



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

CONTENTS

- A. General description of project activity
- B. Application of a baseline and monitoring methodology.
- C. Duration of the project activity / crediting period
- D. Environmental impacts
- E. Stakeholders' comments

Annexes

- Annex 1: Contact information on participants in the project activity
- Annex 2: Information regarding public funding
- Annex 3: Baseline information
- Annex 4: Monitoring plan



Abbreviations

UASB	Upflow Anaerobic Sludge Blanket
COD	Chemical Oxygen Demand
GHG	Greenhouse gas
IRR	Internal rate of return
CCS	Chok Chai Starch Co., Ltd.

**SECTION A. General description of project activity****A.1 Title of the project activity:**

Chok Chai Starch Wastewater Treatment and Energy Generation Project in Uthai Thani, Thailand (the Project)

Version 1.0 28/04/2008

A.2. Description of the project activity:

Chok Chai Starch Co., Ltd. (CCS) manufactures Native and Modified Starch, extracted and refined from tapioca root, at its starch factory in Uthai Thani Province, in the lower part of the North region of Thailand. The production of Native starch, totalling about 90,000 tonnes (at full capacity) annually, produces a large amount of high organic content wastewater, which emits methane when treated in anaerobic open lagoons prior to land application for agricultural use in eucalyptus plantations that surround the lagoons, on-site.

The Project, to be carried out by CCS at its starch factory, is the installation and operation of an anaerobic digestion and methane recovery system for the treatment of wastewater coupled with an energy generation system. In the absence of the Project, the wastewater will be treated in a series of anaerobic open lagoons, emitting methane during the long decomposition process. The captured methane will be collected and destructed in:

- (a) two (2) hot oil burners which are used for the production of hot thermal oil for heating air in process dryers; and
- (b) a 450kW power generator to produce electricity for on-site consumption, after purification of the biogas; and
- (c) an open type flare, in case of excess biogas production.

These activities are expected to replace up to approximately 3 million litres of bunker oil per year that would have been used in the absence of the project activity.

The Project will therefore be responsible for two types of emission reductions. The first is the avoidance of methane, a potent greenhouse gas (GHG), that would be emitted from the baseline open lagoons, through its capture and destruction. The second is the displacement of fossil fuels by the Project's carbon neutral energy, which will result in the reductions of carbon dioxide emissions from the combustion of bunker oil for onsite heat production and fossil fuel displacement via grid electricity displacement. The project activity is expected to reduce GHGs by an average of about 65,000 tonnes annually.

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

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



- Reduction in reliance of fossil fuels. The project activity will displace internal bunker oil consumption. While the Project itself is a small one, it is nevertheless significant in that the replication of such projects nation-wide will amount to a large reduction in the long term.

A.3. Project participants:
Table 1: Table of project participants

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

Chok Chai Starch Co., Ltd. (CCS)

CCS is a Thai-based producer of starch founded in 2002 and is one of the major producers of premium quality native and modified tapioca starches to the Asian and European markets. CCS is one of the subsidiaries under Keng Seng Group, established in 1969, which runs tapioca soft and hard pellet businesses.

CCS is the entity implementing the project activity.

Mitsubishi UFJ Securities Co., Ltd. (MUS)

Through its Clean Energy Finance Committee, MUS provides consulting services to promote Clean Development Mechanism (CDM) and Joint Implementation (JI) projects. MUS is the CDM advisor to the Project and the contact for the project activity.

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.:

Uthai Thani Province

A.4.1.3. City/Town/Community etc:

Tambon Tubluang, Amphur Banrai, Uthai Thaneer Province



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

Uthai Thani Province is approximately 219 km north of Bangkok and has an area of 6,730 km², sharing borders with Nakhon Sawan, Chainat, Suphanburi, Tak, Kamphaeng Phet, and Kanchanaburi Provinces. The major industry is agriculture, with principal crops including rice, tapioca, sugar cane and some maize.

The project is located at 224 Moo 2, Tubluang-Danchang Road, Tubluang, Banrai, Uthai Thane 61140, Thailand. The factory is on Route 333 in the Southern of Uthai Thani Province, about 26 km north of the Danchang intersection. The area is predominantly agricultural, with rice grown in low-lying areas and tapioca or sugar cane grown on higher, dryer ground.

The facility can be separated into two phases as follows:

Phase I

Biogas from Phase I is generated from digestion of the high organic content wastewater from the production of Native starch. The biogas system was commissioned as Phase I in June 2004. It is estimated that approximately 90,000 tonnes of Native starch is produced annually.

Phase II

Biogas from Phase II will be generated from digestion of the high organic content wastewater from the production of Native starch expansion line which is anticipated to be constructed in year 2009.

The CDM project activity for which this PDD is prepared involves only Phase I. Therefore, only activities occurred from Phase I are included in the project boundary. If and when CCS implements Phase II, this will be dealt with as a separate CDM project.



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

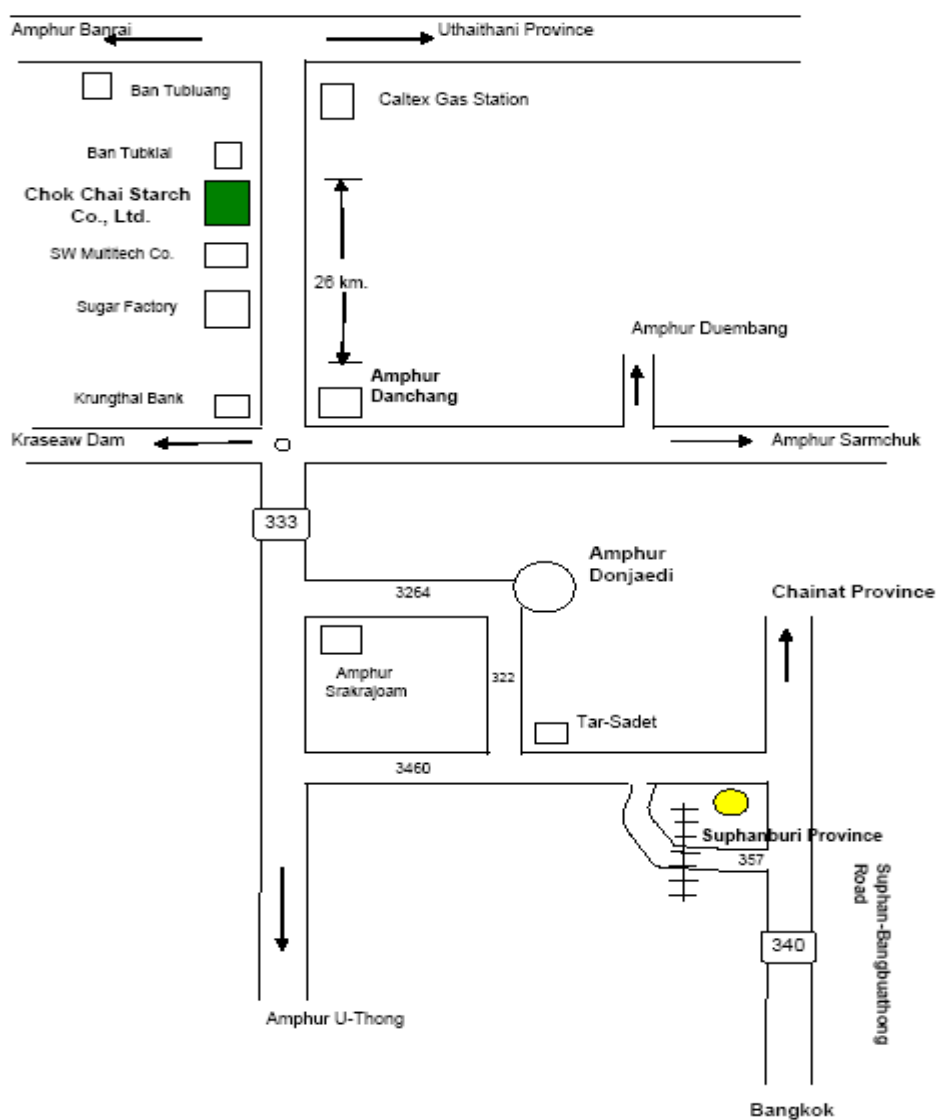


Figure 2: Direction to the plant in Thai (information from CCS)

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

The Project fits under the following two categories of project activity:

- Sectoral Scope 13
Waste handling and disposal

A.4.3. Technology to be employed by the project activity:**Wastewater treatment system:**

Under the project activity, the wastewater will be treated with an Upflow Anaerobic Sludge Blanket (UASB) tank with an active volume of 4,650 m³, then treated with aerobic post treatment. In the digester, the organic compounds in the wastewater are broken down with the help of anaerobic bacteria, which thrive in the absence of oxygen. The digester uses an anaerobic process which forms a blanket of granular sludge that is suspended in the tank. Wastewater flows upwards through the blanket and is processed by the anaerobic microorganisms.

The designed hydraulic retention time in the anaerobic digester is 1.87 days, reducing the Chemical Oxygen Demand (COD) load by approximately 90%, and the biogas recovered, before the wastewater is discharged for further treatment in the existing open lagoons followed by an activated sludge system.

The final effluent is either a) pumped via underground piping to the surrounding eucalyptus plantation, which covers approximately 5+ hectares of the CCS premises or b) gravity flowed to wetland. The effluent from wetland is recycled to use within the project site during the dry season

A relatively small amount of sludge is removed infrequently from the existing open lagoons. When sludge is removed, it is given to local farmers for application on tapioca fields or used on-site for soil application.

Thermal energy generation system:

A 4,000,000 kcal/hr burner will be co-fired using biogas collected in the UASB system and fuel oil. The hot thermal oil produced from burner is used in heating air in Native starch process dryers. Biogas will be fed to 2nd burner for Modified starch process dryers only when the 1st burner is shut down. In the absence of the Project, approximately 3 millions liter of additional bunker oil per year will be required for Phase I process. Under the project, the bunker oil is replaced by biogas generated in the UASB system.

**Power generation system:**

Under the Project, approximately 1,000 m³/hr biogas is generated in the UASB digester. The biogas amount ranging from 300 to 350m³/hr, is purified and used as feed for the 450kW GUASCOR power generator to produce roughly 3,406 MWh/year of electricity for onsite consumption.

Excess biogas flare:

The biogas flare is designed to ignite on overpressure of the biogas supply to the burners, although it can be operated with a nominal flow to enable a constant flare. While it has the capacity to handle 100% of the biogas flow or up to 1,200 m³/hr, under normal operation the flare is not utilized.

The situations before and after the start of implementation of the project activity are illustrated in Figures below.

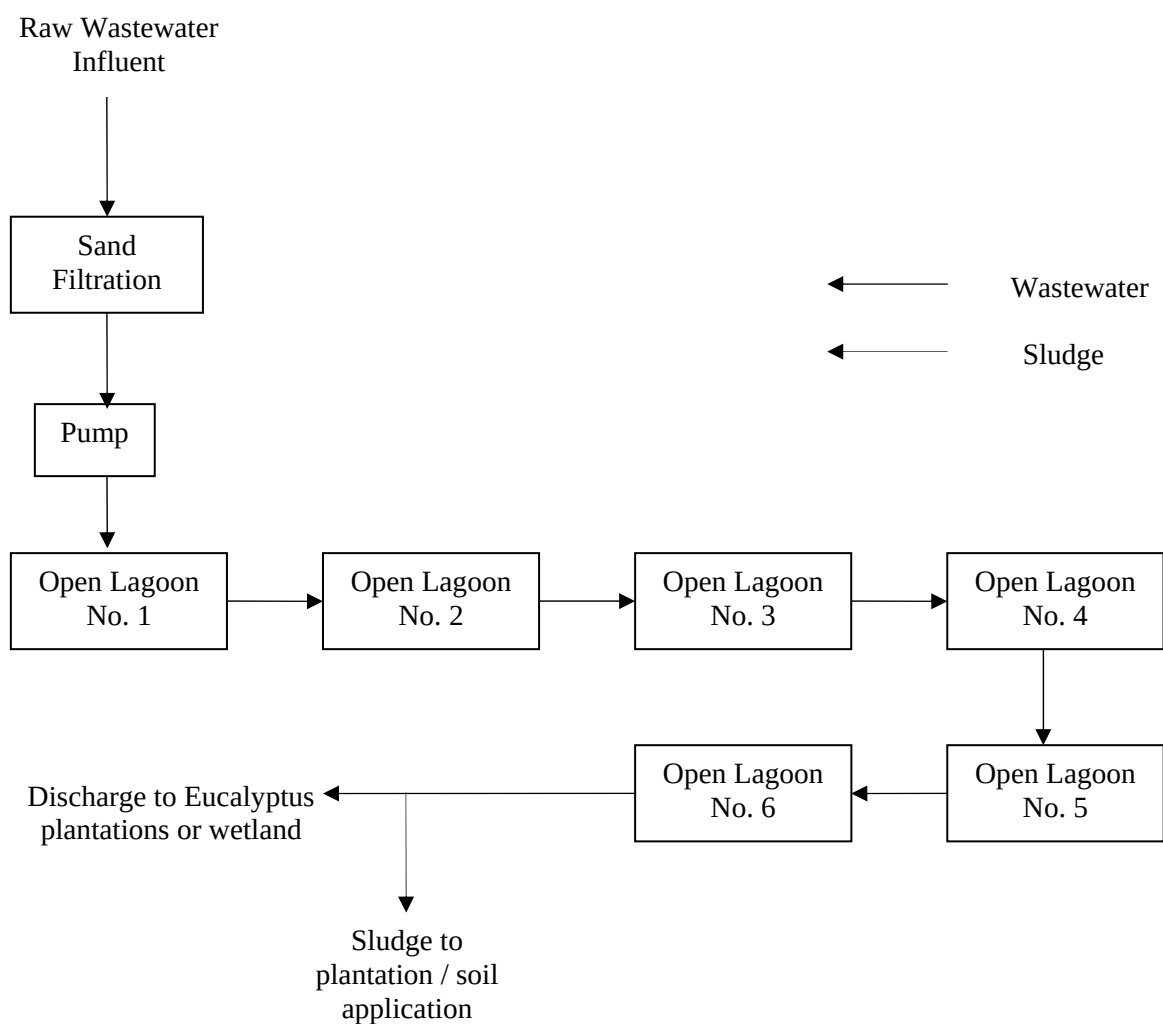
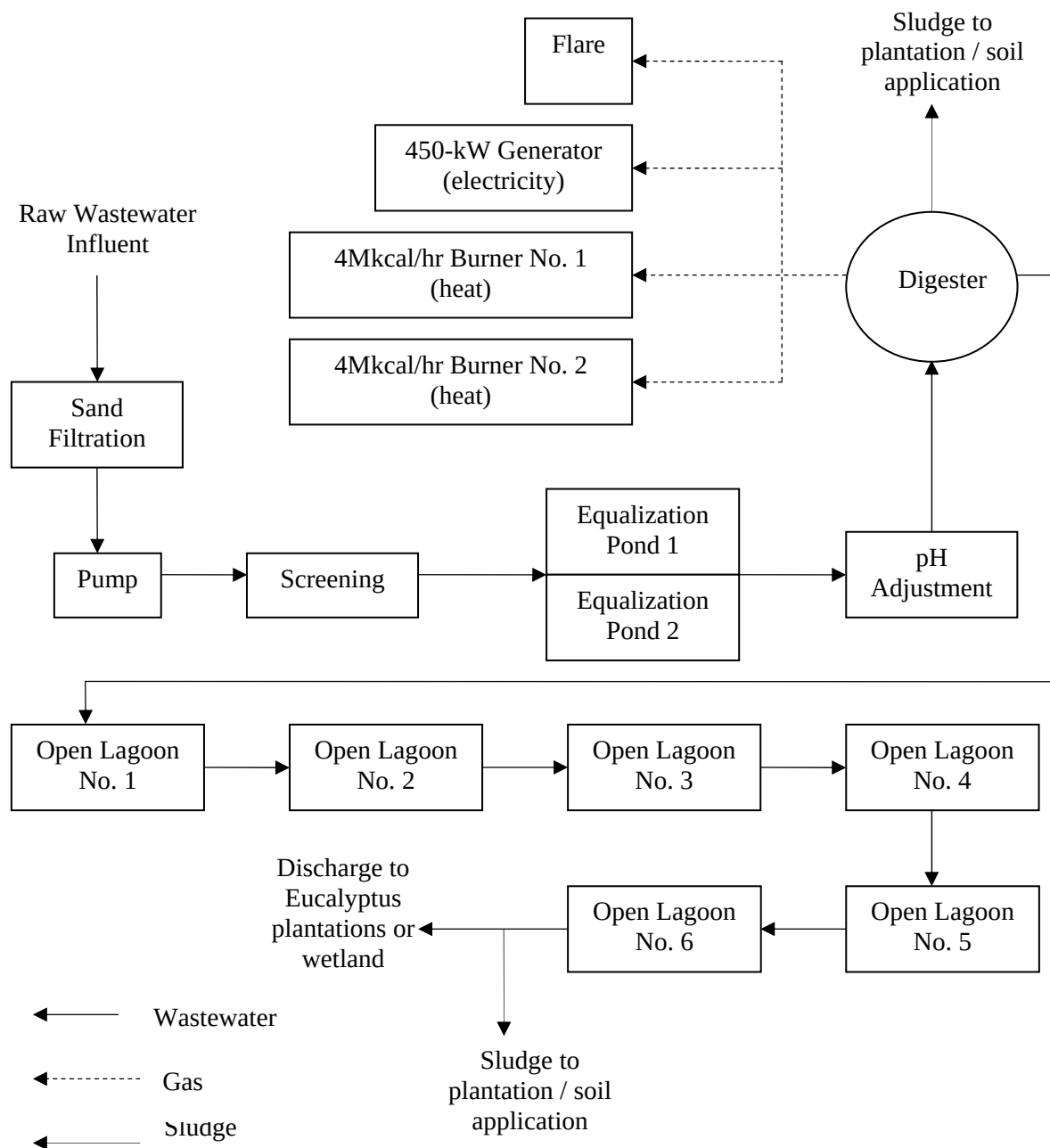


Figure 3: Layout of the wastewater treatment plant in the absence of the project

**Figure 4: Layout of the wastewater treatment plant after the implementation of the project activity**

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

The estimated amount of emission reductions over the crediting period is shown below.

Table 2: *Ex ante* estimation of emission reductions

Years	Estimation of annual emission reductions in tonnes of CO ₂ e
2009	57,997
2010	57,997
2011	57,997
2012	57,997
2013	57,997
2014	57,997
2015	57,997
2016	57,997
2017	57,997
2018	57,997
Total estimated reductions (tonnes of CO ₂ e)	579,970
Total number of crediting years	10
Annual average of the estimated reductions over the crediting period (tCO ₂ e)	57,997

A.4.5. Public funding of the project activity:

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

**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 following approved baseline and monitoring methodology is applied.

- ACM0014: “Avoided methane emissions from wastewater treatment”
Version 02.1, valid from 28/03/2008

The tools used in the PDD are listed below:

- Version 05 of the *Tool for the demonstration and assessment of additionality* (“Additionality Tool”),
- Version 01 of the *Tool to calculate the emission factor for an electricity system*,
- Version 01 of the *Tool to determine project emissions from flaring gases containing methane* (“Flaring Tool”),
- Version 01 of the *Tool to calculate baseline, project and/or leakage emissions from electricity consumption*, and
- Version 01 of the *Tool to calculate project or leakage CO₂ emissions from fossil fuel combustion*

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

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

Table 3: Scenarios applicable to the methodology

Scenario	Description of the historical situation	Description of the project activity
1	The wastewater is not treated, but directed to open lagoons that have clearly anaerobic conditions.	CCS’s wastewater is treated in a new anaerobic digester. The biogas extracted from the anaerobic digester is used to generate heat and electricity and flared. The residual from the anaerobic digester after treatment is directed to open lagoons.
2	The wastewater is treated in a wastewater treatment plant. Sludge is generated from primary and/or secondary settlers. The sludge is directed to sludge pit(s) that have clearly anaerobic conditions.	This scenario is not applicable to the project activity.

Therefore, the project activity of wastewater treated in a new anaerobic digester, scenario 1, is applied for this project.

Table 4: Applicability conditions for Scenario 1

Applicability condition		Project case
1	The average depth of the open lagoons or sludge	The average depth of the open lagoons are at



	pits is at least 1 m.	least 1 m. Four of six ponds are over 5 m deep
2	Heat and electricity requirements per unit input of the water treatment facility remain largely unchanged in the baseline scenario and the project activity	Heat and electricity requirements per unit input of the water treatment facility remain largely unchanged in the baseline scenario and the project activity. This can be supported with historical records.
3	Data requirements as laid out in this methodology are fulfilled	Data requirements in this methodology can be fulfilled
4	The residence time of the organic matter in the open lagoon system should be at least 30 days	The residence time of the organic matter in the open lagoon system was over 30 days, based on lagoon design and flow rate
5	Local regulations do not prevent discharge of wastewater in open lagoons	This condition is not relevant to the project. The effluent of the wastewater at the open lagoons discharge point is below the local regulations standard. However, the effluent is discharged either to Eucalyptus plantation or wetland.

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

As per the methodology, the spatial extent of the project boundary includes:

- The site where the wastewater is treated in both the baseline and the project scenario;
- Any on-site power plants that supply electricity to the wastewater;
- Any on-site facilities to generate heat that is used by the wastewater treatment system;
- The anaerobic digester, the power and heat generation equipment and the flare installed under the project activity;
- If grid electricity is displaced from electricity generation with biogas from an aerobic digester: 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 emission sources included in the project boundary are described in Table 5 below.

Table 5: Emission sources included and excluded from the project boundary

Source		Gas	Included/ Excluded	Justification / Explanation
Baseline	Wastewater treatment process	CH ₄	Included	The major source of emissions in the baseline from open lagoons
		N ₂ O	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	The Project displaces fossil fuel based electricity with electricity generation from biogas.
		CH ₄	Excluded	Excluded for simplification. This is conservative.
		N ₂ O	Excluded	Excluded for simplification. This is conservative.
	Thermal energy generation	CO ₂	Included	The Project displaces fossil fuel oil with biogas generated from anaerobic digester for thermal energy generation.
		CH ₄	Excluded	Excluded for simplification. This is conservative.



Project activity	Wastewater treatment process	N ₂ O	Excluded	Excluded for simplification. This is conservative.
		CH ₄	Included	The treatment of wastewater under the project activity causes different emissions: (i) Methane emissions from the lagoons; (ii) Physical leakage of methane from the digester system; (iii) Methane emissions from flaring.
		CO ₂	Excluded	CO ₂ emissions from the decomposition of organic waste are not accounted for.
		N ₂ O	Excluded	Excluded for simplification. As per ACM0014, sludge treatment is not included in the project boundary for scenario 1.
	On-site electricity use	CO ₂	Included	On-site electricity consumed by project activity which is not generated from biogas will be accounted for.
		CH ₄	Excluded	Excluded for simplification. This emission source is assumed to be very small.
		N ₂ O	Excluded	Excluded for simplification. This emission source is assumed to be very small.
	On-site fossil fuel consumption	CO ₂	Included	On-site fossil fuel consumed by project activity which is not generated from biogas will be accounted for.
		CH ₄	Excluded	Excluded for simplification. This emission source is assumed to be very small.
		N ₂ O	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:

The most plausible baseline scenario is identified in the following steps:

- 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

The alternative scenarios available to CCS and that provide comparable outputs to the Project are summarized in the table below.

Table 6: List of plausible alternatives to the Project

Alternative	Wastewater treatment	Energy production	Description of alternative scenario
A	Sequential treatment using UASB system and existing open lagoon (W5)	Used to produce process heating and electricity (H3, E3)	The Project undertaken without being registered as a CDM project activity
B	Sequential treatment using	Not utilized, i.e.	The wastewater treatment



	UASB system and existing open lagoon (W4)	continuation use of grid electricity and bunker oil (H2, E2)	method is the same as the Project, but does not include biogas utilization and hence smaller capital cost
C	Sequential treatment using anaerobic/aerobic system other than UASB and existing open lagoon (W5 / W3)	Used to produce process heating (H3, E3) or not utilized (in the case of aerobic system), i.e. continuation use of grid electricity and bunker oil (H2, E2)	This alternative involves an upgrade to a wastewater treatment system with comparable results to the Project
D	Open lagoons (W1)	Uncontrolled release into the atmosphere, i.e. continuation use of grid electricity and bunker oil (H2, E2)	This is the continuation of current practice
E	Open lagoons in short- to medium-term, upgrade to sequential treatment using UASB system and existing open lagoon in future (W1 and W5)	Uncontrolled release into the atmosphere in short- to medium-term, i.e. continuation use of grid electricity and bunker oil (H2, E2), used to produce process heating in future (H3, E3)	This is the continuation of current practice, with the Project undertaken without being registered as a CDM project activity in the future

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

All alternatives identified are complying with applicable laws and regulations.

Step 3. Eliminate alternatives that face prohibitive barriers

Of the five alternatives identified in Step I above, all but Alternative D, the continuation of current practice, can be immediately ruled out as plausible alternatives, as delineated below.

Alternative A: As further discussed in Section B.5 below, this alternative involves high risk and upfront capital cost that is not acceptable to CCS in the absence of the CDM.

Alternative B: This is a less advantageous option as compared to Alternative A. While the upfront cost is lower, not only does this alternative involve the same high risks, but there is no cost recovery in the form of reduced fossil fuel consumption.

Alternative C: This alternative is not plausible for similar reasons to Alternative A. Biogas recovery systems can be largely divided into two categories. The first category represented by Alternative A involves high capital costs. The second category represented by Alternative C involves a cheaper technology. Despite the lower cost, the latter alternative is still not feasible due to the significantly lower performance and reliability, which project developers find unacceptable.

Alternative D: This is the continuation of current practice. CCS' original plan prior to the decision to proceed with the CDM project activity was to continue treatment of its wastewater in the existing lagoons,



and to increase the capacity of the open lagoons either by increasing the number of ponds or increasing the volume of each pond as necessary to cater for any increase in starch production capacity.

Alternative E: This alternative involves the implementation of the Project without the assistance of the CDM not immediately but in the future. For the same reasons outlined for Alternative A, this alternative was not acceptable to CCS. In addition, as briefly discussed in Alternative D, the project circumstances will remain the same in the future, as the CCS starch factory has an abundance of land such that any increase in production capacity or tightening of discharge limits can be catered for by simply increasing the capacity of the open lagoons.

Therefore, the most plausible baseline scenario is Alternative D, the continuation of current practice. As only one alternative remains, per ACM0014, Alternative D is considered the baseline.

Step 4. Compare economic attractiveness of remaining alternatives

This is not relevant as reason given above. As per ACM0014, Alternative D is considered the baseline.

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):
--

The Project's additionality is demonstrated by applying the latest version of the "Tool for the demonstration and assessment of additionality" (Version 05)

Step 1. Identification of alternatives to the project activity consistent with current laws and regulations

Realistic and credible alternatives to the project activity is identified in this step through the following sub-steps.

Sub-step 1a. Define alternatives to the project activity

See Section B.4. The most plausible baseline scenario is the continuation of current practice.

Sub-step 1b. Consistency with mandatory laws and regulations

All alternatives identified are consistent with mandatory laws and regulations.

Step 2. Investment analysis

The IRR is chosen as the most suitable indicator for the project type and decision-making context.

Sub-step 2a – Determine the appropriate analysis method

As the CDM project activity generates financial benefits in the form of reduced consumption of fuel oil, the simple cost analysis is not appropriate. Of the remaining investment comparison analysis and benchmark analysis, the benchmark analysis is chosen.

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

At the time the Project was being considered by CCS in early 2003, the treatment in anaerobic open lagoons was a prevalent and standard industry practice, being by far the least cost option for wastewater treatment that meets the legal discharge limit. While other options, such as the installation of an anaerobic digester (the Project carried out without the CDM) are also available, all require significant investments in comparison to the simple, low-tech open lagoon. Reflecting risks such as the risk posted to the smooth operation of the factory as well as the significant investments involved, the internal benchmark IRR used by CCS at the time was 20%. If retrospectively, one applies the benchmark analysis, a premium would have been added to the government bond rate of a little above 4% at the time, to reflect risks to private sector investment and the significant risk inherent to using an unfamiliar technology, particularly in view of the potential to adversely affect the core business at CCS. This would have resulted in a benchmark of between 15% and 20%. A benchmark in this range is supported by the National Energy Policy Office's¹ study Biomass-based Power Generation and Cogeneration within Small Rural Industries of Thailand, which cites a hurdle rate of 23%. Despite this study being for biomass, rather than biogas fuels, the IRR it cites is pertinent to this Project as the study focuses on energy generation in the context of rural food industries.

For conservatism, an IRR of 15% is adopted.

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

The following table summarizes the Project's IRR calculation, including all assumptions made.

Table 7: Assumptions and results for calculation of the Project's IRR

Input Parameters		Value	Unit	Notes
Total cost for CDM project activity		78,000,000	THB	
Loan	Equity percentage	100	%	
	Interest rate	N/A		
	Loan period	N/A		
Annual costs	Operation and Maintenance	3,900,000	THB/year	5% of total cost
	Cost of chemicals	2.56	THB/m ³ effluent	To maintain optimal digester operation
Fuel savings / Power income		6.99 2.15	THB/litre THB/kWh	5-year average oil price from 1998 – 2002
Depreciation	Depreciation rate	5,200,000	THB/year	
	Salvage value	0	THB	
Tax rate		30	%	Applied to increased profit from fuel savings
Project life		15	years	
Operating	Operating days in year	330	days	

¹ The National Energy Policy Office is the predecessor to the Energy Policy and Planning Office, both under the Ministry of Energy



parameters	COD load of raw effluent	15.0	kg/m ³	Based on historic records
	COD treatment efficiency	90	%	From technology provider (mid-range values adopted)
	Biogas generation rate	0.35	m ³ /kgCOD	
	Biogas methane content	65	% by volume	
	Biogas leakage from digester	15	%	CCS assumption
	Methane energy content	36.3	MJ/m ³	
	Flare rate	0		For normal operation
	Fuel oil heat value	41.2	MJ/l	From CCS' fuel supplier
IRR		8.96	%	

As can be seen in the above table, the IRR of the Project if carried out under business-as-usual stands at 8.96%, well below the expected IRR of 15%.

Sub-step 2d – Sensitivity analysis

In order to test the robustness of the assumptions made, sensitivity analyses were carried out as follows:

1. 10% decrease in annual costs (O&M and chemicals). This is a realistic target that CCS is striving to achieve.
2. 20% increase in biogas capture. This is also a target that CCS is striving to achieve, by maximising the quality and stability of the biogas captured.
3. 5% increase in fuel prices. Based on CCS expectations.

The above changes in assumptions increased the IRRs for each of the cases to 9.76%, 11.67% and 12.67% respectively. The sensitivity analyses show that in spite of the range of realistic and optimistic assumptions made, the project returns remain unfavourable.

It is noteworthy that the COD loading of the wastewater is indirectly proportional to the extraction efficiency of the starch in the factory. Thus, maximizing the project activity's returns is at odds with maximizing profits from CCS' core business. Naturally, priority is given to running the core business of starch production, regardless of whether it results a lower COD load and therefore lower biogas yield. The possibility of lower biogas yields exacerbates the problem of a low IRR.

Furthermore, the implementation of the Project required an upgrading of skills for the proper operation and maintenance of the anaerobic digester, as well as the gas burners. There are numerous variables, such as the COD load of incoming wastewater and the temperature conditions that affect the quantity and quality of the biogas. As the quality of the biogas feed is crucial to the smooth operation of the burners, which in turn is important for the uninterrupted operation of the starch factory, the upgrading of skills was a significant challenge to CCS.

The challenge is even more significant when taking into account the context of the food processing industry, where very few plant owners have ventured into advanced technology for wastewater treatment. Indeed, it is understood that most projects which are now attempting to introduce this technology is doing so with the assistance of the CDM, while others did so with funding sources no longer available. Against



this backdrop, the technology barrier faced by CCS is too high to justify the risk of going ahead under business-as-usual.

Sub-step 3b – Show that the identified barriers would not prevent the implementation of at least one of the alternatives (except the proposed project activity)

The continuation of current practice does not require any upgrading of skills.

It would have been the most economical way to implement this option as the existing lagoons are still in good conditions. The wastewater treatment for the plant could and would have been treated using the existing open lagoon system for years. If it is required, the number or volume of lagoons can be increased when Phase II is implemented.

Thus, at least one option, the continuation of current practice, would not have been prevented by the barriers identified in Sub-step 3a.

Step 4. Common practice analysis

Sub-step 4a – Analyze other activities similar to the proposed project activity

According to the Thai Tapioca Starch Association, there are 75-80 tapioca starch plants in Thailand. Of these, there are approximately 15 plants of a similar size to CCS that have or have just completed the installation of biogas recovery systems, including CIGAR, UASB and CSTR technologies.

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

Of all of these Projects, the majority of them have been implemented within the past three years, after the implementation of the CDM-registered Korat Waste to Energy Project. It is understood that these projects were commenced on the strong expectation, as is the case for CCS, of eventual Thai government approval².

Starting dates of the project activity and validation

It is required that where the starting date of the project activity falls before the date of validation, evidence is to be provided to show that the incentive from the CDM was seriously considered in the decision to proceed with the project activity. As given in Section C.1.1., the starting date of the project activity, was March 2004, which is prior to commencement of the validation.

There is evidence to show that CCS seriously considered the CDM from the very early stages of the project development. The Project was first considered as a solution to the problem of odours from the open lagoon treatment system but was not implemented due to the high costs involved. Various consultants then advised CCS of the attractiveness of an advanced treatment system due to the CER revenues, and there was much talk in the industry from all biogas digester suppliers. It is thought that all similar projects were developed with the same goal in mind.

² The Thai DNA handed out the first LoAs to projects in 2007, many years after the inception of many projects including the A.T.Biopower and Korat projects, which were initiated in 2001/2.

**B.6. Emission reductions:****B.6.1. Explanation of methodological choices:**

The emission reduction due to the Project is calculated in the following manner.

$$ER_y = BE_y - PE_y \quad \text{Equation 1}$$

Baseline Emissions

Baseline emissions are estimated as follows:

$$BE_y = BE_{CH_4,y} + BE_{EL,y} + BE_{HG,y} \quad \text{Equation 2}$$

where:

- BE_y = Baseline emissions in year y (tCO₂e/yr)
- $BE_{CH_4,y}$ = Methane emissions from anaerobic treatment of the wastewater in open lagoons in the absence of the project activity in year y (tCO₂/yr)
- $BE_{EL,y}$ = CO₂ emissions associated with electricity generation that is displaced by the project activity and / or electricity consumption in the absence of the project activity in year y (tCO₂/yr)
- $BE_{HG,y}$ = CO₂ emissions associated with fossil fuel combustion for heating equipment that is displaced by the project in year y (tCO₂/yr)

The calculation method and input values of the baseline emissions are described in the ensuing tables. Baseline emissions are calculated in three steps, as follows:

- Step 1: Calculation of baseline emissions from anaerobic treatment of the wastewater;
- Step 2: Calculation of baseline emissions from generation and consumption of electricity (if applicable);
- Step 3: Calculation of baseline emissions from heat generation (if applicable);

Steps 2 and 3 are applicable in this project as electricity and heat are generated from biogas generated in the anaerobic digester.

Step 1: Calculation of baseline emissions from anaerobic treatment of the wastewater

As required by ACM0014, one of the two given methods, the Organic Removal Ratio (ORR) Method (Step 1b), is selected for the estimation of methane emissions from open lagoons.

Table 8: Formulae, input values and data sources for the calculation of $BE_{CH_4,y}$

Parameter	Description	Value	Source
-----------	-------------	-------	--------



Equation 3			
$BE_{CH_4,y} = GWP_{CH_4} \times B_o \times (COD_{BL,y} - COD_{aerobic,BL} - COD_{OX,BL,y} - COD_{se\ dim,BL,y})$			
$BE_{CH_4,y}$	Methane emissions from anaerobic treatment of the wastewater in open lagoons in the absence of the project activity in year y (tCO ₂ /yr)	Calculated	Refer to Equation 3
GWP_{CH_4}	Global Warming Potential of methane valid for the commitment period (tCO ₂ e/tCH ₄)	21	ACM0014
B_o	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	ACM0014
$COD_{BL,y}$	Quantity of chemical oxygen demand that would be treated in open lagoons in the absence of the project activity in year y (tCOD / yr)	Calculated	Refer to Equation 4
$COD_{aerobic,BL}$	Annual quantity of chemical oxygen demand that would degrade aerobically in the lagoon (tCOD / yr)	Calculated	Refer to Equation 5
$COD_{OX,BL,y}$	Annual quantity of chemical oxygen demand that would be chemically oxidised through sulphate in the wastewater in year y (tCOD / yr)	Calculated	Refer to Equation 6
$COD_{se\ dim,BL,y}$	Amount of chemical oxygen demand lost through sedimentation in the lagoon before the start of the project activity (tCOD / yr)	Calculated	Refer to Equation 7
Equation 4			
$COD_{BL,y} = AD_{BL} \times COD_{PJ,y}$ $COD_{BL,y} = \left[1 - \frac{COD_{out,x}}{COD_{in,x}} \right] \times \left[\sum_{m=1}^{12} F_{PJ,dig,m} \times w_{COD,dig,m} \right]$			
$COD_{BL,y}$	Quantity of chemical oxygen demand that would be treated in open lagoons in the absence of the project activity in year y (tCOD / yr)	Calculated	Refer to Equation 4
AD_{BL}	Effluent adjustment factor expression the percentage of COD that is degraded in open lagoons in the absence of the project activity	0.992	Refer to Equation 4



$COD_{PJ,y}$	Quantity of chemical oxygen demand that is treated in the anaerobic digester in the project activity in year y (tCOD / yr)	15,444	Refer to Equation 4	
$COD_{out,x}$	COD of the effluent in the period x (t COD / year)	123.55	As per maximum allowable COD effluent (0.12 kgCOD/m ³) under Thai regulations	
$COD_{in,x}$	COD directed to the open lagoons in the period x (t COD / year)	15,444	As per historical records 2004-05 CCS, to be monitored	
$F_{PJ,dig,m}$	Quantity of wastewater that is treated in the anaerobic digester in the project activity in month m (m ³ / month)	Month	$F_{PJ,dig,m}$	CCS, to be monitored
		Jan	96,720	
		Feb	87,360	
		Mar	96,720	
		Apr	93,600	
		May	96,720	
		Jun	93,600	
		Jul	96,720	
		Aug	96,720	
		Sep	-	
		Oct	81,120	
		Nov	93,600	
		Dec	96,720	
$w_{COD,dig,m}$	Average COD in the wastewater that is treated in the anaerobic digester in the project activity in month m (t COD / m ³)	0.015	CCS, to be monitored	
Equation 5				
$COD_{aerobicBL} = A \times f_{COD,aerobic}$				
$COD_{aerobic,BL}$	Annual quantity of chemical oxygen demand that would degrade aerobically in the lagoon (tCOD / yr)	Calculated	Refer to Equation 5	
A	Surface of the lagoon (ha)	6.15	CCS, to be validated	
$f_{COD,aerobic}$	Quantity of COD degraded to CO ₂ under aerobic conditions per surface area of the lagoon (tCOD/ha yr)	92.7	ACM0014	
Equation 6				
$COD_{OX,BL,y} = F_{PJ,y} \times \sum_s w_{s,y} \times R_s \times 0.001$				
$COD_{OX,BL,y}$	Annual quantity of chemical oxygen demand that would be chemically	Calculated	Refer to Equation 6	



	oxidised through sulphate in the wastewater in year y (tCOD / yr)		
$F_{PJ,y}$	Quantity of wastewater treated in the digester in year y (m ³ / yr)	1,029,600	CCS, to be monitored
$w_{s,y}$	Average concentration of chemical oxidative substances in the wastewater treated in digester in year y (kg/m ³)	0	There are no chemical oxidatives used in the process
R_s	Specific reduction in COD by substance s (t COD / t substance)	0	There are no chemical oxidatives used in the process
Equation 7			
$COD_{se\ dim, BL, y} = \sum_1^i [area_i \times increase_i] \times \rho_density \times COD_content$			
$COD_{se\ dim, BL, y}$	Amount of chemical oxygen demand lost through sedimentation in the lagoon before the start of the project activity (tCOD / yr)	Calculated	Refer to Equation 7
area	Area of the each lagoon (m ²)	28,140 for # 1 14,875 for # 2 5,849 for # 3 5,905 for # 4 4,357 for # 5 2,400 for # 6	CCS
increase	Increasing of each pond water level height due to sedimentation (m/year)	0	Assumed for the purpose of <i>ex ante</i> estimation, to be monitored
$\rho_sediment$	Sediment density (ton/m ³)	1.0	Assumed for the estimation, CCS, to be monitored
COD_content	B-fraction COD content (g COD/g sediment; wet basis)	0	Assumed for the purpose of <i>ex ante</i> estimation, to be monitored
i	Number of lagoon	6	CCS

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

In this step, baseline emissions are calculated from consumption of electricity associated with the treatment of wastewater (scenario 1) and from generation of electricity in the grid (E2).

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

Table 9: Formula, input values and data sources for the calculation of $BE_{EL,y}$

Parameter	Description	Value	Source
-----------	-------------	-------	--------



Equation 8			
$BE_{EL,y} = (EC_{BL,y} + EG_{PJ,y}) \times EF_{BL,EL,y}$			
$BE_{EL,y}$	CO ₂ emissions associated with electricity generation that is displaced by the project activity and / or electricity consumption in the absence of the project activity in year y (tCO ₂ /yr)	Calculated	Refer to Equation 8
EC_{BL}	Annual quantity of electricity that would be consumed in the absence of the project activity for the treatment of the wastewater (MWh/yr)	0	Assumed as it is very small. This is allowed under ACM0014 as a simplification measure
$EG_{PJ,y}$	Net quantity of electricity generated in year y with biogas from the new anaerobic biodigester (MWh/yr)	3,406	CCS, to be monitored
$EF_{BL,EL,y}$	Baseline emission factor for electricity generated and/or consumed in the absence of the project activity in year y (tCO ₂ /MWh)	0.448	$EF_{BL,EL,y} = EF_{grid,y}$ as the baseline scenario for displacement of electricity generated with biogas from the anaerobic digester is E2. Refer to Annex 3

Step 3: Baseline emissions from generation of heat

In the Project, fossil fuels from the generation of heat in burners are displaced (scenario H2). In this step, baseline emissions are calculated as follows:

Table 10: Formula, input values and data sources for the calculation of $BE_{HG,y}$

Parameter	Description	Value	Source
Equation 9			
$BE_{HG,y} = \frac{HG_{PJ,y} \times EF_{CO2,FF,boiler}}{\eta_{BL,burner}}$			
$BE_{HG,y}$	CO ₂ emissions associated with fossil fuel combustion for heating equipment that is displaced by the project in year y (tCO ₂ /yr)	Calculated	Refer to Equation 9
$HG_{PJ,y}$	Net quantity of heat generated in year y with biogas from the new anaerobic	66.35	CCS, to be monitored.



	digester (TJ/year)		
$EF_{CO_2,FF,burner}$	CO ₂ emission factor of the fossil fuel type used in burner for heat generation in the absence of the project activity (tCO ₂ /TJ)	77.4	IPCC 2006 Table 2.2 (for residual fuel oil)
$\eta_{BL,burner}$	Efficiency of the burner that would be used for heat generation in the absence of the project activity	N/A	HG _{PJ,y} is based on heat input, not output, for the <i>ex ante</i> estimation, to be monitored

Project Emissions

Emissions attributed to the project activity depend on scenario 1 in Table 1 and the configuration of the project activity. The following project emission sources are applicable to the Project.

- (i) Methane emissions from the lagoons (effluent from the treatment under the project activity is directed to a lagoon system);
- (ii) Physical leakage of methane from the digester system;
- (iii) Methane emissions from flaring;
- (iv) CO₂ emissions from consumption of electricity and / or fossil fuels in the project activity.

Project emissions are calculated as follows:

$$PE_y = PE_{CH_4,effluent,y} + PE_{CH_4,digest,y} + PE_{flare,y} + PE_{EC,y} + PE_{FC,y} \quad \text{Equation 10}$$

where:

- PE_y = Project emissions in year y (tCO₂e/yr)
- $PE_{CH_4,effluent,y}$ = Project emissions from treatment of wastewater effluent from the anaerobic digester in year y (tCO₂e/yr)
- $PE_{CH_4,digest,y}$ = Project emissions from physical leakage of methane from the anaerobic digester in year y (tCO₂e/yr)
- $PE_{flare,y}$ = Project emissions from flaring of biogas generated in the anaerobic digester in year y (tCO₂/yr)
- $PE_{EC,y}$ = Project emissions from electricity consumption in year y (tCO₂/yr)
- $PE_{FC,y}$ = Project emissions from fossil fuel consumption in year y (tCO₂/yr)

The calculation method and input values of the project emissions in accordance with ACM0014 are described in the ensuing tables.

(i) Project methane emissions from effluent from the digester



A new digester is installed under the project activity and the effluent from this digester is directed to open lagoons (scenario 1). In this step, the calculation of any CH₄ emissions is conservatively carried out in the same way as for the baseline using the organic removal ratio (ORR) method and is calculated as follows:

Table 11: Formula, input values and data sources for the calculation of $PE_{CH_4, effluent, y}$

Parameter	Description	Value		Source
Equation 11				
$PE_{CH4, effluent, y} = GWP_{CH4} \times B_o \times (COD_{PJ, effl, dig, y} - COD_{PJ, aerobic} - COD_{PJ, OX, y} - COD_{PJ, se\ dim, y} - COD_{PJ, effl, lag, y})$				
$PE_{CH4, effluent, y}$	Project emissions from treatment of wastewater effluent from the anaerobic digester in year y (tCO2e/yr)	Calculated		Refer to Equation 11
GWP_{CH4}	As per Table 8	See above		See above
B_o	As per Table 8	See above		See above
$COD_{PJ, effl, dig, y}$	Quantity of COD in the effluent from the digester in year y (tCOD/yr)	Calculated		Refer to Equation 12
$COD_{PJ, aerobic}$	Annual quantity of COD that degrades aerobically in the lagoon under the project activity (tCOD/yr)	Calculated		Refer to Equation 13
$COD_{PJ, OX, y}$	Annual quantity of COD that is chemically oxidized through oxidizing substances in the effluent from digester in year y (tCOD/yr)	Calculated		Refer to Equation 14
$COD_{PJ, se\ dim, y}$	Amount of COD lost through sedimentation in the lagoon under the project activity (tCOD/yr)	Calculated		Refer to Equation 15
$COD_{PJ, effl, lag, y}$	Quantity of COD in the effluent of the open lagoon in which the effluent from digester is treated in year y (tCOD/yr)	Calculated		Refer to Equation 16
Equation 12				
$COD_{PJ, effl, dig, y} = \sum_{m=1}^{12} F_{PJ, effl, dig, m} \times w_{COD, effl, dig, m}$				
$COD_{PJ, effl, dig, y}$	Quantity of COD in the effluent from the digester in year y (tCOD/yr)	Calculated		Refer to Equation 12
$F_{PJ, effl, dig, m}$	Quantity of effluent from the digester in month m (m ³ /month)	Month	$F_{PJ, effl, dig, m}$	CCS, to be monitored
		Jan	96,720	
		Feb	87,360	
		Mar	96,720	
		Apr	93,600	
		May	96,720	
		Jun	93,600	
		Jul	96,720	



		Aug	96,720	
		Sep	-	
		Oct	81,120	
		Nov	93,600	
		Dec	96,720	
$w_{\text{COD,effl,dig,m}}$	Average COD in the effluent from the digester in month m (tCOD/m ³)	0.0015		CCS, to be monitored
Equation 13				
$\text{COD}_{\text{PJ,aerobic}} = A \times f_{\text{COD,aerobic}}$				
$\text{COD}_{\text{PJ,aerobic}}$	Annual quantity of COD that degrades aerobically in the lagoon under the project activity (tCOD/yr)	Calculated	Refer to Equation 13	
A	Surface of the lagoon (ha)	6.15	CCS, to be validated	
$f_{\text{COD,aerobic}}$	Quantity of COD degraded to CO2 under aerobic conditions per surface area of the lagoon (tCOD / ha yr)	92.7	ACM0014	
Equation 14				
$\text{COD}_{\text{PJ,OX,y}} = \sum_m^{12} F_{\text{PJ,effl,dig,m}} \times \sum_s w_{\text{s,effl,y}} \times R_s \times 0.001$				
$\text{COD}_{\text{PJ,OX,y}}$	Annual quantity of COD that is chemically oxidized through oxidizing substances in the effluent from digester in year y (tCOD/yr)	Calculated	Refer to Equation 14	
$F_{\text{PJ,effl,dig,m}}$	As per Table 10	See above	See above	
$w_{\text{s,effl,y}}$	Average concentration of chemical oxidative substance s in the effluent from digester in year y (kg/m ³)	0	There are no chemical oxidatives used in the process	
R_s	Specific reduction in COD by substance s (t COD/t substance)	0	There are no chemical oxidatives used in the process	
s	Substances in the effluent of the digester that can chemically oxidize organic matter	None		
Equation 15				
$\text{COD}_{\text{se dim,PJ,y}} = \sum_1^i [\text{area}_i \times \text{increase}_i] \times \rho_{\text{density}} \times \text{COD}_{\text{content}}$				
$\text{COD}_{\text{se dim,PJ,y}}$	Amount of COD lost through sedimentation in the lagoon under the project activity (tCOD/yr)	Calculated	Refer to Equation 15	
area	Area of the each lagoon pond (m ²)	28,140 for # 1 14,875 for # 2 5,849 for # 3 5,905 for # 4 4,357 for # 5	CCS	



		2,400 for #6	
increase	Increasing of each pond water level height due to sedimentation (m/year)	0	Assumed for the purpose of <i>ex ante</i> estimation, to be monitored
ρ_{sediment}	Sediment density (ton/m ³)	1.0	Assumed for the estimation, CCS, to be monitored
COD_content	B-fraction COD content (g COD/g sediment; wet basis)	0	Assumed for the purpose of <i>ex ante</i> estimation, to be monitored
i	Number of lagoon pond	6	CCS
Equation 16			
$\text{COD}_{\text{PJ,effl,lag,y}} = \sum_{m=1}^{12} F_{\text{PJ,effl,lag,m}} \times W_{\text{COD,effl,lag,m}}$			
$\text{COD}_{\text{PJ,effl,lag,y}}$	Quantity of COD in the effluent of the open lagoon in which the effluent from digester is treated in year y (tCOD/yr)	Calculated	Refer to Equation 16
$F_{\text{PJ,effl,lag,m}}$	Quantity of effluent from the open lagoon in which the effluent from the digester is treated in month <i>m</i> (m ³ /month)	Month	$F_{\text{PJ,effl,lag,m}}$
		Jan	96,720
		Feb	87,360
		Mar	96,720
		Apr	93,600
		May	96,720
		Jun	93,600
		Jul	96,720
		Aug	96,720
		Sep	-
		Oct	81,120
		Nov	93,600
		Dec	96,720
$W_{\text{COD,effl,lag,m}}$	Average COD in the effluent from the open lagoon in which the effluent from the digester is treated in month <i>m</i> (tCOD/m ³)	0.00012	CCS, to be monitored

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

The project activity includes the construction of a new anaerobic digester. The emissions directly associated with the operation of digesters involve the physical leakage of methane from the digester system. In this step, methane emissions from the new digester are calculated as follows:

Table 12: Formula, input values and data sources for the calculation of $PE_{\text{CH}_4,\text{digest,y}}$

Parameter	Description	Value	Source
-----------	-------------	-------	--------



Equation 17			
$PE_{CH_4,digest,y} = F_{biogas,y} \times FL_{biogas,digest} \times W_{CH_4,biogas,y} \times GWP_{CH_4} \times 0.001$			
$PE_{CH_4,digest,y}$	Project emissions from physical leakage of methane from the anaerobic digester in year y (tCO ₂ e/yr)	Calculated	Refer to Equation 17
$F_{biogas,y}$	Amount of biogas collected in the outlet of the new digester in year y (m ³ /yr)	4,864,860	CCS, to be monitored
$FL_{biogas,digest}$	Fraction of biogas that leaks from the digester (m ³ biogas leaked / m ³ biogas produced)	0.15	Default value as per parameter $EF_{CH_4,digest,y}$ in ACM0014
$W_{CH_4,biogas,y}$	Concentration of methane in the biogas in the outlet of the new digester (kg CH ₄ / m ³)	0.65	CCS, to be monitored
GWP_{CH_4}	As per Table 8	See above	See above

(iii) Methane emissions from flaring

Under the project activity, biogas generated in the anaerobic digester may be occasionally flared. Methane may be released as a result of incomplete combustion in the flare. In this step, methane emissions from flaring are calculated based on the latest approved version of the “Tool to determine project emissions from flaring gases containing methane” as follows:

Table 13: Formula, input values and data sources for the calculation of $PE_{flare,y}$

Parameter	Description	Value	Source
Equation 18			
$PE_{flare,y} = \sum_{h=1}^{8760} TM_{RG,h} \times (1 - \eta_{flare,h}) \times \frac{GWP_{CH_4}}{1000}$			
$TM_{RG,h} = FV_{RG,h} \times fv_{CH_4,RG,h} \times \rho_{CH_4,n}$			
$PE_{flare,y}$	Project emissions from flaring of biogas generated in the anaerobic digester in year y (tCO ₂ /yr)	Calculated	Refer to Equation 18
$TM_{RG,h}$	Mass flow rate of methane in the residual gas in the hour h (kg/h)	Calculated	Refer to Equation 18
$\eta_{flare,h}$	Flare efficiency in hour h	0.5	Default value for open flare.
GWP_{CH_4}	As per Table 8	See above	See above
$FV_{RG,h}$	Volumetric flow rate of the residual gas in dry basis at normal conditions	0	CCS, to be monitored



	in hour h (m^3/h)		
$fv_{CH_4, RG, h}$	Volumetric fraction of methane in the residual gas on dry basis in hour h	0.65	CCS, to be monitored
$\rho_{CH_4, n}$	Density of methane at normal conditions (kg/m^3)	0.716	Default value provided in Flaring Tool

(iv) Project emissions from electricity consumption $PE_{EC, y}$ and combustion of fossil fuels $PE_{FC, y}$ in the project

Electricity is generated with biogas under the project activity. In this step, the electricity consumption for the operation of the project activity is subtracted from the total on-site electricity generation with biogas in calculating $EG_{PJ, y}$ in the baseline emissions calculation. As $EG_{PJ, y}$ represents the net electricity generation resulting from the project activity, according to the latest approved version of the “Tool to calculate baseline, project and/or leakage emissions from electricity consumption”, $PE_{EC, y} = 0$.

A small amount of fossil fuels is combusted in the project activity. The CO_2 emission from fossil fuel combustion ($PE_{FC, y}$) is calculated using the latest approved version of the “Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion”

Table 14: Formula, input values and data sources for the calculation of $PE_{FC, y}$

Parameter	Description	Value	Source
Equation 19			
$PE_{FC, j, y} = \sum_i FC_{i, j, y} \times COEF_{i, y}$			
$PE_{FC, j, y}$	Project emissions from fossil fuel consumption in year y (tCO_2/yr)	Calculated	Refer to Equation 19
$FC_{i, j, y}$	Quantity of fuel type i combusted in process j during the year y (Liter/yr)	0	CCS, to be monitored
$COEF_{i, y}$	CO_2 emission coefficient of fuel type i in year y (tCO_2 / Liter)	0.00319	CCS, to be monitored, as per fuel oil supplier
i	Fuel types combusted in process j during the year y	Bunker oil	CCS, to be monitored

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

Data / Parameter:	$COD_{out, x}$ $COD_{in, x}$
Data unit:	ton COD / unit of time (year, month)
Description:	- COD of the effluent in the period x - COD directed to the open lagoons (scenario 1) in the period x
Source of data used:	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:	- 123.55 t COD / year (as per maximum allowable COD effluent under Thai regulations) - 15,444 t COD / year (based on historical records in 2004-05)
Justification of the choice of data or description of measurement methods and procedures actually applied :	Undertaken measurements for the typical operation conditions of the plant and ambient conditions of the site
Any comment:	x = Representative historical reference period (at least one year)

Data / Parameter:	B_0
Data unit:	tCH ₄ / tCOD
Description:	Maximum methane producing capacity, expressing the maximum amount of CH ₄ that can be produced from a given quantity of 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 :	No measurement procedures. The default IPCC value for B_0 is used.
Any comment:	Default value of 0.21 kg CH ₄ / kg COD as a conservative assumption

Data / Parameter:	$f_{\text{COD,aerobic}}$
Data unit:	t COD / ha yr
Description:	Quantity of chemical oxygen demand degraded to CO ₂ under aerobic conditions per surface area of the lagoon
Source of data used:	ACM0014
Value applied:	92.7 t COD / ha yr
Justification of the choice of data or description of measurement methods and procedures actually applied :	Default as per ACM0014, applicable to the organic removal ratio method
Any comment:	Applicable to the organic removal ratio method

Data / Parameter:	D
Data unit:	m
Description:	Average depth of the lagoon
Source of data used:	CCS
Value applied:	5.08
Justification of the choice of data or	Determine the average depths of the whole lagoon under normal operating conditions



description of measurement methods and procedures actually applied :	
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 the wastewater
Source of data used:	CCS
Value applied:	0 (it is assumed to be very small)
Justification of the choice of data or description of measurement methods and procedures actually applied :	N/A. This emission source is not considered for simplicity and conservatism.
Any comment:	

Data / Parameter:	$EF_{grid,y}$
Data unit:	tCO ₂ / MWh
Description:	Grid emission factor in year y
Source of data used:	EGAT, DEDE, EPPO, IPCC
Value applied:	0.448
Justification of the choice of data or description of measurement methods and procedures actually applied :	Based on procedures as per the “Tool to calculate the emission factor for an electricity system” See Annex 3
Any comment:	See Annex 3

Data / Parameter:	$EF_{CO_2,FF,burner}$
Data unit:	tCO ₂ / TJ
Description:	CO ₂ emission factor of the fossil fuel type used in the burner for heat generation in the absence of the project activity
Source of data used:	2006 IPCC Guidelines
Value applied:	77.4
Justification of the choice of data or description of measurement methods and procedures actually applied :	No measurement procedures



Any comment:	Default value for residual fuel oil
--------------	-------------------------------------

Data / Parameter:	GWP_{CH_4}
Data unit:	tCO ₂ e / tCH ₄
Description:	Global warming potential for CH ₄
Source of data used:	IPCC
Value applied:	21 for the first commitment period
Justification of the choice of data or description of measurement methods and procedures actually applied :	No measurement procedures
Any comment:	Shall be updated according to any future COP/MOP decisions

Data / Parameter:	Rs
Data unit:	t COD / t substance
Description:	Specific reduction in COD by substance s
Source of data used:	The most conservative default value from review of published literature
Value applied:	0
Justification of the choice of data or description of measurement methods and procedures actually applied :	Not applicable. There is no oxidative substance s such as SO ₄ in CCS' wastewater.
Any comment:	

Data / Parameter:	A
Data unit:	Unit of area (ha)
Description:	Surface of the lagoon
Source of data used:	CCS
Value applied:	- 6.15 for both COD _{aerobic,BL} and COD _{PJ,aerobic} calculations
Justification of the choice of data or description of measurement methods and procedures actually applied :	Measure and check against design area
Any comment:	

B.6.3 Ex-ante calculation of emission reductions:

B.6.3.1 Baseline emissions

**Estimation of $BE_{CH_4,y}$**

Using the formula and input values given in Table 8, $BE_{CH_4,y}$ was calculated as 65,048 tCO₂e/yr.

Estimation of $BE_{EL,y}$

Using the formula and input values given in Table 9, $BE_{EL,y}$ was calculated based on the net quantity of electricity generated with biogas from digester through the generator. The emission from this source was estimated as 1,526 tCO₂e/yr.

Estimation of $BE_{HG,y}$

Using the formula and input values given in Table 10, $BE_{HG,y}$ was calculated as 5,135 tCO₂e/yr.

B.6.3.2 Project emissions**Estimation of $PE_{CH_4,effluent,y}$**

Based on the formula and input values provided in Table 11, $PE_{CH_4,effluent,y}$ was calculated as 3,751 tCO₂e/yr.

Estimation of $PE_{CH_4,digest,y}$

Using the formula and input values given in Table 12, $PE_{CH_4,digest,y}$ was calculated as 9,961 tCO₂e/yr.

Estimation of $PE_{flare,y}$

Based on the formula and input values provided in Table 13, $PE_{flare,y}$ was calculated as 0 tCO₂e/yr.

Estimation of $PE_{FC,y}$

$PE_{FC,y}$ was calculated based on the formula and input values provided in Table 14. The emission from this source was estimated as 0 tCO₂e/yr.

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

**Table 15: Ex-ante estimation of emission reductions**

Year	Estimation of project activity emissions (tCO ₂ e)	Estimation of baseline emissions (tCO ₂ e)	Estimation of leakage (tCO ₂ e)	Estimation of overall emission reductions (tCO ₂ e)
2009	13,712	71,709	0	57,997
2010	13,712	71,709	0	57,997
2011	13,712	71,709	0	57,997
2012	13,712	71,709	0	57,997
2013	13,712	71,709	0	57,997
2014	13,712	71,709	0	57,997
2015	13,712	71,709	0	57,997
2016	13,712	71,709	0	57,997
2017	13,712	71,709	0	57,997
2018	13,712	71,709	0	57,997
Total (tonnes of CO ₂ e)	137,120	717,090	0	579,970

B.7 Application of the monitoring methodology and description of the monitoring plan:**B.7.1 Data and parameters monitored:**

The parameters used to determine the project emissions from flaring of the residual gas stream in year y will be monitored as per the “Tool to determine project emissions from flaring gases containing Methane” as follows:

Data / Parameter:	$fv_{i,h}$
Data unit:	-
Description:	Volumetric fraction of component i in the residual gas in the hour h where $i = CH_4$
Source of data to be used:	CCS, to be monitored
Value of data applied for the purpose of calculating expected emission reductions in section B.5	0.65
Description of measurement methods and procedures to be applied:	Using calibrated continuous gas analyzer or alternatively with periodical measurement at 95% confidence level
QA/QC procedures to be applied	CCS will define the error in estimate for different level of measurement frequency. The level of accuracy will be deducted from average concentration of measurement.
Any comment:	Used for the calculations of $PE_{flare,y}$



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:	CCS, directly measured 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:	Ensure that the same basis (dry) is considered and the measurement of volumetric fraction of all components in the residual gas when the temperature exceeds 60 C. Measure continuously. Values to be averaged hourly or at a shorter time interval
QA/QC procedures to be applied	Flow meters are to be periodically calibrated according to the manufacturer's recommendation
Any comment:	Used for the calculations of $PE_{flare,y}$

Data / Parameter:	Other flare operation parameters
Data unit:	-
Description:	Equipments to monitor proper operation of the flare (open flare)
Source of data to be used:	CCS, directly measured using a flame detector and on-line detection system
Value of data applied for the purpose of calculating expected emission reductions in section B.5	N/A
Description of measurement methods and procedures to be applied:	
QA/QC procedures to be applied:	
Any comment:	Used for the calculations of $PE_{flare,y}$

Similarly, the parameters used to determine the project emissions related to the consumption of electricity and heat will be monitored as per the latest approved version of

“Tool to calculate baseline, project and/or leakage emissions from electricity consumption” and

“Tool to calculate project or leakage CO₂ emissions from fossil fuel combustion” as follows:

Data / Parameter:	$EG_{PJ,y}$
--------------------------	-------------



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:	CCS, directly measured
Value of data applied for the purpose of calculating expected emission reductions in section B.5	3,406
Description of measurement methods and procedures to be applied:	Measure continuously by electricity meters. Data will be kept electronically in a systematic and transparent manner.
QA/QC procedures to be applied:	The electricity meter will undergo maintenance / calibration subject to appropriate industry standards. The consistency of the data will be verified through the actual purchase records between CCS and PEA.
Any comment:	Used for the calculation of $BE_{EL,y}$

Data / Parameter:	$EF_{grid,CM,y}$
Data unit:	tCO ₂ /MWh
Description:	Combined margin emission factor for the grid in year y
Source of data to be used:	EGAT, DEDE, EPPO
Value of data applied for the purpose of calculating expected emission reductions in section B.5	0.448
Description of measurement methods and procedures to be applied:	Based on equations as per the “Tool to calculate the emission factor for an electricity system” See Annex 3 Monitoring frequency: - Simple OM: <u>once</u> for each crediting period using the most recent three historical years for which data is available at the time of submission of the CDM-PDD to the DOE for validation (ex-ante option) - Build margin: For the first crediting period, once <i>ex-ante</i> following the guidance included in step 4 as per Tool. For the second and third crediting period, only once <i>ex-ante</i> at the start of the second crediting period.
QA/QC procedures to be applied:	N/A
Any comment:	Used for the calculations of $BE_{EL,y}$ and $PE_{FC,y}$

Data / Parameter:	$TDL_{j,y}$
Data unit:	-
Description:	Average technical transmission and distribution losses for providing electricity to source j in year y



Source of data to be used:	Scenario A is applied. Use a default value of 3% for project and leakage electricity consumption sources
Value of data applied for the purpose of calculating expected emission reductions in section B.5	3%
Description of measurement methods and procedures to be applied:	N/A. Default value as per “Tool to calculate baseline, project and/or leakage emissions from electricity consumption” is used.
Monitoring frequency:	Annually.
QA/QC procedures to be applied:	N/A
Any comment:	Used for the calculations of $BE_{EL,y}$ and $PE_{FC,y}$

Data / Parameter:	$HG_{PJ,y}$
Data unit:	TJ/year
Description:	Net quantity of heat generated in year y with biogas from the new anaerobic digester
Source of data to be used:	CCS calculated, based on directly measured of the amount of biogas captured used for heat generation, the methane content of the gas and the NCV of the methane
Value of data applied for the purpose of calculating expected emission reductions in section B.5	66.35
Description of measurement methods and procedures to be applied:	Using calibrated continuous flow meter
QA/QC procedures to be applied:	Flow meters are to be periodically calibrated according to the manufacturer’s recommendation
Any comment:	Used for the calculation of $BE_{HG,y}$

Data / Parameter:	$NCV_{i,t}$
Data unit:	MJ / l
Description:	Average net calorific value of fossil fuel type <i>i</i> used in the period <i>t</i>
Source of data to be used:	Values provided by CCS’ fuel supplier
Value of data applied for the purpose of calculating expected emission reductions in section B.5	41.2



Description of measurement methods and procedures to be applied:	No measurement procedures as this is third party information. The NCV will be obtained for each fuel delivery, from which weighted average values for the period t should be calculated
QA/QC procedures to be applied:	Verify the values are within the uncertainty range of the IPCC default values as provided in Table 1.2, Vol. 2 of the 2006 IPCC Guidelines. If the values fall out this range, collect additional information from the testing laboratory to justify the outcome or conduct additional measurements.
Any comment:	

Data / Parameter:	$EF_{CO_2,i,t}$
Data unit:	t CO ₂ / TJ
Description:	CO ₂ emission factor of fossil fuel type i used in the period t
Source of data to be used:	IPCC default values at the upper or lower limit – whatever is more conservative – of the uncertainty at a 95% confidence interval as provided in Table 1.4 of Chapter 1 of Vol. 2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories
Value of data applied for the purpose of calculating expected emission reductions in section B.5	77.4 (for residual fuel oil)
Description of measurement methods and procedures to be applied:	No measurement procedures. Any future revision of the IPCC Guidelines will be taken into account
QA/QC procedures to be applied:	N/A
Any comment:	

The parameters used to determine the baseline emissions are as follows:

Data / Parameter:	$F_{PJ,dig,m}$																
Data unit:	m ³ /month																
Description:	Quantity of wastewater that is treated in the anaerobic digester in the project activity in month m																
Source of data to be used:	CCS, directly measured																
Value of data applied for the purpose of calculating expected emission reductions in section B.5	<table border="1"> <thead> <tr> <th>Month</th><th>$F_{PJ,dig,m}$</th></tr> </thead> <tbody> <tr><td>Jan</td><td>96,720</td></tr> <tr><td>Feb</td><td>87,360</td></tr> <tr><td>Mar</td><td>96,720</td></tr> <tr><td>Apr</td><td>93,600</td></tr> <tr><td>May</td><td>96,720</td></tr> <tr><td>Jun</td><td>93,600</td></tr> <tr><td>Jul</td><td>96,720</td></tr> </tbody> </table>	Month	$F_{PJ,dig,m}$	Jan	96,720	Feb	87,360	Mar	96,720	Apr	93,600	May	96,720	Jun	93,600	Jul	96,720
Month	$F_{PJ,dig,m}$																
Jan	96,720																
Feb	87,360																
Mar	96,720																
Apr	93,600																
May	96,720																
Jun	93,600																
Jul	96,720																



	<table> <tr><td>Aug</td><td>96,720</td></tr> <tr><td>Sep</td><td>-</td></tr> <tr><td>Oct</td><td>81,120</td></tr> <tr><td>Nov</td><td>93,600</td></tr> <tr><td>Dec</td><td>96,720</td></tr> </table>	Aug	96,720	Sep	-	Oct	81,120	Nov	93,600	Dec	96,720
Aug	96,720										
Sep	-										
Oct	81,120										
Nov	93,600										
Dec	96,720										
Description of measurement methods and procedures to be applied:	The flow rate is monitored continuously using a flow meter										
QA/QC procedures to be applied:	N/A										
Any comment:	Used for the calculation of $BE_{CH_4,y}$ and $PE_{CH_4,eff,y}$										

Data / Parameter:	$W_{COD,dig,m}$
Data unit:	t COD/m ³
Description:	Average chemical oxygen demand in the wastewater that is treated in the anaerobic digester in the project activity in month <i>m</i>
Source of data to be used:	CCS, directly measured
Value of data applied for the purpose of calculating expected emission reductions in section B.5	0.015
Description of measurement methods and procedures to be applied:	Measure the COD regularly according to national or international standards
QA/QC procedures to be applied:	N/A
Any comment:	Used for the calculation of $BE_{CH_4,y}$

Data / Parameter:	$W_{s,y}$
Data unit:	kg/m ³
Description:	Average concentration of chemical oxidative substance <i>s</i> in the wastewater treated in the digester in year <i>y</i>
Source of data to be used:	CCS, directly measured
Value of data applied for the purpose of calculating expected emission reductions in section B.5	0 (No chemical oxidative substance used in the digester)
Description of measurement methods and procedures to be applied:	Measure the COD regularly according to national or international standards



applied:	
QA/QC procedures to be applied:	N/A
Any comment:	Used for the calculation of $BE_{CH_4,y}$ (Organic removal ratio)

Data / Parameter:	$\eta_{BL,burner}$
Data unit:	%
Description:	Efficiency of the burner that would be used for heat generation in the absence of the project activity
Source of data to be used:	CCS, to be measured
Value of data applied for the purpose of calculating expected emission reductions in section B.5	N/A, as $HG_{PJ,y}$ for <i>ex ante</i> estimation based on heat input, not output
Description of measurement methods and procedures to be applied:	Manufacturer nameplate data for efficiency of the existing equipment or measure combustion efficiency during monitoring
QA/QC procedures to be applied:	Routine maintenance as per manufacturer's recommendation
Any comment:	Used for the calculation of $BE_{HG,y}$

Data / Parameter:	$F_{PJ,effl,dig,m}$																										
Data unit:	$m^3/month$																										
Description:	Quantity of effluent from the digester in month m																										
Source of data to be used:	CCS, directly measured																										
Value of data applied for the purpose of calculating expected emission reductions in section B.5	<table border="1"> <thead> <tr> <th>Month</th><th>$F_{PJ,effl,dig,m}$</th></tr> </thead> <tbody> <tr><td>January</td><td>96,720</td></tr> <tr><td>February</td><td>87,360</td></tr> <tr><td>March</td><td>96,720</td></tr> <tr><td>April</td><td>93,600</td></tr> <tr><td>May</td><td>96,720</td></tr> <tr><td>June</td><td>93,600</td></tr> <tr><td>July</td><td>96,720</td></tr> <tr><td>August</td><td>96,720</td></tr> <tr><td>September</td><td>-</td></tr> <tr><td>October</td><td>81,120</td></tr> <tr><td>November</td><td>93,600</td></tr> <tr><td>December</td><td>96,720</td></tr> </tbody> </table>	Month	$F_{PJ,effl,dig,m}$	January	96,720	February	87,360	March	96,720	April	93,600	May	96,720	June	93,600	July	96,720	August	96,720	September	-	October	81,120	November	93,600	December	96,720
Month	$F_{PJ,effl,dig,m}$																										
January	96,720																										
February	87,360																										
March	96,720																										
April	93,600																										
May	96,720																										
June	93,600																										
July	96,720																										
August	96,720																										
September	-																										
October	81,120																										
November	93,600																										
December	96,720																										
Description of measurement methods	Monitor continuously using flow meter																										



and procedures to be applied:	
QA/QC procedures to be applied:	Flow meters are to be periodically calibrated according to the manufacturer's recommendation
Any comment:	Used for the calculation of, $PE_{CH4, effluent, y}$

Data / Parameter:	$F_{PJ, effl, lag, m}$																										
Data unit:	$m^3/month$																										
Description:	Quantity of effluent from the open lagoon in which the effluent from the digester is treated in month m																										
Source of data to be used:	CCS, directly measured																										
Value of data applied for the purpose of calculating expected emission reductions in section B.5	<table border="1"> <thead> <tr> <th>Month</th><th>$F_{PJ, effl, lag, m}$</th></tr> </thead> <tbody> <tr><td>January</td><td>96,720</td></tr> <tr><td>February</td><td>87,360</td></tr> <tr><td>March</td><td>96,720</td></tr> <tr><td>April</td><td>93,600</td></tr> <tr><td>May</td><td>96,720</td></tr> <tr><td>June</td><td>93,600</td></tr> <tr><td>July</td><td>96,720</td></tr> <tr><td>August</td><td>96,720</td></tr> <tr><td>September</td><td>-</td></tr> <tr><td>October</td><td>81,120</td></tr> <tr><td>November</td><td>93,600</td></tr> <tr><td>December</td><td>96,720</td></tr> </tbody> </table>	Month	$F_{PJ, effl, lag, m}$	January	96,720	February	87,360	March	96,720	April	93,600	May	96,720	June	93,600	July	96,720	August	96,720	September	-	October	81,120	November	93,600	December	96,720
Month	$F_{PJ, effl, lag, m}$																										
January	96,720																										
February	87,360																										
March	96,720																										
April	93,600																										
May	96,720																										
June	93,600																										
July	96,720																										
August	96,720																										
September	-																										
October	81,120																										
November	93,600																										
December	96,720																										
Description of measurement methods and procedures to be applied:	Monitor continuously using flow meter																										
QA/QC procedures to be applied:	Flow meters are to be periodically calibrated according to the manufacturer's recommendation																										
Any comment:	Used for the calculation of $PE_{CH4, effluent, y}$																										

Data / Parameter:	$W_{COD, effl, dig, m}$
Data unit:	$t\ COD/m^3$
Description:	Average chemical oxygen demand in the effluent from the digester in month m
Source of data to be used:	CCS, directly measured
Value of data applied for the purpose of calculating expected emission reductions in section B.5	0.0015



Description of measurement methods and procedures to be applied:	Measure the COD regularly according to national or international standards
QA/QC procedures to be applied:	Standard calibration will be carried out
Any comment:	Used for the calculation of $PE_{CH_4, effluent, y}$

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 in month m
Source of data to be used:	CCS, directly measured
Value of data applied for the purpose of calculating expected emission reductions in section B.5	0.00012
Description of measurement methods and procedures to be applied:	Measure the COD regularly according to national or international standards
QA/QC procedures to be applied:	Standard calibration will be carried out
Any comment:	Used for the calculation of $PE_{CH_4, effluent, y}$

Data / Parameter:	$W_{S, effl, y}$
Data unit:	kg/m ³
Description:	Average concentration of chemical oxidative substance s in the effluent from the digester in year y
Source of data to be used:	CCS, directly measured
Value of data applied for the purpose of calculating expected emission reductions in section B.5	0 (No chemical oxidative substance used in the digester)
Description of measurement methods and procedures to be applied:	Measure regularly according to national or international standards
QA/QC procedures to be applied:	Standard calibration will be carried out by licensed laboratory
Any comment:	For the calculation of $PE_{CH_4, effluent, y}$



Data / Parameter:	$F_{\text{biogas}, y}$
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:	CCS, directly measured
Value of data applied for the purpose of calculating expected emission reductions in section B.5	4,864,860
Description of measurement methods and procedures to be applied:	The flow rate is monitored continuously using a flow meter.
QA/QC procedures to be applied:	Flow meters will undergo maintenance/calibration subject to appropriate industry standards. The frequency of calibration and control procedures will be different for each application.
Any comment:	For the calculation of $PE_{\text{CH}_4, \text{digest}, y}$

Data / Parameter:	$FL_{\text{biogas}, \text{digest}, y}$
Data unit:	$\text{m}^3 \text{biogas leaked} / \text{m}^3 \text{biogas produced}$
Description:	Fraction of biogas that leaks from the digester (similar to parameter $EF_{\text{CH}_4, \text{digest}, y}$)
Source of data to be used:	default value as per parameter $EF_{\text{CH}_4, \text{digest}, y}$ in ACM0014 (based on 2006 IPCC guidelines).
Value of data applied for the purpose of calculating expected emission reductions in section B.5	0.15
Description of measurement methods and procedures to be applied:	Using calibrated portable gas meters to be measured at wet basis or alternatively with periodical measurement at 95% confidence level
QA/QC procedures to be applied:	CCS will define the variability of the concentration and define the error in estimate for different level of measurement frequency. The level of accuracy will be deducted from average concentration of measurement.
Any comment:	For the calculation of $PE_{\text{CH}_4, \text{digest}, y}$

Data / Parameter:	$W_{\text{CH}_4, \text{biogas}, y}$
Data unit:	$\text{kg CH}_4 / \text{m}^3$
Description:	Concentration of methane in biogas in the outlet of the new digester
Source of data to be used:	CCS, to be monitored
Value of data applied	0.65



for the purpose of calculating expected emission reductions in section B.5	
Description of measurement methods and procedures to be applied:	Using calibrated continuous gas analyzer or alternatively with periodical measurement at 95% confidence level
QA/QC procedures to be applied:	CCS will define the error in estimate for different level of measurement frequency. The level of accuracy will be deducted from average concentration of measurement.
Any comment:	For the calculation of $PE_{CH4,digest,y}$

Data / Parameter:	$COD_{PJ,se\ dim,y}$
Data unit:	t COD / yr
Description:	Amount of chemical oxygen demand lost through sedimentation in the lagoon under the project activity
Source of data to be used:	CCS, to be monitored
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:	Sampling procedures described in Annex II as per ACM0014 (twice a year at start of season and end of season)
QA/QC procedures to be applied:	Standard calibration will be carried out
Any comment:	For the calculation of $PE_{CH4,effluent,y}$

B.7.2 Description of the monitoring plan:

CCS will appoint an executive to be responsible for all data monitoring, acquisition and recording for CDM purposes. Staffs have been trained in the operation of all monitoring equipment and all readings will be taken in a systematic and transparent manner under the supervision of management. Quality control and assurance procedures are to be undertaken for data monitored as outlined in the monitoring plan, which will be developed. A database will be maintained to record all relevant data as in the monitoring plan. Such monitoring procedures and management structure will be in accordance with ISO 9001 standard requirements which CCS is accredited for in year 2006.

The management team will review the data archived and submit a complete set of documentation, which indicates the calculation procedure as well as the *ex post* emission reduction estimate, to the general manager regularly. In addition to the internal verification by general manager, this properly recorded



documentation will also be verified externally by an independent Designated Operational Entity (DOE) on an annual basis.

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 in 03/04/2008 by MUS.

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

PDD Writer : Prasit Vaiyavatjamai
pvaiyavatjamai@gmail.com

Quality Control Officer : Kyoko Tochikawa
ktochikawa@cefconsulting.com

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

**SECTION C. Duration of the project activity / crediting period****C.1 Duration of the project activity:****C.1.1. Starting date of the project activity:**

05/03/2004

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

10 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:**

This section is intentionally left blank.

C.2.1.2. Length of the first crediting period:

This section is intentionally left blank.

C.2.2. Fixed crediting period:**C.2.2.1. Starting date:**

01/01/2009 or from the date of registration, whichever is later.

C.2.2.2. Length:

15 years

**SECTION D. Environmental impacts****D.1. Documentation on the analysis of the environmental impacts, including transboundary impacts:**

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

- Improvement of local air quality – odour. One of the major problems associated with wastewater treatment is the pungent odour arising from the open lagoons, during the long decomposition process. By treating the wastewater from the starch factory in a digester that allows accelerated decomposition in a controlled environment, this will significantly improve the air quality, which is important not only beyond the CCS factory's borders, but also to CCS staff within the grounds.
- Improvement of local air quality – fossil fuel. By using the methane contained in the recovered biogas, the Project taps into an unused, environmentally friendly and renewable energy source. In doing so, it will reduce the consumption of fuel oil at the CCS factory.
- Improvement of security of local ground water. Since the biodigester is made from concrete, there is greater security against leakage of waste water into the water sources around the factory compared with open lagoons which could seep or overflow.

No negative impacts are identified with the Project.

It is noted that as SQS will adhere to its environmental management plan for continuous improvement, in accordance with its ISO9001 accreditation.

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

Under Thai regulations, no environmental impact assessment or equivalent were required for the project activity.

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

CCS invited local leaders to inspect its factory premises on 21/07/2004. A total of 18 persons, including the management and committee members of the Tubluang Tambol Administrative Councils³ and a Kamnan and Village Heads from the area attended the session. The attendance list were as follows::

Mr. Anuchit Putklang	CCS Factory Manager
Mr. Tabian Pomkam	Kamnan Tambol Tubluang
Mr. Ongarj Sukput	Tubluang Tambol Administrative
Mr. Prarob Juntorn	Village Head Tubluang Moo 1
Mr. Sawang Juntorn	Village Head Tubklai Moo 2
Mr. Den Thongpatha	Village Head Tubman Moo 3
Mr. Rat Libmee	Village Head Nhongkae Moo 4
Mr. Suvin Chaknam	Village Head Suanploo Moo 5
Mr. Panya Khuntae	Village Head Tungna Moo 6
Mr. Paitool Juntorn	Village Head Par U Moo 7
Mr. Prom Haewpetch	Village Head Rungaroon Moo 8
Mr. Amphur Intar	Village Head Par Bua Moo 9
Mr. Jarun Mahawonganan	Village Head Sang Chan Moo 11
Mr. Suriwong Haewpetch	Village Head Silathong Moo 12
Mr. Boonsuang Intar	Village Head Par Daeng Moo 13
Mr. Pinyo Penguan	Village Head Tubklai Moo 14
Mr. Boonchoo Kamnar	Village Head Putor Moo 15
Ms. Pakarkarn Pookung	Secretary of the meeting

The session included:

- Opening remarks by Mr. Anuchit Putklang
- A verbal presentation about CCS and the UASB wastewater treatment system
- Inspection of the Factory and wastewater treatment system
- Responses to comments
- Lunch

³ A Tambol consists of a cluster of 5 - 10 villages



Figure 5: The presentation of the Project by the CCS Factory Manager



Figure 6: Visitors inspecting the biogas plant

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

Two main issues were raised during the session:

1. It was asked how to monitor the efficiency of the system;
2. It was asked whether the bad smell from the wastewater treatment plant would cause nausea to people in the area.

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

1. In response to the question relating to system efficiency, the participants were provided with an explanation about how the system works during the presentation and were invited to inspect the wastewater system. They were told that the high technology (UASB) digester was selected to treat wastewater with high efficiency (90%), and would not discharge contaminated water to the environment. Wastewater would be monitored and samples would be collected for testing regularly at the laboratory to ensure the efficiency of the system.
2. It was explained to the attendees that by installing an advanced system (UASB) which will allow for a faster treatment of wastewater in an enclosed environment, the Project will dramatically reduce the bad odour that may have affected the villagers in the past.

As a result of the session, the local representatives were pleased with the project's wastewater treatment system and environmental impact prevention plan. They were satisfied that they will be able to report back positively to villagers to whom they are ultimately accountable.

**Annex 1****CONTACT INFORMATION ON PARTICIPANTS IN THE PROJECT ACTIVITY**

Organization:	Chok Chai Starch Co., Ltd. (Project Owner)
Street/P.O.Box:	71 Soi Saladaeng 1/1, Saladaeng Road,
Building:	
City:	Silom, Bangrak
State/Region:	Bangkok
Postcode/ZIP:	10500
Country:	Thailand
Telephone:	+66 (0)2 233 4486 to 88
FAX:	+66 (0)2 237 5545
E-Mail:	
URL:	
Represented by:	
Title:	Managing Director
Salutation:	Mr.
Last Name:	Saengsiripongpun
Middle Name:	
First Name:	Surasak
Department:	
Mobile:	
Direct FAX:	
Direct tel:	
Personal E-Mail:	surasak@kengsenggroup.com

Organization:	Mitsubishi UFJ Securities Co., Ltd. (CDM Advisor)
Street/P.O.Box:	2-4-1 Marunouchi, Chiyoda-ku
Building:	Marunouchi Building, 26 th Floor
City:	Tokyo
State/Region:	
Postcode/ZIP:	100-6317
Country:	Japan
Telephone:	+81 3 6213 6331
FAX:	+81 3 6213 6175
E-Mail:	
URL:	http://www.sc.mufig.jp/english/e_cefc/
Represented by:	
Title:	Chairman, Clean Energy Finance Committee
Salutation:	Mr.
Last Name:	Watanabe
Middle Name:	
First Name:	Hajimi
Department:	Clean Energy Finance Committee



CDM – Executive Board

page 53

Mobile:	
Direct FAX:	+81 3 6213 6175
Direct tel:	+81 3 6213 6331
Personal E-Mail:	watanabe-hajime@sc.mufg.jp



Annex 2

INFORMATION REGARDING PUBLIC FUNDING

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

**Annex 3****BASELINE INFORMATION**

Please refer to Section B.6. for details.

The Project applies the following six steps:

Step 1: Identify the relevant electric power system

For the Project, electricity system is defined by the spatial extent of the power plants that are physically connected through transmission and distribution lines to the project activity and that can be dispatched without significant transmission constraints.

There is no layer dispatch system and no DNA guidance of grid boundaries available in Thailand, the grid boundary system is defined at the national level for the project activity.

Step 2: Select an operating margin (OM) method

The calculation of the operating margin emission factor ($EF_{grid,OM,y}$) is based on one of the following methods: (a) Simple OM, (b) Simple adjusted OM, (c) Dispatch Data Analysis OM or (d) Average OM.

Calculation using the Dispatch Data Analysis OM method, while being the first methodological choice, is not feasible as no dispatch data is publicly available for the Thai grid. Since EGAT's low-cost / must-run resources constitute less than 50% of the total grid generation in average of five most recent years, option (a), the Simple OM method, was chosen. Table 1 demonstrates the total grid generation data for five most recent years.

Table 1: The total grid generation for low-cost / must-run resources in year 2003-2007 (Sourced from EGAT)

Type of fuel	Generation (GWh)				
	2003	2004	2005	2006	2007
Natural Gas	85,688	90,289	94,468	94,398	98,148
Heavy Oil	2,434	5,468	7,640	7,808	2,967
Diesel Oil	75	233	177	77	28
Lignite	16,856	17,994	18,335	18,028	18,498
Imported Coal	2,445	2,411	2,280	6,441	12,383
Imports	2,473	3,378	4,372	5,152	4,488
Hydroelectric (Low-cost/must-run)*	7,208	5,896	5,671	7,950	7,961
Renewable Energy*	1,231	1,842	1,856	2,065	2,553
Total low-cost/must-run	8,439	7,738	7,527	10,015	10,514



Total generation	126,851	135,248	142,326	151,934	157,540
Ratio of low-cost/must run to total generation	6.7%	5.7%	5.3%	6.6%	6.7%

The Simple OM emission factor is calculated using 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.

Step 3: Calculate the operating margin emission factor according to the selected method

(a) Simple OM

The simple OM emission factor is calculated as the generation-weighted average CO₂ emissions per unit net electricity generation (tCO₂/MWh) of all generating sources serving the system, not including low-operating cost and must-run power plants / units. It is calculated based on data on the total net electricity generation of all power plants serving the system and the fuel types and total fuel consumption of the project electricity system. (Option C)

The simple OM emission factor is calculated as follows:

$$EF_{\text{grid,OMsimple},y} = \frac{\sum_{im,y} FC_{i,m,y} \times NCV_{i,y} \times EF_{\text{CO}_2,i,y}}{\sum_m EG_{m,y}}$$

Where,

- $EF_{\text{grid,OMsimple},y}$ = Simple operating margin CO₂ emission factor in year y (tCO₂/MWh)
 $FC_{im,y}$ = 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)
 $EF_{\text{CO}_2,i,y}$ = CO₂ emission factor of fossil fuel type i in year y (TCO₂/GJ)
 $EG_{m,y}$ = Net electricity generated and delivered to the grid by power plant / unit m in year y (MWh)

The above calculation was conducted for all fuel types using the fuel consumption data from EGAT's Power Development Plan as shown in the Table 2.

Table 2: EGAT's grid generation ($EG_{m,y}$) and fuel consumption ($FC_{im,my}$) data for 2005-2007
(Sourced from EPPO)

Classificat	Type of	2005	2006	2007	Unit for
-------------	---------	------	------	------	----------



ion	fuel	Generati on (GWh)	Fuel Consumpti on	Generati on (GWh)	Fuel Consumpti on	Generati on (GWh)	Fuel Consumpti on	fuel consumptio n
Non- LCMR	Natural Gas	94,468	1,740	94,398	1,766	98,148	1,715	MMSCFD ⁴
	Heavy Oil	7,640	1,851	7,808	1,895	2,967	780	Mlitres ⁵
	Diesel Oil	177	49	77	21	28	8	Mlitres
	Lignite	18,335	16.57	18,028	15.82	18,498	15.81	Mtons ⁶
	Imported Coal	2,280	2.073	6,441	3.462	12,383	5.434	Mtons
Imports	Laos Hydro	4,372	-	5,152	-	4,488	-	
LCMR	Hydro	5,671	-	7,950	-	7,961	-	
	Renewabl e Energy	1,856	-	2,065	-	2,553	-	
Total Non-LCMR + Imports			127,271		131,904		136,512	
Total			134,798		141,919		147,026	

Table 3: Input values $NCV_{i,y}$ and $EF_{CO_2,i,y}$ for the calculation of grid CO_2 emission factor

Type of fuel	Original Units for Fuel Consumption	NCV^7 (TJ/Unit)	CO_2 Emission Factors ⁸ ($kgCO_2/TJ$)	Oxidation Factors ⁹ (fraction)
Natural Gas	MMSCFD	372.30	54,300	1
Heavy Oil	Mlitres	39.77	75,500	1
Diesel Oil	Mlitres	36.42	72,600	1
Lignite	Mtons	10,470	90,900	1
Imported Coal	Mtons	26,370	89,500	1

⁴ MMSCFD = million standard cube feet per day (106 ft³/day)⁵ Mlitres = milliliters⁶ Mtons = millitons⁷ based on data from Study on Electricity Sector Baseline in Thailand Dec2005; according to (http://www.onep.go.th/CDM/0038829_GridEmissions.pdf)⁸ IPCC 2006 Vol 2 Table 1.4 (IPCC default values at the lower limit of the uncertainty at a 95% confidence interval)⁹ IPCC 2006 Volume 2 Table 1.4

Table 4: Output values for the calculation of grid CO₂ emission factor

Type of fuel	Fuel Consumption (TJ)			CO ₂ Emissions (tCO ₂)		
	2005	2006	2007	2005	2006	2007
Natural Gas	647,802	657,482	638,495	35,175,649	35,701,262	34,670,251
Heavy Oil	73,614	75,364	31,021	5,557,877	5,689,993	2,342,055
Diesel Oil	1,785	765	291	129,561	55,526	21,153
Lignite	173,499	165,587	165,542	15,771,088	15,051,855	15,047,740
Imported Coal	54,662	91,303	143,284	4,892,282	8,171,662	12,823,921

Table 5: Simple OM emission factor

	2005	2006	2007	Unit
Total CO ₂ Emissions	61,526,457	64,670,298	64,905,120	tCO ₂
Total Generation Non-LCMR + Imports	127,270,800	131,903,500	136,512,000	MWh
Simple OM Emission Factor	0.48	0.49	0.48	tCO ₂ /MWh
3-year Average Simple OM Emission Factor	0.483			tCO ₂ /MWh

Therefore, the 3-year average Simple OM emission factor is set ex ante as 0.483 tCO₂/MWh.

Step 4: Identify the cohort of power units to be included in the build margin

The sample group of power units *m* used to calculate the build margin consists of either:

- the set of five power units that have been built most recently, or
- 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.

From these two options, the sample group that comprises the larger annual generation is to be chosen. In the case of the Thai grid, option (b) represents a larger amount of generation.

EGAT does not make publicly available generation data on individual plants. Therefore, data from the Department of Alternative Energy Development and Efficiency (DEDE) and Energy Policy and Planning Office, Ministry of Energy (EPPO) was used. Table 6 details the grid data for the recent power plant capacity additions that comprise 20% for the system generation.

For the data vintage, option 1, the *ex ante* calculation was chosen.

Step 5: Calculate the build margin emission factor

The build margin emissions factor is calculated as the generation-weighted average emission factor (tCO₂/MWh) of all power units *m* during the most recent year *y* for which power generation data is available, calculated as follows:



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

Where,

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

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

$EF_{\text{EL},m,y}$ = CO₂ emission factor of per unit m in year y (tCO₂/MWh)

Table 6: Generation and Fuel Consumption Data for Recently Built Plants, Sourced from DEDE¹⁰ and EPPO¹¹ (updated on June 9, 2008)

Plant name	Commission Date	Fuel type	Capacity (MW)	Generation (GWh)	Efficiency (Btu/kWh)	Fuel Consumption ¹² (TJ)	CO2 emission (tCO ₂)
BLCP Power (IPP)	13-Aug-06	Coal	673.3	4,024	8,910	37,826	3,438,365
Krabi	14-Aug-03	Heavy Oil	340	1,126	8,918	10,594	799,844
EPEC (IPP)	25-Mar-03	Natural Gas	350	2,385	7,020	17,664	959,131
Glow IPP	31-Jan-03	Natural Gas	713	5,425	6,979	39,943	2,168,928
SPP - collective	from 1-Jan-03 to 31-Dec-07	Renewable	202.8	4,971	-	0	-
SPP - collective	from 1-Jan-03 to 31-Dec-07	Natural Gas	112.2	830	-	7,011	380,719
Ratchaburi (IPP)	18-Apr-02, 1-Nov-02	Natural Gas	2,041	15,002	7,214	114,177	6,199,799
Total			4,432	33,763		227,215	13,946,786

¹⁰ <http://www.dede.go.th/dede/index.php?id=830>

¹¹ http://www.eppo.go.th/power/data/data_website_spp.xls

¹² 1Btu = 1055 J



BM Emission Factor (tCO ₂ /MWh)	0.413
--	-------

The total generation was 147,026 GWh for 2007, the latest year for which data is publicly available. The grid data for the recent power plant capacity additions is 33,763 GWh, which is larger than 20% of total generation (or 29,405.20 GWh). The 3-year average build margin emission factor is calculated at 0.413 tCO₂/MWh.

Step 6: Calculate the combined margin emission factor

The combined margin emissions factor is calculated as follows:

$$EF_{\text{grid,CM},y} = (EF_{\text{grid,OM},y} \times w_{\text{OM}}) + (EF_{\text{grid,BM},y} \times w_{\text{BM}})$$

Where,

- $EF_{\text{grid,CM},y}$ = Build margin CO₂ emission factor in year y (tCO₂/MWh)
- $EF_{\text{grid,OM},y}$ = Operating margin CO₂ emission factor in year y (tCO₂/MWh)
- w_{OM} = Weighting of operating margin emissions factor (%)
- w_{BM} = Weighting of build margin emissions factor (%)

For all types of the projects except wind and solar power generation project activities, $w_{\text{OM}} = 0.5$ and $w_{\text{BM}} = 0.5$ for the first crediting period, and $w_{\text{OM}} = 0.25$ and $w_{\text{BM}} = 0.75$ for the second and third crediting periods.

Table 7: Combined Margin Factor Calculation

	Weighting emissions factor (%)	CO ₂ emission factor (tCO ₂ /MWh)
3-year Average Simple OM Emission Factor	50	0.483
BM Emission Factor	50	0.413
CM Emission Factor (tCO ₂ /MWh)		0.448

The CM emission factor is the weighted average of the OM and BM emission factors, where the default weightings are 50% each. As the emission factors were calculated as 0.483 tCO₂/MWh and 0.413 tCO₂/MWh, for the OM and BM respectively, the resultant combined margin CO₂ emission factor is 0.448 tCO₂/MWh.



Annex 4

MONITORING INFORMATION

Please refer to Section B.7. for details.

1. Data archiving

All data will be archived on paper and/or electronically, and kept until 2 years after the end of the crediting period.

2. Emergency procedures

Emergency procedures in terms of both monitoring and operation are in place, in accordance with ISO9001.
