CLEAN DEVELOPMENT MECHANISM
PROJECT DESIGN DOCUMENT FORM (CDM-PDD)
Version 03 - in effect as of: 28 July 2006

CONTENTS

SECTION A. General description of project activity

A.1 Title of the project activity:

Biogas Power Generation Project at Bio-ethanol factory in Nakhonsawan Province, Thailand
Version 03
06/01/2010

A.2. Description of the project activity:

The project is a biogas to energy facility and aims to process the wastes coming from molasse-based bio-ethanol plant in Thailand.

Kaset Thai Suger (KTS) owns the largest single sugar mill line in the world with a crushing capacity of 45,000 tons of cane per day (TCD). The molasse produced by the sugar mill is used as raw material to produce fuel-grade ethanol in the ethanol plant of Ekarat Pattana Co., Ltd. (EPC) with a capacity of 200,000 liters per day (LPD). The project consists of biomethanation facility, which will produce biogas and generate an installed capacity of 10.0 MW of electricity, and will treat the wastewater generated by the ethanol plant of EPC in an anaerobic condition, while producing biogas. The biogas produced will be used as fuel in gas engines with at total installed capacity of 10.0 MW. About 8.0 MW of the generated electricity will be sold to the Provincial Electricity Authority (PEA) under the Very Small Power Producer (VSPP) scheme of Thailand. Thailand is committed to support the production of power from renewable sources and has a target to increase the share of renewable energy from 2,057 MW to 3,251 MW by 2012. The project activity is expected to reduce GHG's by an average of about 199,000 tonnes annually.

A.3. Project participants:

Table 1: 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)	• Elarat Pattana Co., Ltd (**EPC**) • A.T. Tri Econergy (Takhli) Co., Ltd. (AT Tri)	**No**
Japan	Tohoku Electric Power Co., Inc.	**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 project activity:

A.4.1. Location of the project activity:

A.4.1.1. Host Party(ies):

Thailand

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

Nakhonsawan Province

A.4.1.3. City/Town/Community etc:

9 Moo14 Nongpho District, Amphur Takli

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

<Coordinates shall be included later.>

The Nakhonsawan Province is approximately 160 kilometres north of Bangkok and has an area of 9,597 km2 and neighboring provinces are Kamphaeng Phet, Phichit, Phetchabun, Lop Buri, Sing Buri, Chai Nat, Uthai Thani and Tak. The major industries are agriculture with principal crops including rice and sugar cane and river fishery.
The factory is located approximately 10 kilometres east of Route 1 and 25 kilometres South-East of Nakhonsawan, the capital of the Province. The area is untamed and partly agricultural with sugar cane grown.

The co-ordinates are: longitude 100 deg 14 min 34 sec, latitude 15 deg 21 min 46 sec.

Figure 1: Map of Thailand

Figure 1: Map of Thailand with Nakhonsawan Province highlighted (Courtesy of Wikipedia)

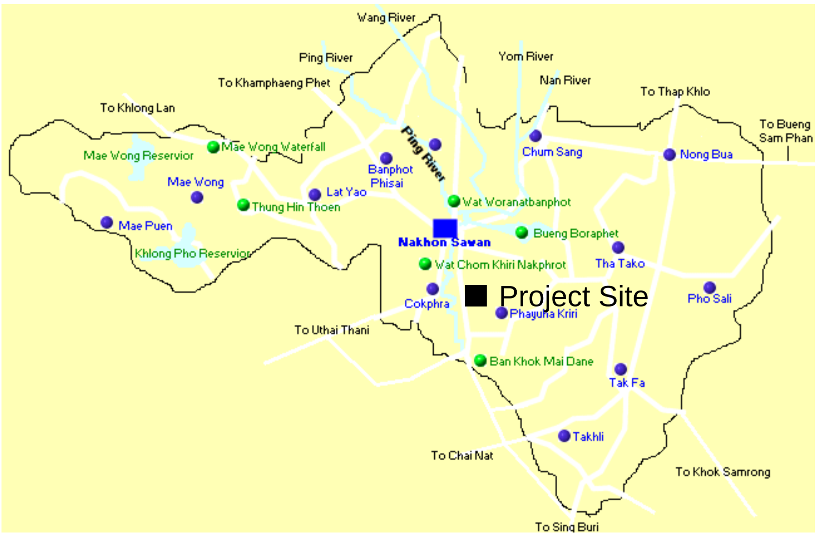

Figure 2: Map of Nakhonsawan Province (Courtesy of sawadee.om)

A.4.2. Category(ies) of project activity:

The Project fits under the following category of the project activity:
- Sectoral Scope 13
  Waste handling and disposal

A.4.3. Technology to be employed by the project activity:

The production of biogas happens though a biological process called biomethanation or anaerobic digestion. Biogas is principally composed of methane (CH4) and carbon dioxide (CO2) and is produced from organic wastes such as wastewater from ethanol production, which will be the feedstock to be used in this project. The waste water, when mixed with various types of bacteria in a crossed container called digester, creates an anaerobic (oxygen-free) environment for the digesting bacteria to thrive. Several different types of bacteria work together to break down complex organic wastes in stages. Symbiotic groups of the digestion perform different functions at different stages of the digestion process. There are four basic types of microorganisms involved. Hydrolytic bacteria break down complex organic wastes into sugars and amino acids. Fermentative bacteria then convert those products into organic acids. Acidogenic microorganisms convert the acids into hydrogen, carbon dioxide and acetate. Finally, the methanogenic bacteria produce biogas from acetic acid, hydrogen and carbon dioxide. Depending on the waste feedstock and system design, the resulting biogas contains around 55-75% of methane.

After filtering and drying, the biogas that is produced will be utilized as fuel in gas engines to generate electricity. The gas engines and the peripherals making up the power plant system consist of standard equipment that are available in the market.

A.4.4 Estimated amount of emission reductions over the chosen crediting period:

Table 2: Ex-ante Emission Reductions

Year	Annual estimation of emission reductions in tonnes of CO_2e
2011	199,058
2012	199,058
2013	199,058
2014	199,058
2015	199,058
2016	199,058
2017	199,058
Total estimated reductions (tCO_2e)	**1,393,406**
Total number of crediting years	**7**
Annual average over the crediting period of estimated reductions (tCO_2e)	**199,058**

[Remark]: Above annual estimation of emission reductions is based on calculation uses historical data of COD of the effluent which are currently available. Continuous analysis on waste water can support the larger amount of annual estimation of emission reductions.

A.4.5. Public funding of the project activity:

There are no public and/or ODA funds involved in this project. This project will be carried out with equity funds contributed by investors, borrowing from banks and proceeds from sales of Certified Emission Reductions.

SECTION B. Application of a baseline and monitoring methodology

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

The approved baseline and monitoring methodology and tools applied to the project activity are:

Version 03.1 of ACM0014 "Avoided methane emissions from wastewater treatment"

Version 05.2 of "Tool for assessment and demonstration of additionality"

Version 01 of "Tool to determine project emissions from flaring gases containing methane"

Version 02 of "Tool to calculate the emission factor for an electricity system"

Version 01 of "Tool to calculate baseline, project and/or leakage emissions from electricity consumption"

B.2 Justification of the choice of the methodology and why it is applicable to the project activity:

The project activity involves the installation of a new anaerobic treatment system in an existing open lagoon based wastewater treatment facility at a tapioca starch production plant.

ACM0014 Version 03.1 has been chosen because the project activity matches with one of the applicable scenarios of the relevant methodology as shown in the table below:

Table 3: Scenario applicable to ACM0014 Version 03.1 compared to the project case

Scenario	Description of the historical situation	Description of the project activity	Project case
1	The wastewater is not treated, but directed to open lagoons that have clearly anaerobic conditions.	The wastewater is treated in a new anaerobic digester. The biogas extracted from the anaerobic digester is flared and/or used to generated electricity and/or heat. The effluent from the anaerobic digester after the treatment is directed to open lagoons or is treated under	In the project situation, the wastewater is treated in a newly installed anaerobic digester. The biogas extracted from the anaerobic digester is used to generate electricity with the excess biogas being flared to ensure complete methane decomposition. The effluent from the anaerobic digester after the

		clearly aerobic conditions (e.g. dewatering and land application)	treatment is directed to open lagoons.

The project activity also meets all the applicability conditions set forth in the methodology, as described below.

- The depth of the anaerobic lagoons should be at least 1m.

The anaerobic lagoons in the project activity have depth of more than 1m.

- Heat and electricity needs per unit input of the water treatment facility remain largely unchanged before and after the project;

The new wastewater treatment system using anaerobic digesters needs to consume some electricity. This electricity consumption by the project activity will be sourced from the electricity generated with biogas collected from the digester of the project activity. In accordance with the applied baseline methodology, any on-site electricity consumption due to the project activity will be subtracted from the electricity generated by the project activity. Operation of the anaerobic digester installed by the project does not require additional heat.

- Data requirements as laid out in this methodology are fulfilled

As described in section B.7 below, data requirements will be fulfilled. In particular, organic materials flow into and out of the considered lagoon based treatment system and the contribution of different removal processes will be measured and quantified.

- The residence time of the organic matter on the open lagoon system should be at least 30 days

The minimum hydraulic residence time of the lagoon system based on the UASB maximum design flow rate (9,600 m^3/day of protein water) is over 30 days.

- Local regulations do not prevent discharge of wastewater in open lagoons

Thai law does not prohibit the discharge of wastewater into open lagoons. The use of anaerobic lagoons is standard practice in the tapioca processing industry in Thailand.

B.3. Description of the sources and gases included in the project boundary

In accordance with the ACM0014 Version 03.1, the spatial extent of the project boundary for this project activity includes:

- The site where the wastewater is treated in both the baseline and the project scenario;
- The sites where any sludge is applied to lands;
- The anaerobic digester, the power and/or heat generation equipment and/or the flare installed under the project activity;

- The power plants connected to the grid, with the geographical boundary as specified in the latest approved version of the "Tool to calculate the emission factor for an electricity system".

The flow diagram of the project boundary, physically delineating the project activity is as follow:

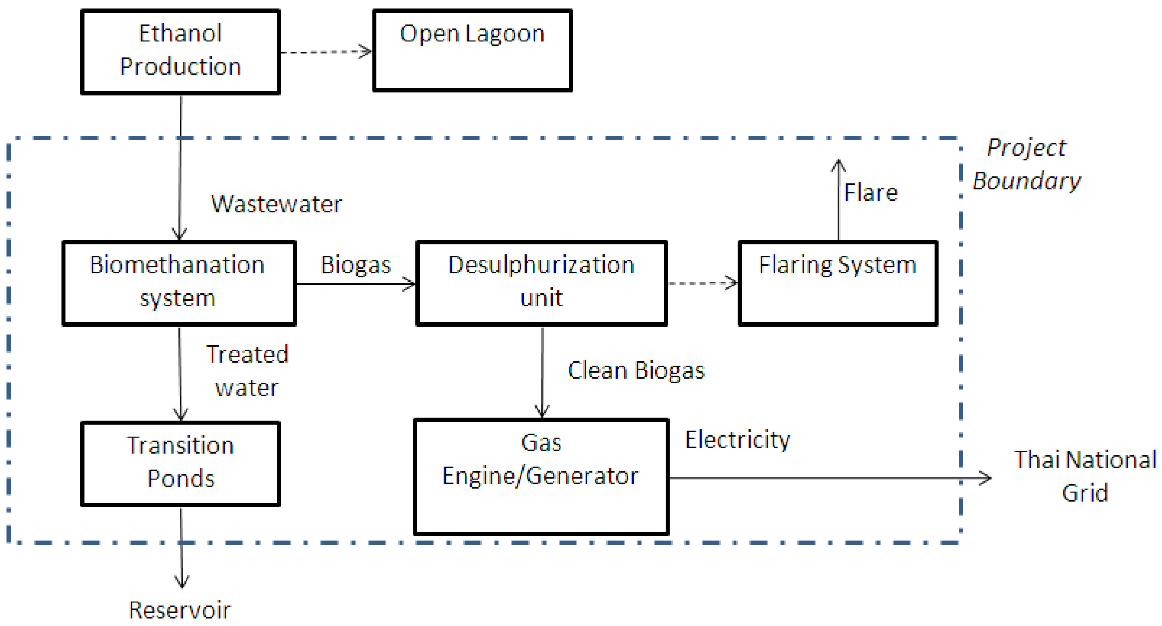

Figure 3: Flow Diagram of the project boundary

The emission sources included in the project boundary are described in Table 3 below.

Table 4: Emission sources included and excluded from the project boundary

	Source	Gas	Included/ Excluded	Justification/Explanation
Baseline	Wastewater treatment processes	CH_4	Included	This is the major source of emissions in the baseline from open lagoons.
		N_2O	Excluded	Excluded for simplification. This is conservative.
		CO_2	Excluded	CO_2 emissions from the decomposition of organic waste are not accounted for.
	Electricity consumption/ generation	CO_2	Included	Electricity is generated with biogas from anaerobic digesters under the project activity, and electricity generation in the grid is displaced by the project activity.
		CH_4	Excluded	Excluded for simplification. This is conservative.
		N_2O	Excluded	Excluded for simplification. This is conservative.
	Thermal energy generation	CO_2	Included	Excluded. Thermal energy is not generated with biogas from anaerobic digesters under the project activity.
		CH_4	Excluded	Excluded for simplification. This is conservative.
		N_2O	Excluded	Excluded for simplification. This is conservative.

Project Activity	Wastewater treatment processes	CH_4	Included	The treatment of wastewater under the project activity causes the following project emissions, which are included: (i) Methane emissions from the lagoons (effluent from the treatment under the project activity is directed to lagoons); (ii) Physical leakage of methane from the digester system; (iii) Methane emissions from flaring (excess biogas from the digester is flared);
			Excluded	The following emission sources are excluded as they do not affect the project activity: (iv) Methane emissions from land application of sludge; (the project does not involve land application of sludge) (v) Methane emissions from wastewater removed in the dewatering process (no dewatering facility is installed as a part of the project activity)
		CO_2	Excluded	CO_2 emissions from the decomposition of organic waste are not accounted for.
		N_2O	Excluded	The project does not involve land application of sludge.
	On-site electricity use	CO_2	Excluded	Electricity is consumed by the anaerobic digester which is implemented by the project activity. A biogas fuelled power generation system will be installed. The electricity consumed by the project activity will be supplied by the electricity generated with biogas, therefore this component will be excluded. Any on-site electricity consumption will be subtracted from the electricity generation of the biogas as per the methodology instructions.
		CH_4	Excluded	Excluded for simplification. This emission source is assumed to be very small.
		N_2O	Excluded	Excluded for simplification. This emission source is assumed to be very small.
	On-site fossil fuel consumption	CO_2	Excluded	Not applicable to the project.
		CH_4	Excluded	Excluded for simplification. This emission source is assumed to be very small.
		N_2O	Excluded	Excluded for simplification. This emission source is assumed to be very small.

B.4. Description of how the baseline scenario is identified and description of the identified baseline scenario:

As per the baseline methodology, ACM0014 Version 03.1, the baseline determination follows a four-step process below.

Step 1: Identification of alternative scenarios
Step 2: Eliminate alternatives that are not complying with applicable laws and regulations
Step 3: Eliminate alternatives that face prohibitive barriers
Step 4: Compare economic attractiveness of remaining alternatives

Step 1: Identification of alternative scenarios

In accordance with the methodology, realistic and credible alternatives with regards to the possible scenarios that would occur in the absence of the project activity are listed below:

Wastewater treatment

W1. The use of open lagoons for the treatment of the wastewater (continuation of current practice);
W2. Direct release of wastewater to a nearby water body;
W3. Aerobic wastewater treatment facilities (e.g. activated sludge or filtered bed type treatment);
W4. Anaerobic digester with methane recovery and flaring;
W5. Anaerobic digester with methane recovery and utilization for electricity or heat generation (The Project undertaken without being registered as a CDM project activity)

Electricity generation

E1. Power generation using fossil fuels in a captive power plant;
E2. Electricity generation in the grid (continuation of current practice);
E3. Electricity generation using renewable sources (The Project undertaken without being registered as a CDM project activity)

Step 2: Eliminate alternatives that are not complying with applicable laws and regulations

Among all the identified alternative scenarios in Step 1 above, W2 "Direct release of wastewater to a nearby water body" is prohibited by the Thai regulation. All alternatives other than W2 comply with the applicable laws and regulations of Thailand. Therefore, Alternative W2 is eliminated from the further analysis.

Step 3: Eliminate alternatives that face prohibitive barriers

Scenarios that face prohibitive barriers should be eliminated by applying Step 3 of the latest version of the "Tool for the demonstration and assessment of additionality" agreed by the CDM Executive Board.

Sub-step 3a. – Identify barriers that would prevent the implementation of the proposed CDM project activity:

Following two barriers have been identified as the realistic and credible barriers that would prevent the implementation of the proposed project activity from being carried out if the project activity was not registered as a CDM project activity.

- Investment barriers
- Technological barriers

Sub-step 3b. – Show that the identified barriers would not prevent the implementation of at least one of the alternatives:

Wastewater treatment

W1. The use of open lagoons for the treatment of the wastewater (continuation of current practice); It is the wastewater treatment practice most widely seen at ethanol plants in Thailand. Wastewater is left to stand in an open lagoon system so that COD will decompose under largely anaerobic conditions. This practice requires low capital and O&M costs and low maintenance. The related technology, skills and labor are readily available in Thailand and there are few risks associated with this technology. EPC is currently utilizing open lagoon based system. W1, therefore, does not face any technical or financial barriers. This alternative is the continuation of current practice.

W2. Direct release of wastewater to a nearby water body; W2 was eliminated as the result of Step 2 above.

W3. Aerobic wastewater treatment facilities (e.g. activated sludge or filtered bed type treatment); Even though W3, introduction of aerobic wastewater treatment system, is making increasing inroads in South East Asia as an alternative waste management option, aerobic treatment of molasses-based wastewater is nonexistent within Thailand due to its complexity. The aerobic treatment of molasses-based wastewater is extremely difficult, and the project participants are not aware of any successfully working plants which employ this technology. As such, the local labour force has no knowhow regarding the operation of such a system. The installation and O&M costs for such a system will also be extremely high Therefore, it is concluded that W3 faces considerable technical and financial barriers.

W4. Anaerobic digester with methane recovery and flaring; Anaerobic bioreactor technology exists in Thailand, however, as in many other countries worldwide, it is a niche technology and not yet widespread. Since anaerobic digester technology is seen as a high risk, with limited performance guarantee, the majority of firms are still relying on lagoon based wastewater treatment system, as EPC has done up until now. Due to the prevalence of such practice there is a dearth of skills and labor necessary to operate and maintain new wastewater treatment system properly. These facts entail significant performance and technology risks in effluent treatment, which all translate to higher costs. Due to the high initial investment and O&M costs associated with implementation of anaerobic bioreactor technology along with the high technology risks, it would not be financially viable to install anaerobic digesters without additional income from CDM and from the generation of electricity. Furthermore, because the existing open lagoon based treatment system fulfills all regulatory requirements for industrial wastewater discharge in Thailand, there is no legal obligation for EPC to install an anaerobic digester. W4, therefore, faces a significant technical and financial barrier.

W5. Anaerobic digester with methane recovery and utilization for electricity or heat generation (The Project undertaken without being registered as a CDM project activity) Even though this option is generally accepted as the best way to treat and utilize high COD/BOD wastewater, as described for W4 above, implementation of anaerobic bioreactor technology in Thailand faces a significant technological and investment barrier. Utilization of biogas for electricity generation brings certain revenue to the project developer (i.e. electricity cost saving or income from electricity sales). This revenue, however, is not sufficient to overcome risks associated with installation of anaerobic bioreactor technology, and even less for the challenging technology for treating molasses-based wastewater. Implementation of the anaerobic digester and biogas utilization system requires the import of new and sophisticated skills for optimal operation and maintenance. While the success of this alternative depends on the quantity and quality of biogas generated, starting up and maintaining the anaerobic bioreactor at optimal conditions is difficult because anaerobic microbial growth in the bioreactor is affected by numerous variables such as the COD load of incoming wastewater, the temperature and the pH conditions. Operators at EPC's plant have no prior experience in operating and maintaining an anaerobic digestion process with a methane recovery system. All of these barriers are compounded when considering a molasses-based wastewater treatment system. This entails significant performance and technology risks in effluent treatment. It is financially not viable to invest in an anaerobic digester and additional equipment (the majority of which has to be imported from overseas) and training for electricity generation when the only income that might be gained is electricity sales. W5, therefore, faces significant prohibitive barriers.

Among all alternatives, W1 is the only realistic and credible scenario that is in compliance with laws and regulations which faces no preventive barriers.

Electricity generation with biogas

E1. Power generation using fossil fuels in a captive power plant; EPC Plant currently meets its electricity demand by purchasing electricity from the connected grid. Due to the high initial investment and O&M costs associated with implementation and maintenance of a captive power plant, EPC would not feel obliged to install another captive power plant. Operating and maintaining a captive power plant would add a significant technical burden to the factory operators. Moreover, in Thailand, of the power plants of a capacity less than 10MW, almost none of them use fossil fuel, as the prevailing practice is to use renewable sources. However, the overwhelming majority import power from the grid and use that as their principal source of power. Power generation technology is sophisticated and therefore any error in engineering & design, implementation, construction, commissioning & testing, operation & maintenance, overhaul and decommissioning can easily prove detrimental to a company. Additionally, it is a given (in Thailand at least) that captive power supply is never as reliable as the grid-power. E1 thus faces investment and technological barriers.

E2. Electricity generation in the grid (continuation of current practice); EPC’s ethanol plant currently meets [percentage?] of their electricity demand by purchasing electricity from the grid. Historically this has always been the case. The only risks would be unreliability in supply, but in Thailand this has not been an issue. E2 faces no preventive barrier.

E3. Electricity generation using renewable sources (The Project undertaken without being registered as a CDM project activity); There is no reliable and economically feasible renewable energy source is found in the vicinity of the project facility. EPC does not possess experience in power generation using renewable sources. Without know-how and experience, it would be very difficult for the plant operator of EPC to operate/maintain a new renewable power generation facility. There are high initial investment and O&M costs associated with implementation and maintenance of a captive power plant using renewable sources. It is clear that E3 faces technological and investment barriers.

Thus, it is concluded that Alternative E2 is the only realistic and credible scenarios with regard to the possible scenarios that would occur in the absence of the project activity.

Based on the step-wise approach conducted above, it is concluded that there is only one combination of the most plausible baseline scenario as follow:

W1: *The use of open lagoons for the treatment of the wastewater*, and
E2: *Electricity generation in the grid*

Step 4. Compare economic attractiveness of remaining alternatives

As per the methodology this step is not carried out because there is only one set of alternative scenario remains through barrier analysis in Step 3 above.

It is indicated that ACM0014 Version 03.1 is only applicable if it can be demonstrated that the most plausible baseline scenario is W1 for the treatment of wastewater and, if applicable, E1/E2 for the generation of electricity. The identified baseline scenario meets this applicability condition. Therefore ACM0014 Version 03.1 is applicable to the project activity.

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 CDM project activity (assessment and demonstration of additionality):

In accordance with the ACM0014 Version03.1, the latest version of the "Tool for the demonstration and assessment of additionality" agreed by the CDM Executive Board. Version 05.2 of the "Tool for the demonstration and assessment of additionality" is employed for the project activity through the following steps:

Step1. Identification of alternatives to the project activity consistent with mandatory laws and regulations;
Step2. Investment analysis or Step3. Barrier analysis; and
Step4. Common practice analysis

Step1. Identification of alternatives to the project activity consistent with current laws and regulations

Sub-step1a. Define alternatives to the project activity:

As shown in Step 1 in Section B.4., the following alternatives have been identified.

<u>Wastewater treatment</u>

W1. The use of open lagoons for the treatment of the wastewater (continuation of current practice);
W2. Direct release of wastewater to a nearby water body;
W3. Aerobic wastewater treatment facilities (e.g. activated sludge or filtered bed type treatment);
W4. Anaerobic digester with methane recovery and flaring;
W5. Anaerobic digester with methane recovery and utilization for electricity or heat generation (The Project undertaken without being registered as a CDM project activity)

<u>Electricity generation</u>

E1. Power generation using fossil fuels in a captive power plant;
E2. Electricity generation in the grid (continuation of current practice);
E3. Electricity generation using renewable sources (The Project undertaken without being registered as a CDM project activity)

Sub-step1b. Consistency with mandatory laws and regulations:

Please see Step 2 in Section B.4. All alternatives identified except for W2 (*Direct release of wastewater to a nearby water body)* are consistent with mandatory laws and regulations.

Step2. Investment analysis

The IRR is selected as the most suitable economic indicator. In accordance with the "Tool for the demonstration and assessment of additionality" (Version 05.2), the project participant chooses to calculate the equity IRR.

Sub-step 2a – Determine the appropriate analysis method

Since the project activity will generate the financial benefits through the sales of electricity to the gird, the simple cost analysis is not appropriate analysis method. Of the remaining methods indicated in the Tool, the benchmark analysis is chosen.

Sub-step 2b – Option III. Apply benchmark analysis

As per the "Guidance on the Assessment of Investment Analysis" (Version 02), the equity IRR of the project activity is compared with the benchmark value derived from required/expected returns on equity (ROE) of the overall listed companies in Thailand published by the Stock Exchange of Thailand (SET)[1]. The resultant benchmark is 23.51%, calculated applying the operational results of the listed companies in Energy and Utility Industry.

The Project's major activity is renewable electricity generation and sales to the grid. In view of this, the ROE derived from a power utility sector is deemed to be appropriate for the BOT provider to make an investment decision in this type of project activity.

Sub-step 2c – Calculation and comparison of financial indicators

At the time when the BOT provider decided to submit the proposal to EPC, the company carried out the investment analysis with the input values provided in the table below:

Table 5: Assumptions and results for the equity IRR

Input Parameters		Value	Unit	Remarks
Total cost for CDM project activity		[Remark]	USD	
Loan	Loan	[Remark]	USD	60% of the total cost
	Equity	[Remark]	USD	40% of the total cost
	Interest rate	8	%	

[1] ROE for the listed companies by industry can be seen from the following website: http://www.set.or.th/en/market/market_statistics.html

Go to "Quarterly", click " 2007 Year Ended" and choose "Energy and Utilities". ROE can be obtained as Net Profits / Equities * 100.

	Loan period	5	Years	
Annual costs	Maintenance	[Remark]	USD/year	5% escalation ratio to be added for the subsequent years
	Insurance	[Remark]	USD/year	
	Technical consultants	[Remark]	USD/year	
	Labor force	[Remark]	USD/year	
Sales of electricity	Electricity generation	64,944,000	kWh/year	
	Electricity tariff to PEA	0.08	USD/kWh	3% escalation ratio to be added for the subsequent years
	VSPP renewable subsidy	0.009	USD/kWh	
Project life		23	Years	
IRR		17.4	%	

As can be see in the above table, the equity IRR of the project activity under the business-as-usual stands at 17.45%, well below the expected IRR of 23.51%

[Remark]: Confidential information has been deleted.

Sub-step 2d – Sensitivity analysis

In order to demonstrate the assumption above is robust, the sensitivity analysis is made for the following scenarios:

1. 10% decrease in the annual costs
2. 10% decrease in the project cost

The resultant IRR reflecting the above variation is increased to 18.27% and 20.39% respectively. Thus, it is concluded that the project activity is not a financially attractive course of action in spite of the range of realistic assumptions.

It is noteworthy that very few plant owners have ventured into advanced wastewater treatment technology with their own equity. In fact, it is understood that most projects which have been attempting to install this technology are implemented with the assistance of the CDM or with the government funding.

The challenge is more significant when taking into account the context of the ethanol production industry in Thailand where such advanced wastewater treatment technology has not been applied yet.. Moreover, despite the fact that biomethanation is a good way to utilize wastewater, it does not completely solve the problem for EPC since the mass and color of biomethanized wastewater remain the same. This requires EPC to find a solution to minimize the volume of wastewater.

Step4. Common practice analysis

Sub-step 4a. – Analyze other alternatives similar to the proposed project activity:

To date, EPC and A.T. Tri are not aware of any similar activities in Thailand involving anaerobic digestion of molasses-based wastewater with recovery of biogas for power generation which are currently operational and have not been developed as a CDM activity.

Sub-step 4b. – Discuss any similar options that are occurring:

The project developer, A.T. Tri, was first made aware of the possibility of CDM when ---- contacted them with a project proposal that outlined the revenues to be earned through the sale of CERs. As a result, the decision was made to proceed with the project activity. An MOU was signed between EPC and A.T. Tri in which CDM was clearly seen as an essential element to proceed with this project. The MOU will be presented to DOE for validation.

Start date of the project activity

According to "Guidelines On The Demonstration And Assessment of Prior Consideration of The CDM", (Version 03) EB49 Report Annex 22, in the case of project activities with a starting date on or after 02 August 2008, the project participant must inform a Host Party DNA and/or the UNFCCC secretariat in writing of the commencement of the project activity and of their intention to seek CDM status. Such notification must be made within six months of the project activity start date and shall contain the precise geographical location and a brief description of the proposed project activity, using the standardized form F-CDM-Prior Consideration.

To this end, the project participant has filled in the "Prior Consideration of the CDM Form", EB48 Annex 62), which was sent to the UNFCCC Secretariat on 03 November 2009.

B.6. Emission reductions:

B.6.1. Explanation of methodological choices:

In order to quantify emission reductions achieved by the project activity, procedures to calculate baseline emissions, project emissions, leakage and emission reductions set out in the methodology are applied in the following manner.

Baseline emissions

Baseline emissions are estimated as follows:

$$BE_y = BE_{CH4,y} + BE_{EL,y} + BE_{HG,y} \qquad \text{Equation 1}$$

Where:

BE_y = Baseline emissions in year y (tCO_2e/yr)

$BE_{CH4,y}$ = Methane emissions from anaerobic treatment of the wastewater in open lagoons (scenario1) in the absence of the project activity in year y (tCO_2e/yr)

$BE_{EL,y}$ = CO_2 emissions associated with electricity generation that is displaced by the project activity in year *y* (tCO_2e/yr)

$BE_{HG,y}$ = CO_2 emissions associated with fossil fuel combustion for heating equipment that is displaced by the project in year *y* (tCO_2e/yr)

Baseline emissions for the project activity are calculated in the following three steps:

Step1: Calculation of baseline emissions from anaerobic treatment of the wastewater;
Step2: Calculation of baseline emissions from generation and consumption of electricity;
Step3: Calculation of baseline emissions from heat generation

Step1: Calculation of baseline emissions from anaerobic treatment of the wastewater

The methodology proposes two alternative methods for the estimation of methane emissions from open lagoons:

(a) The Methane Conversion Factor (MCF) Method
(b) The Organic Removal Ratio (ORR) Method

Among these two options, option (a) The Methane Conversion Factor (MCF) Method is selected for the project activity.

Step 1a: Methane Conversion Factor (MCF) method

The baseline methane emissions from anaerobic treatment of the wastewater in open lagoons are estimated based on the chemical oxygen demand (COD) of the wastewater that would enter the lagoon in the absence of the project activity ($COD_{PJ,y}$), the maximum methane producing capacity (B_0) and a methane conversion factor ($MCF_{BL,y}$) which expresses the proportion of the wastewater that would decay to methane, as follows:

Table 6: Baseline Methane Emissions from Anaerobic Treatment of Wastewater

$BE_{CH4,y} = GWP_{CH4} \times MCF_{BL,y} \times B_O \times COD_{BL,y}$				Equation 2
Parameter	Description	Unit	Value	Source
$BE_{CH4,y}$	Methane emissions from anaerobic treatment of the wastewater in open lagoons in the absence of the project activity in year *y*	tCO_2e/yr	Calculated	Equation 2
GWP_{CH4}	Global Warming Potential of methane valid for the commitment period	tCO_2e/tCH_4	21	IPCC
B_0	Maximum methane producing capacity, expressing the maximum amount of CH_4 that can be produced from a given quantity of chemical oxygen demand	$tCH_4/tCOD$	0.21	Methodology default value. Justification for the use of default value is

				provided in section B.6.2.
$MCF_{BL,y}$	Average baseline methane conversion factor (fraction) in year *y*, representing the fraction of ($COD_{PJ,y}$ x B_0) that would be degraded to CH_4 in the absence of the project activity	fraction	0.596	Equation 6
$COD_{BL,y}$	Quantity of chemical oxygen demand that would be treated in open lagoons (scenario 1) in the absence of the project activity in year *y*	tCOD/yr	79,380	Equation 3

Determination of $COD_{BL,y}$

Table 7: Determination of $COD_{BL,y}$

$COD_{BL,y} = AD_{BL} \times COD_{PJ,y}$				Equation 3
$AD_{BL} = 1 - \frac{COD_{out,x}}{COD_{in,x}}$				Equation 4
$COD_{PJ,y} = \sum_{m=1}^{12} F_{PJ,dig,m} \times w_{COD,dig,m}$				Equation 5
Parameter	Description	Unit	Value	Source
$COD_{BL,y}$	Quantity of COD that would be treated in open lagoons in the absence of the project activity in year *y*	tCOD/yr	Calculated	Equation 3
AD_{BL}	Effluent adjustment factor expression the percentage of COD that is degraded in open lagoons in the absence of the project activity	fraction	1 (tentatively applied)	Equation 4
$COD_{PJ,y}$	Quantity of COD that is treated in the anaerobic digester or under clearly aerobic conditions in the project activity in year *y*	tCOD/year	113,400	Equation 5
$COD_{out,x}$	COD of the effluent in the period *x*	tCOD	34,020	EPC Based on one year historical data (2007)
$COD_{in,x}$	COD directed to the open lagoons in the period *x*	tCOD	113,400	EPC Based on one year historical data (2007)
x	Representative historical reference	-	1	-

	period (at least one year)			
$F_{PJ,dig,m}$	Quantity of wastewater that is treated in the anaerobic digester or under clearly aerobic conditions in the project activity in month *m*	m^3/month	45,000	EPC To be monitored after project implementation.
$w_{COD,dig,m}$	Average COD in the wastewater that is treated in the anaerobic digester or under clearly aerobic conditions in the project activity in month *m*	$tCOD/m^3$	0.21	EPC To be monitored after project implementation. Design COD concentration to the digester ($0.21t/m^3$) is used for ex-ante calculation
m	Months of year *y* of the crediting period	-	-	-

Determination of $MCF_{BL,y}$

The quantity of methane generated from COD disposed to the open lagoon depends mainly on the temperature and the depth of the lagoon or sludge pit. Accordingly, the methane conversion factor is calculated based on a factor f_d, expressing the influence of the depth of the lagoon or sludge pit on methane generation, and a factor $f_{T,y}$ expressing the influence of the temperature on the methane generation. In addition, a conservativeness factor of 0.89 is applied to account for the considerable uncertainty associated with this approach. $MCF_{BL,y}$ is calculated as follows:

Table 8: Determination of $MCF_{BL,y}$

$MCF_{BL,y} = f_d \times f_{T,y} \times 0.89$				Equation 6
Parameter	Description	Unit	Value	Source
$MCF_{BL,y}$	Average baseline methane conversion factor (fraction) in year *y*, representing the fraction of ($COD_{PJ,y} \times B_0$) that would be degraded to CH_4 in the absence of the project activity	fraction	0.596	Equation 6
f_d	Factor expressing the influence of the depth of the lagoon or sludge pit on methane generation	fraction	0.7	ACM0014 Version 03.1 Value used for lagoons with depth up to 5 meters

$f_{T,y}$	Factor expressing the influence of the temperature on the methane generation in year y	fraction	0.9569	Equation 11
0.89	Conservativeness factor	fraction	0.89	ACM0014 Version 03.1

Determination of $f_{T,y}$

As per the methodology, the factor $f_{T,y}$ is calculated with the help of a monthly stock change model which aims at assessing how much COD degrades in each month. The amount of organic matter available for degradation of methane is assumed to be equal to the amount of organic matter directed to the open lagoon, less any affluent, plus the COD that may have remained in the lagoon from previous months, as follows:

Table 9: Determination of $f_{T,y}$

$$f_{T,y} = \frac{\sum_{m=1}^{12} f_{T,m} \times COD_{available,m}}{\sum_{m=1}^{12} COD_{BL,m}}$$				Equation 11
$$COD_{available,m} = COD_{BL,m} + \left(1 - f_{T,m}\right) \times COD_{available,m-1}$$				Equation 7
$$COD_{BL,m} = AD_{BL} \times COD_{PJ,m}$$				Equation 8
$$COD_{PJ,m} = F_{PJ,dig,m} \times w_{COD,dig,m}$$				Equation 9
$$f_{T,m} = \exp\left(\frac{E \times \left(T_{2,m} - T_1\right)}{R \times T_1 \times T_{2,m}}\right) \quad if \quad 283K < T_{2,m} < 303K$$ $$= 0 \quad if \quad T_{2,m} < 283K$$ $$= 1 \quad if \quad T_{2,m} > 303K$$				Equation 10
Parameter	Description	Unit	Value	Source
$f_{T,y}$	Factor expressing the influence of the temperature on the methane generation in year *y*	fraction	0.9569	Equation 11
$f_{T,m}$	Factor expressing the influence of the temperature on the methane generation in month *m*	fraction	Values provided in Annex 3	Equation 10
$COD_{available,m}$	Quantity of COD available for degradation in the open lagoon in month *m*	tCOD/month	Values provided in Annex 3	Equation 7
$COD_{BL,m}$	Quantity of chemical oxygen demand that would be treated in	tCOD/month	6,615	Equation 8

	open lagoons in the absence of the project activity in month *m*			
$COD_{PJ,m}$	Quantity of COD that is treated in the anaerobic digester or under clearly aerobic conditions in the project activity in month *m*	tCOD/month	9,450	Equation 9
$F_{PJ,dig,m}$	Quantity of wastewater that is treated in the anaerobic digester or under clearly aerobic conditions in the project activity in month *m*	m^3/month	45,000	EPC. To be monitored after project implementation.
$w_{COD,dig,m}$	Average COD in the wastewater that is treated in the anaerobic digester or under clearly aerobic conditions in the project activity in month *m*	tCOD/m^3	0.21	EPC. To be monitored after project implementation. Design COD concentration to the digester (0.21t/m^3) is used for ex-ante calculation.
E	Activation energy constant	cal/mol	15,175	ACM0014 Version 03.1
$T_{2,m}$	Average temperature at the project site in month *m*	K	Values provided in Annex 3	EPC. To be monitored after project implementation. Average of monthly average air temperature from 2005 to 2007 is used for ex-ante calculation. (Data obtained from ---------- Meteorological Department)
T_1	303.16	K	303.16	ACM0014 Version 03.1
R	Ideal gas constant	cal /K mol	1.987	ACM0014 Version 03.1
m	Months of year *y* of the crediting period	-	1-12	-

Step 2: Baseline emissions from generation and/or consumption of electricity

The Project activity involves electricity generation from collected biogas. As determined in the section B.4., the most plausible alternative scenario for the generation of electricity in the Project activity is the generation of electricity in the grid (E2). Baseline emissions associated with generation and/or consumption of electricity is estimated for the following source:

- Baseline emissions from the generation of electricity in the grid (E2) in the absence of electricity generation with biogas.

Baseline emissions from consumption of electricity associated with the treatment of wastewater (annual quantity of electricity that would be consumed in the absence of the project activity for the treatment of wastewater) will be ignored to be conservative.

Although there is an existing 3 MW coal-fired power plant at the project site, this emission source will be ignored to be conservative.

Baseline emissions from the generation and / or consumption of electricity are calculated as follows:

Table 10: Baseline Emission from the Electricity Generation

$BE_{EL,y} = (EC_{BL} + EG_{PJ,y} - EC_{PJ,y}) \times EF_{BL,EL,y}$				Equation 15
Parameter	Description	Unit	Value	Source
$BE_{EL,y}$	CO_2 emissions associated with electricity generation that is displaced by the project activity in the absence of the project activity in year *y*.	tCO_2/year	Calculated	Equation 15
$EC_{BL,y}$	Annual quantity of electricity that would be consumed in the absence of the project activity for the treatment of wastewater.	MWh/year	0	Set to zero to be conservative
$EG_{PJ,y}$	Net quantity of electricity generated in year *y* with biogas from the new anaerobic biodigester.	MWh/year	64,944	EPC. To be monitored after project implementation. Expected power generation by the project activity using biogas is used for ex-ante calculation.
$EF_{BL,EL,y}$ ($=EF_{grid,y}$)	Baseline emission factor for electricity generated and / or consumed in the absence of the project activity in year *y*	tCO_2/MWh	0.4838	Thai official grid emission factor

As per the methodology, the determination of $EF_{BL,EL,y}$ depends on the baseline scenario and the configuration at the project site. The methodology instructs that the grid emission factor should be used ($EF_{BL,EL,y} = EF_{grid,y}$) if the baseline scenario for displacement of electricity generated with biogas from the anaerobic digester is E2.

Official grid emission factor released by the Thai government is used.[2] A note on the method of arriving at the Combined Margin ("CM") for determining the grid emission factor is included in Annex 3.

Step 3: Baseline emissions from generation of heat

The project activity does not involve heat generation from collected biogas, so baseline emissions from this source will be ignored.

Project emissions

As discussed in Section B.2, conditions of the project activity matches Scenario 1 provided in the baseline methodology applied (ACM0014 Version 03.1). Project emissions attributed to the project activity may include the following:

(i) Methane emissions from the lagoons;

(ii) Physical leakage of methane from the digester system;

(iii) Methane emissions from flaring;

(iv) Methane and nitrous oxide emissions from land application of sludge;

(v) CO_2 emissions from consumption of electricity and or fossil fuels in the project activity.

$$PE_y = PE_{CH4,effluent,y} + PE_{flare,y} + PE_{sludge,LA,y} + PE_{EC,y} + PE_{FC,y} \qquad \text{Equation 19}$$

PE_y	= Project emissions in year *y* (tCO_2e/yr)
$PE_{CH4,effluent,y}$	= Project emissions from treatment of wastewater effluent from the anaerobic digester in year *y* (tCO_2e/yr)
$PE_{CH4,digest,y}$	= Project emissions from physical leakage of methane from the anaerobic digester in year *y* (tCO_2e/yr)
$PE_{flare,y}$	=Project emissions from flaring of biogas generated in the anaerobic digester in year *y* (tCO_2e/yr)
$PE_{sludge,LA,y}$	= Project emissions from land application of sludge in year *y* (tCO_2e/yr)
$PE_{EC,y}$	= Project emissions from electricity consumption in year *y* (tCO_2e/yr)
$PE_{FC,y}$	= Project emissions from fossil fuel consumption in year *y* (tCO_2e/yr)

(i) Project methane emissions from effluent from the digester ($PE_{CH4,effluent,y}$)

[2] Source: http://www2.dede.go.th/cdm/doc.htm

Effluent from the digesters installed under the project activity is directed to open lagoons. A significant amount of the COD load is usually degraded in the new anaerobic digester and open lagoons can be expected to operate largely aerobic conditions. However, due to the uncertainty regarding the exact extent of aerobic/anaerobic degradation after the project implementation, the calculation of any CH4 emissions is conservatively carried out in the same way as for the baseline, using the methane conversion factor method.

Table 11: Project Methane Emissions from Effluent from Digester

$PE_{CH4,effluent,y} = GWP_{CH4} \times MCF_{PJ,y} \times B_0 \times (COD_{PJ,effl,dig,y} - COD_{PJ,effl,lag,y})$				Equation 14
$COD_{PJ,effl,dig,y} = \sum_{m=1}^{12} F_{PJ,effl,dig,m} \times w_{COD,effl,dig,m}$				Equation 15
$COD_{PJ,effl,lag,y} = \sum_{m=1}^{12} F_{PJ,effl,lag,m} \times w_{COD,effl,lag,m}$				Equation 16
Parameter	Description	Unit	Value	Source
$PE_{CH4,effluent,y}$	Project emissions from treatment of wastewater effluent from the anaerobic digester in year y	tCO_2/yr	Calculated	Equation 14
GWP_{CH4}	Global warming potential of methane valid for the commitment period	tCO_2e/tCH_4	21	IPCC
B_0	Maximum methane producing capacity, expressing the maximum amount of CH_4 that can be produced from a given quantity of chemical oxygen demand	$tCH_4/tCOD$	0.21	Methodology default value. Justification for the use of default value is provided in section B.6.2.
$COD_{PJ,effl,dig,y}$	Quantity of COD in the effluent from the digester in year y	tCOD/yr	Calculated	Equation 15
$COD_{PJ,effl,lag,y}$	Quantity of COD in the effluent of the open lagoon pr dewatering facility in which the effluent from the digester is treated in year y	tCOD/yr	Calculated	Equation 16
$F_{PJ,effl,dig,m}$	Quantity of effluent from the open lagoon or dewatering facility in which the effluent from the digester is treated in month m	m^3/month	45,000	EPC. To be monitored after project implementation.
$w_{COD,effl,lag,m}$	Average COD in the effluent from the open lagoon or dewatering facility in which the effluent from the digester is treated in month m	$tCOD/m^3$	0.21	EPC. To be monitored after project implementation. Design COD concentration to the digester ($0.21t/m^3$) is used for ex-ante

				calculation.

Determination of $MCF_{PJ,y}$

Table 12: Determination of $MCF_{PJ,y}$

$MCF_{PJ,y} = f_d \times f_{PJ,T,y}$				Equation 17
Parameter	Description	Unit	Value	Source
$MCF_{PJ,y}$	Project methane conversion factor (fraction) in year y, representing the fraction of ($COD_{PJ,effluent,y} \times B_0$) that degrades to CH_4	Fraction	Calculated	Equation 17
f_d	Factor expressing the influence of the depth of the lagoon or dewatering facility on methane generation	fraction	0.7	ACM0014 Version 03.1 Value used for lagoons with depth up to 5 meters
$f_{PJ,T,y}$	Factor expressing the influence of the temperature on the methane generation under the project activity in year y	fraction	0.9569	Equation 11, 18-20

Determination of $f_{PJ,T,y}$

The factor $f_{PJ,T,y}$ is calculated as under baseline emissions, with the help of a monthly stock exchange model which aims at assessing how much COD degdades in each month as follows:

Table 13: Determination of $f_{PJ,T,y}$

$COD_{PJ,available,m} = (COD_{PJ,effl,dig,m} - COD_{PJ,effl,lag,m}) + (1 - f_{T,m}) \times COD_{PJ,available,m-1}$				Equation 18
$COD_{PJ,effl,dig,m} = F_{PJ,effl,dig,m} \times w_{COD,effl,dig,m}$				Equation 19
$COD_{PJ,effl,lag,m} = F_{PJ,effl,lag,m} \times w_{COD,effl,lag,m}$				Equation 20
$COD_{PJ,available,m}$	Quantity of COD available for degradation in the open lagoon or dewatering facility under the project activity in month m	tCOD/month	Values provided in Annex 3	Equation 18
$COD_{PJ,effl,dig,m}$	Quantity of COD in the effluent from the digester in month m	tCOD/month	Values provided in Annex 3	Equation 19
$COD_{PJ,effl,lag,m}$	Quantity of COD in the effluent of the open lagoon or dewatering facility in which the effluent from the digester is treated in month m	tCOD/month	Values provided in Annex 3	Equation 20
$F_{PJ,effl,dig,m}$	Quantity of effluent from the	m^3/month	45,000	EPC.

	digester in month m			To be monitored after project implementation.
$w_{COD,effl,dig,m}$	Average COD in the effluent from the digester in month m	$tCOD/m^3$	0.21	EPC. To be monitored after project implementation. Design COD concentration to the digester ($0.21t/m^3$) is used for ex-ante calculation.
$f_{T,m}$	Factor expressing the influence of the temperature on the methane generation in month m	fraction	Values provided in Annex 3	
m	Months of year y of the crediting period	-	1-12	-

(ii) Project emissions related to physical leakage from the digester

Methane emissions from the new digester are calculated as follows:

Table 14: Project Emissions from Digester

$PE_{CH4,diget,y} = F_{biogas,y} \times FL_{biogas,digest} \times w_{CH4,biogas,y} \times GWP_{CH4} \times 0.001$				Equation 21
Parameter	Description	Unit	Value	Source
$PE_{CH4,digest,y}$	Project emissions from physical leakage of methane from the anaerobic digester	tCO_2/yr	Calculated	Equation 21
$F_{biogas,y}$	Amount of biogas collected in the outlet of the new digester in year *y*	m^3/yr	42,443,280	EPC. To be monitored after project implementation. Expected biogas yield specified by the technology

				provider is used for ex-ante calculation
$FL_{biogas,digest}$	Fraction of biogas that leaks from the digester	m^3 biogas leaked/m^3 biogas produced	0.05	ACM0014 Version 03.1 Default leak factor based on the 2006 IPCC guidelines
$w_{CH4,biogas,y}$	Concentration of methane in the biogas in the outlet of the new digester	$kgCH_4/Nm^3$	0.3938	EPC. To be monitored after project implementation. For ex-ante calculation, the value was calculated using biogas methane concentration (55%, volume/volume) , density of methane under normal conditions (0.716kg/m^3)
GWP_{CH4}	Global Warming Potential for methane valid for the commitment period	tCO_2e/tCH_4	21	IPCC

(iii) Methane emissions from flaring

In general all of the biogas produced by the project is utilized for electricity generation. A flaring system will be installed by the project activity to combust excess biogas if any. For the ex-ante calculation, methane emissions from the flare are set to zero.

The amount of biogas sent to flare will be monitored as per the methodology and the methane emissions from flaring will be calculated in accordance with the “Tool to determine project emissions from flaring gases containing methane (hereunder “flaring tool”)”.

Among the options for flaring systems, an enclosed flare system is chosen by the project participants. The following relevant steps and equations from the flaring tool are used to determine the project emissions from flaring of the residual gas stream.

For enclosed flares, the temperature in the exhaust gas of the flare is measured to determine whether the flare is operating or not.

For enclosed flares, either of the following two options can be used to determine the flare efficiency:

(a) To use a 90% default value. Continuous monitoring of compliance with manufacturer's specification of flare (temperature, flow rate of residual gas at the inlet of the flare) must be performed. If in a specific hour any of the parameters are out of the limit of manufacture's specifications, a 50% default value for the flare efficiency should be used for the calculations for this specific hour.
(b) Continuous monitoring of the methane destruction efficiency of the flare (flare efficiency).

The project participants have decided to use option (a), continuous monitoring of compliance with manufacturer's specifications of flare.

In both cases, 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.

The following equation from the flaring tool is used to determine the project emissions from flaring of the residual gas stream.

Table 15: Project Emissions from Flare System

$PE_{flare,y} = \sum_{h-1}^{8760} TM_{RG,h} \times (1-\eta_{flare,h}) \times \frac{GWP_{CH4}}{1000}$				Flaring tool Equation22
Parameter	Description	Unit	Value	Source
$PE_{flare,y}$	Project emissions from flaring of the residual gas stream in year *y*	tCO_2e/yr	0	Flaring tool Equation 22
$TM_{RG,h}$	Mass flow rate of the methane in the residual gas in the hour *h*	kg/h	Calculated	Equation 23
$\eta_{flare,h}$	Flare efficiency in hour *h*	fraction	0.9	Flaring tool default value for enclosed type flare
GWP_{CH4}	Global Warming Potential of methane valid for the commitment period	tCO_2e/tCH_4	21	IPCC
$TM_{RG,h} = FV_{RG,h} \times fv_{CH4,RG,h} \times \rho_{CH4,n}$				Equation 23
$FV_{RG,h}$	Volumetric flow rate of residual gas in dry basis at normal condition sin hour h	m^3/h	0	EPC
$fv_{CH4,RG,h}$	Volumetric fraction of methane in the residual gas on dry basis in hour h	fraction	0.7	EPC
$\rho_{CH4,n}$	Density of methane at normal conditions	fraction	0.716	Flaring tool default value

(iv) Project emissions from land application of sludge

This step is applicable if under the project activity sludge is applied on land. It is expected that sludge will not be generated by the project activity. Project emissions from this source are set to zero in the ex-ante calculation.

(v) Project emissions from electricity consumption and combustion of fossil fuels in the project

All of the electricity consumed by the project activity will be generated with biogas under the project activity.

As instructed in ACM0014 Version 03.1, if electricity is generated with biogas under the project activity, the electricity consumption for the operation of the project activity should be subtracted from the total on-site electricity generation with biogas in calculating $EG_{PJ,y}$ (i.e. $EG_{PJ,y}$ only includes the net electricity generation resulting from the project activity).

It is expected that no fossil fuels are combusted for the purpose of the project activity and the project emissions from this source are excluded from the calculations.

Leakage

As per the methodology, no leakage is estimated.

Emission Reductions

Emission reductions, ER_y (tCO_2e) are calculated as the difference between the total baseline emissions (Equation 1) and the total project emissions (Equation 19). No leakage is estimated.

$$ER_y = BE_y - PE_y$$ Equation 24

Where:

ER_y = Emissions reductions of the project activity in year y (tCO_2e/year)
BE_y = Baseline emissions in year y (tCO_2e/year)
PE_y = Project emissions in year y (tCO_2e/year)

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

Data / Parameter:	$\mathbf{COD_{in,x}}$
Data unit:	t COD /yr
Description:	COD of the effluent in the period *x*
Source of data used:	One year of historical data. If no data is available the COD inflow to and effluent from the lagoon during a measurement campaign of at least 10 days.

Value applied:	113,400
Justification of the choice of data or description of measurement methods and procedures actually applied :	One year historical data (for 2007) provided by EPC
Any comment:	*x* = Representative historical reference period, 1 year (at least one year) The measurements should be undertaken during a period that is representative for the typical operation conditions of the plant and ambient conditions of the site

Data / Parameter:	**$COD_{out,x}$**
Data unit:	t COD /yr
Description:	COD of the effluent in the period x
Source of data used:	One year of historical data. If no data is available the COD inflow to and effluent from the lagoon during a measurement campaign of at least 10 days.
Value applied:	34,020
Justification of the choice of data or description of measurement methods and procedures actually applied :	One year historical data (for 2007) provided by EPC
Any comment:	*x* = Representative historical reference period, 1 year (at least one year) The measurements should be undertaken during a period that is representative for the typical operation conditions of the plant and ambient conditions of the site

Data / Parameter:	**B_0**
Data unit:	$kgCH_4/kgCOD$
Description:	Maximum methane producing capacity, expressing the maximum amount of CH4 that can be produced from a given quantity of chemical oxygen demand (COD).
Source of data used:	2006 IPCC Guidelines
Value applied:	0.21
Justification of the choice of data or description of measurement methods and procedures actually applied :	IPCC default value of 0.21 $kgCH_4/kgCOD$ for CH_4 emission factor was selected.
Any comment:	

Data / Parameter:	**f_d**
Data unit:	-
Description:	Factor expressing the influence of the depth of the lagoon on methane

	generation
Source of data used:	Apply the following values for the corresponding average depth of the open lagoon Depth > 5 m: 70% (or 0.7) Depth 1-5 m: 50% (or 0.5) Depth < 1m: 0% (or 0)
Value applied:	0.7
Justification of the choice of data or description of measurement methods and procedures actually applied :	Based on the measured average lagoon depth provided by EPC
Any comment:	Applicable to the methane conversion factor (MCF) method.

Data / Parameter:	**D**
Data unit:	m
Description:	Depth of the lagoon
Source of data used:	Measured by EPC
Value applied:	-----
Justification of the choice of data or description of measurement methods and procedures actually applied :	As provided in the approved baseline and monitoring methodology, ACM0014. Determine the average depths of the whole lagoon/sludge pit under normal operating conditions
Any comment:	---

Data / Parameter:	**EC_{BL}**
Data unit:	MWh/yr
Description:	Annual quantity of electricity that would be consumed in the absence of the project activity for the treatment of wastewater
Source of data used:	EPC
Value applied:	0
Justification of the choice of data or description of measurement methods and procedures actually applied :	Ignored for conservativeness
Any comment:	---

Data / Parameter:	**$EF_{grid,,y}$ (=$EF_{grid,CM,y}$)**
Data unit:	tCO_2/MWh
Description:	Grid emission factor in year *y*
Source of data used:	Thai DNA

Value applied:	0.4838
Justification of the choice of data or description of measurement methods and procedures actually applied :	Calculated using publicly available grid information in accordance with the latest approved version of the “Tool to calculate the emission factor for an electricity system”
Any comment:	Detailed calculation is provided in Annex 3

Data / Parameter:	**$FL_{biogas,digest}$**
Data unit:	m^3 biogas leaked/m^3 biogas produced
Description:	Fraction of biogas that leaks from the digester
Source of data used:	IPCC (2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 5, Chapter 4, Page 4.4)
Value applied:	Use default leak factor of 0.05 m^3 biogas leaked / m^3 biogas produced.
Justification of the choice of data or description of measurement methods and procedures actually applied :	Applicable if a new digester is installed under the project activity.
Any comment:	

Data / Parameter:	**$EF_{N2O,LA,sludge}$**
Data unit:	t CO_2e / t N
Description:	Emission factor of nitrogen from sludge applied to land to be assumed.
Source of data used:	Stehfest, E. and Bouwman, A.F. N_2O and NO emission from agricultural fields and aoils under natural vegetation: summarizing available measurement data and modelling of global annual emissions. The average emission factor used is 0.01 kg N_2O-N/kgN (=0.016 kgN_2O/kgN)
Value applied:	0.016
Justification of the choice of data or description of measurement methods and procedures actually applied :	As provided in ACM 0014 ver 3.1
Any comment:	

Data / Parameter:	**$MCF_{sludge,la}$**
Data unit:	-
Description:	Methane conversion factor for sludge used for land application
Source of data used:	-

Value applied:	0.05
Justification of the choice of data or description of measurement methods and procedures actually applied :	As provided in ACM 0014 ver 3.1
Any comment:	

Data / Parameter:	**GWP_{CH4}**
Data unit:	$t\ CO_2e$ / $t\ CH_4$
Description:	Global warming potential for methane
Source of data used:	IPCC
Value applied:	21
Justification of the choice of data or description of measurement methods and procedures actually applied :	As provided in the IPCC guidelines
Any comment:	Shall be updated according to any future COP/MOP decisions

Data / Parameter:	**GWP_{N2O}**
Data unit:	$t\ CO_2e$ / $t\ N_2O$
Description:	Global warming potential for methane
Source of data used:	IPCC
Value applied:	296
Justification of the choice of data or description of measurement methods and procedures actually applied :	As specified in ACM0014 Version 03.1
Any comment:	Shall be updated according to any future COP/MOP decisions

B.6.3 Ex-ante calculation of emission reductions:

<u>Baseline emissions</u>

Estimation of $BE_{CH4,y}$

Using Equation 2 and values provided in Section B.6.1, $BE_{CH4,y}$ was calculated as 208,639tCO_2/yr

Estimation of $BE_{EL,y}$

Using Equation 12 and values provided in Section B.6.1, $BE_{EL,y}$ was calculated as 31,419tCO_2/yr

Project emissions

Estimation of $PE_{CH4,effluent,y}$

Using Equation 14 and values provided in Section B.6.1, $PE_{CH4,effluent,y}$ was calculated as 23,450tCO_2/yr

Estimation of $PE_{CH4,digest,y}$

Using flaring tool and values provided in Section B.6.1, $PE_{CH4,digest,y}$ was calculated as 17,550 tCO_2/yr

Estimation of $PE_{flare,y}$

As discussed in Section B.6.1, $PE_{flare,y}$ for ex-ante calculation was set to 0 tCO_2/yr

Estimation of $PE_{sludge,LA,y}$

As discussed in Section B.6.1, $\mathbf{PE_{sludge,LA,y}}$ for ex-ante calculation was set to 0 tCO_2/yr

Estimation of $PE_{EC,y}$

As discussed in Section B.6.1, $\mathbf{PE_{EC,y}}$ for ex-ante calculation was set to 0 tCO_2/yr ($PE_{EC,y}$ is subtracted from $EG_{PJ,y}$ to arrive at net $EG_{PJ,y}$)

Estimation of $PE_{FC,y}$

As discussed in Section B.6.1, $\mathbf{PE_{FC,y}}$ for ex-ante calculation was set to 0 tCO_2/yr

Leakage

As per the methodology, leakage is considered to be negligible.

Emission Reductions

$$
\begin{aligned}
ER &= BE_y - PE_y \\
&= (307{,}444\,tCO_2e/yr + 27{,}416\,tCO_2e/yr) - (17{,}550\,tCO_2e/yr) \\
&= (317{,}360\,tCO_2e/yr)
\end{aligned}
$$

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

Table 16: Ex-ante Estimation of Emission Reductions

Year	Estimation of project activity emissions (tCO_2e)	Estimation of baseline emissions (tCO_2e)	Estimation of leakage (tCO2e)	Estimation of overall emission reductions (tCO_2e)
2011	41,000	240,058	0	199,058
2012	41,000	240,058	0	199,058
2013	41,000	240,058	0	199,058
2014	41,000	240,058	0	199,058
2015	41,000	240,058	0	199,058
2016	41,000	240,058	0	199,058
2017	41,000	240,058	0	199,058
Total (tCO_2e)	**287,000**	**1,680,406**	**0**	**1,393,406**

[Remark]: Above annual estimation of emission reductions is based on calculation uses historical data of COD of the effluent which are currently available. Continuous analysis on waste water can support the larger amount of annual estimation of emission reductions.

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

B.7.1 Data and parameters monitored:

Data / Parameter:	$\mathbf{F_{PJ,dig,m}}$
Data unit:	m^3 /month
Description:	Quantity of wastewater that is treated in the anaerobic digester or under clearly aerobic conditions in the project activity in month *m*
Source of data to be used:	Measured by EPC
Value of data applied for the purpose of calculating expected emission reductions in section B.5	45,000
Description of measurement methods and procedures to be applied:	Volume of wastewater will be monitored continuously with a flow meter which will be installed before the digester. Collected data will be aggregated annually for calculations.
QA/QC procedures to be applied:	Flow meters will undergo maintenance / calibration subject to appropriate industry standards.
Any comment:	The value applied for the purpose of ex-ante estimation was calculated using the design daily flow rate of wastewater (------ m^3/day) and expected annual operating days of the plant (330 days).

Data / Parameter:	$\mathbf{F_{PJ,effl,dig,m}}$

Data unit:	m^3 /month
Description:	Quantity of wastewater from the digester in month *m*
Source of data to be used:	Measured by EPC
Value of data applied for the purpose of calculating expected emission reductions in section B.5	45,000-
Description of measurement methods and procedures to be applied:	Volume of treated wastewater from the digester will be monitored continuously with a flow meter which will be installed fter the digester. Collected data will be aggregated annually for calculations.
QA/QC procedures to be applied:	Flow meters will undergo maintenance / calibration subject to appropriate industry standards.
Any comment:	The value applied for the purpose of ex-ante estimation was calculated using the design daily flow rate of wastewater (------ m^3/day) and expected annual operating days of the plant (330 days).

Data / Parameter:	$\mathbf{F_{PJ,effl,lag,m}}$
Data unit:	m^3 /month
Description:	Quantity of wastewater from the open lagoon in which the wastewater from the digester is treated in month *m*
Source of data to be used:	Measured by EPC
Value of data applied for the purpose of calculating expected emission reductions in section B.5	45,000-
Description of measurement methods and procedures to be applied:	Volume of treated wastewater from the open lagoon will be monitored continuously with a flow meter which will be installed after the last lagoon. Collected data will be aggregated annually for calculations.
QA/QC procedures to be applied:	Flow meters will undergo maintenance / calibration subject to appropriate industry standards.
Any comment:	The value applied for the purpose of ex-ante estimation was calculated using the design daily flow rate of wastewater (------ m^3/day) and expected annual operating days of the plant (330 days).

Data / Parameter:	$\mathbf{w_{COD,dig,m}}$
Data unit:	t COD/ m^3
Description:	Average chemical oxygen demand in the wastewater that is treated in the anaerobic digester or under clearly aerobic conditions in the project activity in month m
Source of data to be used:	Measured by EPC

Value of data applied for the purpose of calculating expected emission reductions in section B.5	0.21 (tentative value)
Description of measurement methods and procedures to be applied:	Regular sampling of wastewater flowing into a digester will be monitored with COD analyzer.
QA/QC procedures to be applied:	Measure the COD according to national or international standards
Any comment:	

Data / Parameter:	$\mathbf{w_{COD,effl,dig,m}}$
Data unit:	t COD/ m^3
Description:	Average chemical oxygen demand in treated wastewater from the digester o in month m
Source of data to be used:	Measured by EPC
Value of data applied for the purpose of calculating expected emission reductions in section B.5	0.021 (tentative value)
Description of measurement methods and procedures to be applied:	Regular sampling of wastewater flowing into a digester will be monitored with COD analyzer.
QA/QC procedures to be applied:	Measure the COD according to national or international standards
Any comment:	

Data / Parameter:	$w_{COD,effl,lag,m}$
Data unit:	t COD/ m^3
Description:	Average chemical oxygen demand in the effluent from the open lagoon in which the effluent from the digester is treated.
Source of data to be used:	Measured by EPC
Value of data applied for the purpose of calculating expected emission reductions in section B.5	0.0063
Description of measurement methods and procedures to be applied:	Regular sampling of treated wastewater from the open lagoon will be monitored with COD analyzer.

QA/QC procedures to be applied:	Measure the COD according to national or international standards
Any comment:	

Data / Parameter:	$\mathbf{T_{2.m}}$
Data unit:	K
Description:	Average temperature at the project site in month *m*
Source of data to be used:	National or regional weather statistics
Value of data applied for the purpose of calculating expected emission reductions in section B.5	Data outlined in Annex 3
Description of measurement methods and procedures to be applied:	
QA/QC procedures to be applied:	
Any comment:	

Data / Parameter:	$\mathbf{EG_{PJ,y}}$
Data unit:	MWh/year
Description:	Net quantity of electricity generated in year y with biogas from the new anaerobic digester
Source of data to be used:	Measurements on site
Value of data applied for the purpose of calculating expected emission reductions in section B.5	64,944
Description of measurement methods and procedures to be applied:	Monitored continuously using electricity meters. Data will be recorded with a digital recording system and results will be kept electronically.
QA/QC procedures to be applied:	Electricity meters will undergo maintenance/calibration in accordance with manufacturer's specifications.
Any comment:	

Data / Parameter:	$\mathbf{F_{biogas,y}}$
Data unit:	m^3 /yr
Description:	Amount of biogas collected in the outlet of the new digester in year *y*

Source of data to be used:	Measured by EPC
Value of data applied for the purpose of calculating expected emission reductions in section B.5	42,443,280
Description of measurement methods and procedures to be applied:	Amount of biogas will be measured continuously with a gas flow meter. The collected data will be aggregated annually for calculations.
QA/QC procedures to be applied:	Flow meters will undergo maintenance / calibration subject to appropriate industry standards.
Any comment:	

Data / Parameter:	$w_{CH4,biogas,y}$
Data unit:	kg CH_4 / m^3
Description:	Concentration of methane in biogas in the outlet of the new digester
Source of data to be used:	Measured by EPC
Value of data applied for the purpose of calculating expected emission reductions in section B.5	0.3938
Description of measurement methods and procedures to be applied:	Using calibrated continuous gas analyser or alternatively with periodical measurement at 95% confidence level. For ex-ante calculation, the value was calculated using biogas methane concentration (---%, volume/volume), molar mass of methane (16.0425gCH_4/mol)
QA/QC procedures to be applied:	Near infrared spectrometry will undergo maintenance / calibration subject to appropriate industry standards. The project proponents shall define the error for different levels of measurement frequency. The level of accuracy will be deducted from average concentration o measurement.
Any comment:	

Data / Parameter:	$S_{LA,y}$
Data unit:	m^3/year
Description:	Quantity of sludge applied to land in year
Source of data to be used:	Measured by EPC
Value of data applied for the purpose of calculating expected	0

emission reductions in section B.5	
Description of measurement methods and procedures to be applied:	It is expected that the sludge will not be generated under the project activity. However, the end-use of the sludge will be monitored and documented and in case of land application, the project emissions from such activity will be calculated ex-post.
QA/QC procedures to be applied:	N/A
Any comment:	

Data / Parameter:	$w_{N,sludge,LA}$
Data unit:	t N/ t sludge
Description:	Mass fraction of nitrogen in the sludge applied to land in year y
Source of data to be used:	Measured by EPC
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:	It is expected that the sludge will not be generated under the project activity. However, the end-use of the sludge will be monitored and documented and in case of land application, sample sludge will be submitted to a certified third party laboratory to analyze nitrogen in sludge.
QA/QC procedures to be applied:	
Any comment:	

Data / Parameter:	$fv_{i,h}$
Data unit:	-
Description:	Volumetric fraction of component i in the residual gas in the hour h where i = CH_4, CO, CO_2, O_2, H_2, N_2
Source of data to be used:	Measured by EPC using a continuous gas analyzer
Value of data applied for the purpose of calculating expected emission reductions in section B.5	CH_4: 70% CO: 0% CO_2: 0% O_2: 0% H_2: 0% N_2 : 30%
Description of measurement methods and procedures to be applied:	This parameter will be monitored continuously and values will be averaged hourly. The same basis (dry or wet) will be considered for this measurement and the measurement of the volumetric flow rate of the residual gas ($FV_{RG,h}$) when the residual gas temperature exceeds 60˚C.
QA/QC procedures to	Analysers will be periodically calibrated according to the manufacturer's

be applied:	recommendation. A zero check and a typical value check will be performed by comparison with a standard certified gas.
Any comment:	As discussed in Section B.6.1, $PE_{flare,y}$ for ex-ante calculation was set to 0 tCO2/yr . As a simplified approach, project participants may only measure the methane content of the residual gas and consider the remaining part as N_2.

Data / Parameter:	**$FV_{RG,h}$**
Data unit:	m^3/h
Description:	Volumetric flow rate of the residual gas in dry basis at normal conditions in the hour *h*
Source of data to be used:	Measured by EPC using a flow meter
Value of data applied for the purpose of calculating expected emission reductions in section B.5	-
Description of measurement methods and procedures to be applied:	This parameter will be monitored continuously and values will be averaged hourly. The same basis (dry or wet) will be considered for this measurement and the measurement of volumetric fraction of all components in the residual gas ($fv_{i,h}$) when the residual gas temperature exceeds 60˚C.
QA/QC procedures to be applied:	Flow meters are to be periodically calibrated according to the manufacturer's recommendation.
Any comment:	As discussed in Section B.6.1, $PE_{flare,y}$ for ex-ante calculation was set to 0 tCO2/yr .

Data / Parameter:	**T_{flare}**
Data unit:	^oC
Description:	Temperature in the exhaust gas of the flare
Source of data to be used:	Measurements by EPC
Value of data applied for the purpose of calculating expected emission reductions in section B.5	-
Description of measurement methods and procedures to be applied:	Continuously monitored. Measure the temperature of the exhaust gas stream in the flare by a Type N thermocouple. A temperature above 500˚C indicates that a significant amount of gases are still being burnt and that the flare is operating.
QA/QC procedures to be applied:	Thermocouples should be replaced or calibrated every year.
Any comment:	As discussed in Section B.6.1, $PE_{flare,y}$ for ex-ante calculation was set to 0 tCO2/yr .

B.7.2 Description of the monitoring plan:

All monitoring equipment will be installed by experts and regularly calibrated to the highest standards by EPC. EPC will form a team to maintain and operate the project activity and monitor the parameters required by the methodology. The team will be composed of a plant manager, a Production/Biogas plant supervisor, a Genset/biogas boiler plant supervisor and operational staff. Figure 5 outlines the structure of operational and management of the project activity.

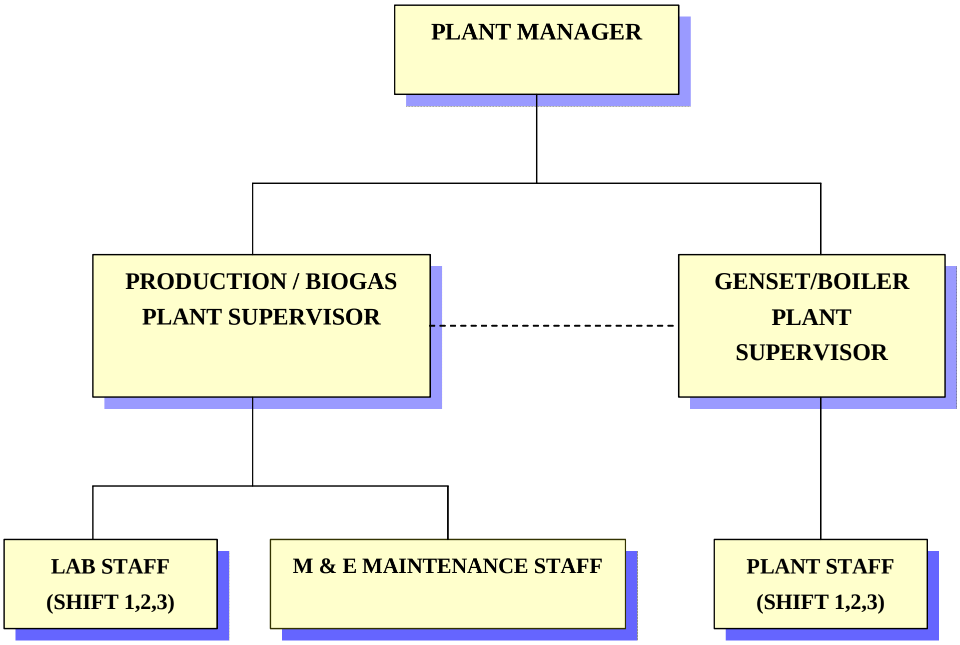

Figure 5: Operational and management structure of the project activity

The team will be the authority that is responsible for the management and operation of the project activity which includes the monitoring of the parameters required for the emission reduction calculation.

Plant manager will be responsible for the management of the team. Plant manager's responsibilities include:

- To review and approve the monthly monitoring report
- To review and approve the calibration schedule
- To review and approve the regular training plan
- To review the results of the calibration and the regular training
- To review and approve an Emergency Management Plan
- To ensure the corrective actions for erroneous measurements and uncertainty

Production/Biogas plant supervisor and Genset plant supervisor will be responsible for the supervision of the staff and the review of the monitored parameters. Supervisors' responsibilities include:

- To review the daily recorded parameters and report aggregated data to the Plant manager on a monthly basis
- To prepare the calibration schedule as per the recommendation of the manufacturer
- To prepare/conduct the regular training plan

- To prepare an Emergency Management Plan
- To initiate the corrective actions for any erroneous measurement and uncertainty found

Each staff will monitor the assigned parameters and conduct lab experiment on a timely basis. Operators are also responsible for reporting erroneous measurement, uncertainty of the parameters for which he/she is responsible.

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

The baseline study was completed on 06/01/2010 by the Clean Energy Finance Committee, Mitsubishi UFJ Securities. The contact details of Mitsubishi UFJ Securities Co., Ltd. appear below:

Clean Energy Finance Committee,
Mitsubishi UFJ Securities Co., Ltd.
watanabe-hajime@sc.mufg.jp

The Clean Energy Finance Committee, Mitsubishi UFJ Securities Co., Ltd. is the CDM Advisor to the Project (not a project participant)..

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:

1 January 2010

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

23 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 July 2011 or the date of registration whichever is later

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. Documentation on the analysis of the environmental impacts, including transboundary impacts:

According to Thai law, the Designated National Authority (DNA) requires either an Environmental Impact Assessment or an Initial Environmental Evaluation (IEE) as part of the DNA approval process for CDM projects. In cases where a project generates power, the EIA is required for any power plant with an installed capacity above 10MW. Based on this size category, the project activity is not mandated to conduct the EIA but the IEE is deemed to be necessary. The project participant is currently selecting a consultant to carry out the study to determine possible environmental impacts, including transboundary impacts.

Thai environmental regulation and standards are delineated below;

1. Air Emission

   There are three potential power plant's stack pollution of significance: Sulfur Dioxide (SO2), Nitrogen Oxides (NOx), and total suspended particulate (TSP). The Thai Emission Standard, is shown in the table below.

   Table 17: Ambient Air Quality Standard

Emission	Avg. 1 hr		Avg. 8 hr		Avg. 24hr		Avg. 1mo		Avg. 1 yr*		Measurement
Carbon Dioxide	34.2	30	10.26	9	-	-	-				Non-dispersive Infrared Detection
Nitrogen Oxide	0.32	0.17									Chemiluminescence
Sulfur Dioxide	0.78	0.30			0.30	0.12			0.10	0.04	Pararosaniline UV-Flourescence
TSP					0.33				0.10		Gravimetric-High Volume
Particle<10 micron					0.12				0.05		Gravimetric-High Volume
Ozone	0.2	0.1									Chemiluminescence

	0	0									
Lead							1.5				Atomic Absorption Spectrometer

Note: 1.*Arithmetic Mean
2. Reference condition is 25 °C at 1 atm or 760 mmHg, excess air at 50% or excess O2 at 7%.
Source: A Directive by Department of Pollution Control (May 1995)

Table 18: Emission Stands for New Power Plants

Pollutants	Type of Fuel			
	Coal	Oil	Gas	Biomass
Sulfur dioxide (SO_2) (ppm)				
Power Plant Size > 500 MW	320	320	20	60
300 – 500 MW	450	450	20	60
< 300 MW	640	640	20	60
Oxide of Nitrogen (As NO_2) (ppm)	350	180	120	200
Particulates (mg/m^3)	120	120	60	120

Note: Reference condition is 25 °C at 1 atm or 760 mmHg, excess air at 50% or excess O2 at 7%.
Source: A Directive by Department of Pollution Control (May 1995)

2. Sound and Noise

Table 1
19: Sound Level Standard

Standard	Sound Level [dB(A)]
Maximum Level	Not more than 115
Average 24 hours	Not more than 70

Source: A Directive by Department of Pollution Control (March 1997)

3. Wastewater standard for Industries and Industrial Estates

Table 20: Waste Water Standard for Industries and Industrial Estates

Parameter	Standard Level	Measurement
1. pH	5.5 – 9.0	pH Meter
2. TDS	≤ 3,000 mg/l	Evaporate at Temperature 103-105 C within 1 hour
3. Suspended Solids	≤ 50 mg/l	Glass Fiber Filter Disc
4. Temperature	≤ 40 C	Thermometer
5. Color and Odor	Acceptable	Not indicated
6. Sulfide as H_2S	≤ 1 mg/l	Titrate
7. Cyanide as HCN	≤ 0.2 mg/l	Condensation and Pyridine Barbituric Acid

8. Fat, Oil and Grease	≤ 5 mg/l	Dissolution and Separation
9. Formaldehyde	≤ 1 mg/l	Spectrophotometry
10. Phenols	≤ 1 mg/l	Condensation and 4-Aminoantipyrine
11. Free Chlorine	≤ mg/l	Lodometric Method
12. Pesticides	No Allowance	Gas-Chromatography
13. BOD	≤ 20 mg/l	Azide Modification at Temperature 20 C within 5 days
14. Total Kjeldahi Nitrogen (TKN)	≤ 100 mg/l	Kjeldahi
15. COD	≤ 120 mg/l	Potassium Dichromate Digestion
16. Heavy Metals		
a. Zinc	≤ 5 mg/l	Atomic Absorption Spectrophotometry (Direct Aspiration Type) or Plasma Emission Spectroscopy (Inductive Coupled Plasma Type)
b. Hexavalent Chromium	≤ 0.25 mg/l	
c. Trivalent Chromium	≤ 0.75 mg/l	
d. Copper	≤ 2 mg/l	
e. Cadmium	≤ 0.03 mg/l	
f. Barium	≤ 1 mg/l	
g. Lead	≤ 0.2 mg/l	
h. Nickel	≤ 1 mg/l	
i. Manganese	≤ 5 mg/l	
j. Arsenide	≤ 0.25 mg/l	Atomic Absorption Spectrophotometry (Hydride Generation) or Plasma Emission Spectroscopy (Inductive Coupled Plasma Type)
k. Seranium	≤ 0.02 mg /l	
l. Mercury	≤ 0.005 mg/l	Atomic Absorption Cold Vapour Technique

Source: A Directive by Department of Pollution Control (January 1996)

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:

As described above, no significant adverse environmental impacts are expected to result from the project activity.

SECTION E. Stakeholders' comments

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

E.2. Summary of the comments received:

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

No negative comments were received from the participants.

Annex 1

CONTACT INFORMATION ON PARTICIPANTS IN THE PROJECT ACTIVITY

Organization:	
Street/P.O.Box:	
Building:	
City:	
State/Region:	
Postfix/ZIP:	
Country:	
Telephone:	
FAX:	
E-Mail:	
URL:	
Represented by:	
Title:	
Salutation:	
Last Name:	
Middle Name:	
First Name:	
Department:	
Mobile:	
Direct FAX:	
Direct tel:	
Personal E-Mail:	

Organization:	
Street/P.O.Box:	
Building:	
City:	
State/Region:	
Postfix/ZIP:	
Country:	
Telephone:	
FAX:	
E-Mail:	
URL:	
Represented by:	
Title:	
Salutation:	
Last Name:	
Middle Name:	
First Name:	
Department:	
Mobile:	
Direct FAX:	
Direct tel:	
Personal E-Mail:	

Annex 2

INFORMATION REGARDING PUBLIC FUNDING

The project involves no ODA or public funding from Parties that are Annex I signatories to the Kyoto Protocol.

Annex 3

BASELINE INFORMATION

Baseline calculations

Table 21: MCF method parameters

m 0	$T_{2,m}$ (K)	$COD_{PJ,m}$ (tCOD /month)	$COD_{available,m}$ (tCOD /month)	$COD_{BL,m}$ (tCOD /month)	$f_{T,m}$ -	exp	$f_{T,m} \times COD_{available,m}$ (tCOD /month)	$COD_{PJ,available,m}$ (tCOD /month)	$COD_{PJ,effl,dig,m}$ (tCOD /month)	$COD_{PJ,effl,lag,m}$ (tCOD /month)	$f_{T,m} \times COD_{PJ,available,m}$ (tCOD /month)
1	300.2	9,450	6,615	6,615	0.7768	0.7768	5,138	662	945	284	514
2	300.7	9,450	7,870	6,615	0.8103	0.8103	6,377	787	945	284	638
3	301.7	9,450	7,547	6,615	0.8815	0.8815	6,653	755	945	284	665
4	302.2	9,450	7,225	6,615	0.9192	0.9192	6,641	722	945	284	664
5	301.2	9,450	7,733	6,615	0.8452	0.8452	6,536	773	945	284	654
6	301.2	9,450	7,812	6,615	0.8452	0.8452	6,603	781	945	284	660
7	301.2	9,450	7,824	6,615	0.8452	0.8452	6,613	782	945	284	661
8	300.7	9,450	8,099	6,615	0.8103	0.8103	6,563	810	945	284	656
9	300.2	9,450	8,423	6,615	0.7768	0.7768	6,543	842	945	284	654
10	300.7	9,450	8,213	6,615	0.8103	0.8103	6,655	821	945	284	665
11	295.7	9,450	10,497	6,615	0.5273	0.5273	5,535	1,050	945	284	554
12	295.7	9,450	11,576	6,615	0.5273	0.5273	6,105	1,158	945	284	610
Total		**113,400 (tCOD /yr)**		**79,380 (tCOD /yr)**	0.7813 (Average)		**75,962 (tCOD /yr)**		**11,340 (tCOD /yr)**	**3,402 (tCOD /yr)**	**7,596 (tCOD /yr)**

Grid CEF calculations

The grid emission factor used in the project activity was obtained from the official report from the Thai DNA, entitled "The estimation of emission factor for an electricity system in Thailand 2007", issued on 26 January 2009[3].

Department of Alternative Energy Development and Efficiency (DEDE), Ministry of Energy has published Thai grid emission factor for year 2007.

According to the document, the emission factor calculation follows procedures outlined in "Tool to calculate the emission factor for an electricity system" version01.1, which is the latest version currently available.

The Simple OM method was chosen as the method of calculating the Operating Margin ("OM"). However, in the aforementioned report, the Build Margin ("BM") was calculated using generation data from IPPs only, ignoring generation from Electricity Generating Authority of Thailand (EGAT), Small Power Producers (SPPs), and Very Small Power Producers (VSPPs). However it is not possible to replicate the calculation because fuel consumption for each power plant connected to the grid is not disclosed in the document due to the confidentiality concerns.

[3] http://www2.dede.go.th/cdm/doc.htm

TGO supports the use of this emission factor (0.5057 kgCO2/kWh) as Thai grid emission factor for now until the updated emission factor becomes available. However, as a conservative approach, the project participant has decided to use the total generation of all generators for calculating the BM, in order to arrive at a lower BM figure, and hence a lower CM.
As a result, BM is reduced to 0.3959 (15,170,168 / 38,321 or (total generation of all IPP generators) /1000).

The calculations are shown below:

$$EF_y = w_{OM,y} \cdot EF_{OM,y} + w_{BM,y} \cdot EF_{BM,y}$$
$$= (0.5) \cdot (0.5716) + (0.5) \cdot (0.3959)$$
$$= 0.4838$$

Annex 4

MONITORING INFORMATION
