d) Average OM.

For this proposed project activity, (a) the Simple OM is applied.

However, according to the 'Tool to calculate the emission factor for an electricity system', the simple OM method can only be sued in case that the Low Cost Must Run resources constitute less than 50% of the total grid generation in average of the 5 most recent years. The following table illustrates that the LCMR resources has been counted for the 5 years average at 5.6 % of the grid.

Table: National grid generation by energy sources and Low-cost/must run constitution

National Grid Generation By Energy Sources
Unit : GWh

Year	Hydro	Fuel Oil	Diesel Oil	Coal & Lignite	Natural Gas	Others (a)	SPP, VSPP (b)	VSPP (c)	Total	Net import	Grand Total
2002	7,471	2,616	168	16,652	69,538	2	12,566	-	109,013	2,539	111,552
2003	7,299	2,941	180	16,807	76,332	2	13,422	-	116,983	2,183	119,166
2004	6,040	7,138	551	17,993	80,489	2	13,513	1	125,727	3,016	128,743
2005	5,798	8,244	414	18,334	85,703	2	13,700	2	132,197	3,777	135,974
2006	8,125	8,350	143	22,051	86,339	3	13,721	10	138,742	4,409	143,151
Remark	(1)	(1)	(1)	(1)	(1)	(1)	(2)	(2)		(3)	

1. Source: Electric Power in Thailand 2006 Report, DEDE, Table 17 page 21
2. Source: Electric Power in Thailand 2006 Report, DEDE, Table 16 page 20
3. Source: Electric Power in Thailand 2006 Report, DEDE, Table 21 page 25

a. Including geothermal, solar cell and wind turbine, etc.
b. Fuel used in SPP, VSPP (Co-generation): NG., coal, lignite, fuel oil, diesel, renewable & others
c. Fuel used in VSPP: Gas engine: Renewable & biogas

Low-cost/must run resources
Unit : GWh

Year	Hydro	Other (a)	Total LCMR	Total	LCMR constitution
2002	7,471	2	7,473	109,013	6.9%
2003	7,299	2	7,301	116,983	6.2%
2004	6,040	2	6,042	125,727	4.8%
2005	5,798	2	5,800	132,197	4.4%
2006	8,125	3	8,128	138,742	5.9%
Average of LCMR constitution					**5.6%**

Besides, for the simple OM, the simple adjusted OM and the average OM, the emission factor can be calculated using one of the two methods mentioned in the tool. The first method is chosen which is:

- Ex-ante option: A 3-year generation-weighted average, 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 emissions factor during the crediting period.

Calculating the operating margin emission factor according to the selected method

According to the tool on how to calculate (a) Simple OM, option A should be preferred and must be used if fuel consumption data is available for each power plant/unit. Therefore, option A is used, the simple OM emission factor is calculated as follows:

$$EF_{grid,OMsimple,y} = \frac{\sum_{i,m} FC_{i,m,y} \cdot NCV_{i,y} \cdot EF_{CO2,i,y}}{\sum_{m} EG_{m,y}}$$

Where :

$EF_{grid,OMsimple,y}$ = Simple operating margin CO_2 emission factor in year *y* (tCO_2/MWh)

$FC_{i,m,,y}$ = Amount of fossil fuel type *i* consumed by power plant/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)

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

i = All fossil fuel types combusted in power plant / unit *m* in year *y*

y = Either the three most recent years for which data is available at the time of submission of the CDM-PDD to the DOE for validation (ex-ante option) or the applicable year during monitoring (ex-post option), following the guidance on data vintage

For this approach (simple OM) to calculate the operating margin, the subscript *m* refers to the power plants/units delivering electricity to the gird, not including low-cost/must run power plant/units, and including electricity imports to the grid. Electricity imports should be treated as one power plant *m*.

Simple OM data used and calculations

Power sources delivering electricity to the grid, not including LC/MR, including imports

Unit : GWh

Year	Fuel Oil	Diesel Oil	Coal & Lignite	Natural Gas	SPP, VSPP *(b)*	VSPP *(c)*	Net import	Total
2004	7,138	551	17,993	80,489	13,513	1	3,016	122,701
2005	8,244	414	18,334	85,703	13,700	2	3,777	130,174
2006	8,350	143	22,051	86,339	13,721	10	4,409	135,023
Sum (2004 - 2006)								**387,898**

The amount of fuel *i* consumed by the relevant power plant *m*, $FC_{i,m,,y}$

Fuel consumption for electric generation to national grid

Year	Fuel Oil (million litres)	Diesel Oil (million litres)	Coal Lignite (thousand tons)	Natural Gas (MMscf)	SPP, VSPP *(b)*	VSPP *(c)*	Net import
2004	1,697	120	16,537	724,560	-	-	-
2005	1,996	83	16,571	764,118	-	-	-
2006	2,030	41	17,166	857,103	-	-	-
Remark	*(4)*	*(4)*	*(4)*	*(4)*	*(5)*	*(5)*	

4. Source: Electric Power in Thailand 2006 Report, DEDE, Table 19, page 23
(excluding fuel consumption from SPP and VSPP)
5. As the amount of fuel consumption in SPP and VSPP is not available, therefore it is not taken into account. This is conservative.

Fuel consumption for electric generation to national grid (tons)

Year	Fuel Oil (tons)	Diesel Oil (tons)	Coal & Lignite (tons)	Natural Gas (tons)
2004	1,578,210	100,800	16,537,000	14,774,376
2005	1,856,280	69,720	16,571,000	15,580,996
2006	1,887,900	34,440	17,166,000	17,477,037

Remark: density of fuel

Fuel oil	0.93 kg/l	source: DEDE, IEA
Diesel oil	0.84 kg/l	source: DEDE, IEA
NG	0.72 kg/m3	source: PTT PCL, Thailand

NCV and EF_{CO2} of fuel *i*

CO2 emission coefficient of fuel 'i' , COEF i

Parameter	Fuel Oil	Diesel Oil	Coal & Lignite	Natural Gas
NCV i (TJ/Gg)	40.4	43.0	11.9	48.0
EF CO2,i (kg/TJ)	77,400	74,100	101,000	56,100
COEF i (tCO2/ton)	**3.13**	**3.19**	**1.20**	**2.69**

Remark

As no local CO2 emission factor per unit of energy is available, 2006 IPCC default values are used.

The Simple OM, $EF_{grid,OMsimple,y}$

Calculation of (FCi,m,y * NCVi,y * EFco2,i,y)

Year	Fuel Oil (tCO2)	Diesel Oil (tCO2)	Coal & Lignite (tCO2)	Natural Gas (tCO2)	Total (tCO2)
2004	4,935,000	321,179	19,875,820	39,784,438	64,916,437
2005	5,804,513	222,149	19,916,685	41,956,505	67,899,852
2006	5,903,388	109,736	20,631,815	47,062,164	73,707,103
Sum	**16,642,901**	**653,064**	**60,424,321**	**128,803,108**	**206,523,393**

Simple OM emission factor (EF OM,y)

Year	Total (GWh)	Total (tCO2)	EF OM,y (tCO2/MWh)
2004	122,701	64,916,437	0.529
2005	130,174	67,899,852	0.522
2006	135,023	73,707,103	0.546
Sum (2004 - 2006)	387,898	206,523,393	
EF OM,y (2004 - 2006)			**0.532**

From the table, $EF_{grid,OMsimple,y}$ = 0.53 tCO_2/MWh

Identifying the cohort of power units to be included in the build margin

According to the 'Tool to calculate the emission factor for an electricity system', the sample group of power unit m used to calculate the build margin consists of either:

- (a) The set of five power units that have been built most recently, or
- (b) The set of power capacity additions in the electricity system that comprise 20% of the system generation (in MWh) and that have been built most recently.

The following table shows the list of most recently built five power plants which also comprise more than 20% (at 20.2 %) of the system generation (in KWh). Besides, all these five power plants are not registered as CDM project activity and not built more than 10 years ago from the date that the proposed project started to supply electricity to the grid.

Plant name (sample group m)		Commercial Operation Date COD	Plant Capacity (MW)	Generation in 2006 (GWh)
Krabi		Aug 2003	340.0	1,126
Ratchaburi, Cogeneration		April 2002	2,041.0	15,002
EPEC		Mar 2003	350.0	2,385
Glow		Jan 2003	713.0	5,425
BLCP		Aug 2006	673.3	4,024
Total				**27,962**
Total grid generation				138,742
Generation of group m is part of total grid generation				**20.2%**

Calculating the build margin emission factor

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

$$EF_{grid,BM,y} = \frac{\sum_m EG_{m,y} \times EF_{EL,m,y}}{\sum_m EG_{m,y}}$$

Where:
$EF_{grid,BM,y}$ = Build margin CO_2 emission factor in year *y* (tCO_2/MWh)
$EG_{m,y}$ = Net quantity of electricity generated and delivered to the grid by power unit *m* in year *y*
$EF_{EL,m,y}$ = CO_2 emission factor of power unit *m* in year *y* (tCO_2/MWh)
m = Power unit included in the build margin
y = Most recent historical year for which power generation data is available

The CO_2 emission factor of each power plant unit m ($EF_{EL,m,y}$) should be determined as per the simple OM.

Option B2 is used to calculate it, as we have data on electricity generation, fuel types and the efficiency of the power unit:

$$EF_{EL,m,y} = \frac{EF_{CO2,m,i,y} \cdot 3.6}{\eta_{m,y}}$$

Where:
$EF_{EL,m,y}$ =CO2 emission factor of power unit *m* in year *y* (tCO_2/MWh)
$EF_{CO2,,mi,y}$ = Average CO2 emission factor of fossil fuel type *i* in power unit *m* in year *y* (tCO_2/GJ)
$\eta_{m,y}$ = Average net energy conversion efficiency of power unit *m* in year *y* (%)
y =Either the three most recent years for which data is available at the time of submission of the CDM-PDD to the DOE for validation (ex ante option) or the applicable year during monitoring (ex post option), following the guidance on data vintage in step 2

Plant name (sample group m)	Commercial Operation Date COD	Plant Capacity (MW)	Generation in 2006 (GWh)	Type of Fuel	Efficiency (Btu/kWh)	efficiency %	EF EL,m (tCO2/MWh)	Emissions (tCO2)	EF BM,y (tCO2/MWh)
Krabi	Aug 2003	340.0	1,126	Fuel oil	8,918	38%	0.73	819,817	
Ratchaburi, Cogeneration	April 2002	2,041.0	15,002	Natural Gas	7,214	47%	0.43	6,404,103	
EPEC	Mar 2003	350.0	2,385	Natural Gas	7,020	49%	0.42	990,737	
Glow	Jan 2003	713.0	5,425	Natural Gas	6,979	49%	0.41	2,240,402	
BLCP	Aug 2006	673.3	4,024	Coal	8,910	38%	0.95	3,819,682	
Total			**27,962**					**14,274,740**	**0.51**
Total grid generation			138,742						
Generation of group m is part of total grid generation			**20.2%**						

From the table, $EF_{grid,BMsimple,y}$ = **0.51 tCO_2/MWh**

Calculating the combined margin emission factor

The combined margin emissions factor is calculated as fellows:

$$EF_{grid,CM,y} = EF_{gird,OM,Y} * w_{OM} + EF_{grid,BM,Y} * w_{BM}$$

Where:
$EF_{BM,Y}$ = Build margin CO_2 emission factor in year *y* (tCO2/MWh)
$EF_{OM,Y}$ = operation margin CO_2 emission factor in year *y* (tCO2/MWh)
w_{OM} = Weight of operating margin emission factor (%)
w_{BM} = Weight of build margin emission factor (%)

The following default value should be used for w_{OM} and w_{BM}:

- Wind and solar power generation project activities: w_{OM} = 0.75 and w_{BM} = 0.25 (owing to their intermittent and non-dispatchable nature) for the first crediting period and for subsequent crediting periods.
- All other project: w_{OM} = 0.5 and w_{BM} = 0.5 for the first crediting period, and w_{OM} = 0.25 and w_{BM} = 0.75 for the second and third crediting period, unless otherwise specified in the approved methodology which refer to this tool.

For this project activity, which 10 year crediting period non renewable, where the electricity is generated from biomass residues, w_{OM} = 0.5 and w_{BM} = 0.5 is chosen.

The Baseline Emission Factor EFy

Parameter		Emission Factor (tCO2/MWh)	Weights
Simple OM	EF OM,y	0.53	0.50
Bulid Margin	EF BM,y	0.51	0.50
Combined Margin	**EF y**	**0.52**	

Therefore, the baseline emission factor EF_y = 0.52 tCO2/MWh

Annex 4

MONITORING INFORMATION

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Annex 5

GOLD STANDARD INFORMATION

See separate document.

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