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

CONTENTS

Annexes

Revision history of this document

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

SECTION A. General description of small-scale project activity

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

Project title: Chantaburi Starch Wastewater Treatment and Biogas Utilization Project

PDD Version: Version 1.0

Date: 23/12/2008

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

The proposed project entails the installation of an up-flow anaerobic sludge blanket technology (UASB) biogas reactor to generate biogas which shall be used to replace fossil fuel usage and generate renewable electricity at an existing starch plant in Ampher Soidao, located in Chantaburi Province in Eastern Thailand. The major components of the project are:

a) the extraction of methane (biogas) from the wastewater stream through the biogas reactor,
b) the reuse of biogas as fuel in an existing boiler within the plant for steam-generation, and
c) the reuse of biogas as fuel for power generation (using an 1.9 MW_{el} gas engines (2*0.95MW)).

As a by-product for each ton of tapioca starch produced in this plant,17 m^3 of wastewater is generated. The proposed project will be implemented by Chantaburi Strach Co., Ltd at their production facility with a total expected wastewater flow-rate of 5100 m^3/day and an average COD concentration of 20,000 mg/L (Design capacity and design load). The starch plant until recently operated under a license issued by department of industrial works which limit the COD of wastewater prior to discharge at 120 mg/L

To meet the government requirement, the existing facility treats wastewater with a series of 11 open anaerobic lagoons with a depth that varies from 5 to 8.4 meters. The anaerobic decay of organic matter within the open lagoons generates biogas containing methane, which is released in an uncontrolled manner to the atmosphere.

The project replaces the existing wastewater treatment practice by adding UASB system into the existing treatment system. The project activity avoids the release of methane into the atmosphere, which would occur due to the anaerobic digestion of the organic content in the open lagoon based wastewater treatment system (anaerobic conditions, leading to methane generation within the lagoon are the result of a lagoon depth greater than 1m and an average atmospheric temperature of about 28C).

In addition, the biogas reactor produces sufficient quantities of biogas to fuel a boiler for the production of process steam for the starch manufacturing plant thus replacing the use of heavy fuel oil, and to fuel a gas engine for the production of power for the starch plant’s own use and sale to the electricity grid, thus replacing the production of power from fossil sources in the PEA[1] under the Very Small Power Producer[2] (VSPP) program.

The replacement of heavy fuel oil in the thermal oil boilers, the replacement of diesel from the generators and displacement of electricity from the national grid, which is generated by fossil fuel fired power plants from the Thai national grid to a large extent, will lead to further reductions of greenhouse gases.

The average estimated emission reduction is 41,034 tonnes per year of CO_2 equivalent.

Sustainable Development Benefits of the Project
According to the definition of sustainable development criteria for CDM projects by Thai DNA[3], the project will directly contribute to sustainable development in Thailand in several ways as shown below:

Natural Resources and Environment benefits

- Reduction of greenhouse gas emissions through the avoided electricity generation by other grid connected power plants;
- Reduction of offensive odor;
- Reduction in usage of non-renewable energy, i.e. fossil fuel for grid electricity generation;
- Improvement of the quality of water discharged into the environment;

Social benefits

- Involvement of local communities through a public participation meeting, in which people accepted the project;
- Increased employment by employing 6 full time staff to operate the system;

Technology transfer benefits

- Promoting technological excellence in Thailand, which could be replicated across Thailand and the region;
- Necessary training on the management of the power plant will be provided to staff;

Economic benefits

- Reduction in dependency on fossil fuel for electricity generation while at the same time enhancing energy security by increasing diversity of supply;

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[1] The Provincial Electricity Authority is a government enterprise under the Ministry of Interior. The authority's responsibility is primarily concerned with the generation, distribution, sales and provision of electric energy services to the business and industrial sectors as well as to the general public in provincial areas, with the exception of Bangkok, Nonthaburi and Samut Prakran provinces.

[2] A Very Small Power Producer (VSPP) can be any private entity, government or state-owned enterprise that generates electricity either (a) from non-conventional sources such as wind, solar and mini-hydro energy or fuels such as waste, residues or biomass, or (b) from conventional sources provided they also produce steam through cogeneration. As per the VSPP program, the VSPP is limited to sell no more than 10MW of its electrical power output to the designated distribution utility, such as Metropolitan Electricity Authority (MEA) and/or Provincial Electricity Authority (PEA).

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

- Generating incomes to the local community through additional local employment;
- Demonstrating the use of CDM as an incentive for bringing about an energy efficiency project;
- Besides, due to rapidly, continuously rising and instability of oil prices, the Thai government has set an ambitious target for the share of renewable energy in electricity production. In year 2003, the government has published the "Energy Strategies for Competitiveness" which targets to increase the share of renewable energy in Thailand from 0.5% in year 2002 to 8% in year 2011 (source: http://www.eppo.go.th/doc/strategy2546/strategy.html). This national plan will benefit from initiatives in industries such as this project. The project, by producing energy from biogas, will directly complement the Thai government's efforts to reduce the country's dependency of imported fossil fuels. Besides, National's electricity generation, which is dominated by natural gas, lignite and imported fuel oil, will also benefit from this kind of project where the electricity fed to the grid come from renewable energy sources.

The Project is, also, implemented on a pure voluntary basis. There is no regulation that requires implementing such a project.

ADDITIONAL REQUIREMENTS FOR THE GOLD STANDARD:
Sustainable Development Screen:

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

A.3. Project participants:

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

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

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

A.4.1.1. Host Party(ies):

Thailand

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

Chantaburi Province

A.4.1.3. City/Town/Community etc:

Saikao subdistrict, Soidao district

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

The proposed project is located approximately 14 km from Soidao district, which is 270 km away from Bangkok. The project coordinates are: 13°6"3'N and 102°18"54'E.

Chantaburi Province

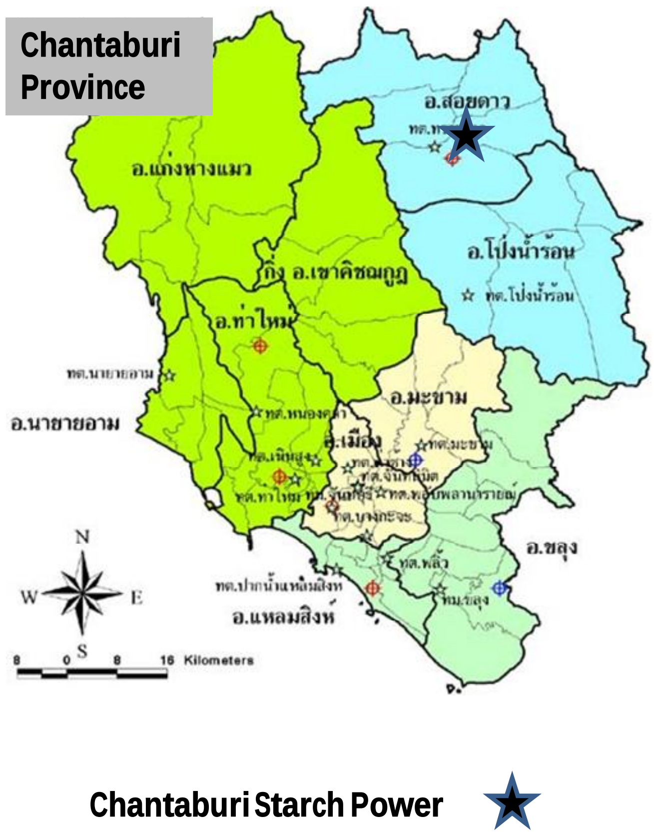

Figure 1. Location of the project

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

Type and category:

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

Methane avoidance component:

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

Heat generation component:

Type I:	Renewable energy projects
Category I.C:	Thermal energy for the user with or without electricity
Sectoral Scope 1:	Energy industries (renewable /non-renewable sources)

Electricity generation component:

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

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

Please refer to Annex 5 for Gold Standard information.

Process and technology description

The wastewater flows from the starch manufacturing unit by gravity sewer into a storage lagoon (made from an existing lagoon, retention time 1-2 days). The influent first passes through a new screen extractor, in order to remove coarse particles (roots, pulp, peels). After the screening the wastewater flows into equalization and settling lagoon (in concrete, sloped) for removal of settleable solids. This lagoon is divided in two parts, one in operation and the other in standby or cleaning.

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

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

The wastewater is then pumped into the methane reactors through an influent distribution system at the bottom of the reactor. The methane reactors are of the UASB (Upflow Anaerobic Sludge Blanket) type, with a special "3 phase separator" device at the top of the reactor.

In the UASB, the wastewater rises through an expanded bed of anaerobic active methanogenic sludge (the so called "sludge blanket") and an internal device at the top of the reactor, which results in a separation of the mixed liquor into clarified wastewater, biogas and sludge. The absence of any mechanical agitation allows a natural selection towards heavy flocs of active methanogenic sludge.

Excess sludge can eventually, from time to time, be withdrawn from the bottom of the reactor. This excess sludge is extremely thick (5-10% DS), stable, can be spread aerobically to be later used as fertilizer, but it is widely sought after to start-up new reactors elsewhere. The effluent of the anaerobic treatment will be further treated in some of the existing lagoons, receiving only ca 2 - 5% of the original load.

Initially the project proponents plan to use most of the resulting biogas in the factory as fuel in an existing thermal oil boiler used for starch drying. The burner of this boiler is modified from fuel oil firing to true dual fuel firing (meaning gradual co-firing of fuel-oil). If any biogas is remaining it shall be flared.

The project will install power generation facility to generate electricity to send back to national grid. After which a part of biogas will be used as fuel in the power generator gensets) consisting of a biogas fired engine and an alternator, to generate maximum about 1.9 MW_{el}. Before use in the power generators, the biogas has to be treated to reduce the sulphur content of the biogas from tapioca starch factory effluent using a biogas "sweetening" plant, based on a proprietary sulphur removal system, which does not use chemicals (except for pH control in the oxidation phase). In practice min. 90% removal is obtained. The scrubber is placed on top of the aeration basin, so as to allow gravitary flow of the washing water back into the inlet of the aeration basin. From the aeration basin, water is continuously pumped into the scrubber tower.

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

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

After the scrubber the biogas goes to an optional proprietary biogas drier, to reduce most of the moisture content of the biogas, because some generator engine suppliers impose limits (not known at this moment) on the % humidity of the biogas, whereas when it comes from the anaerobic reactor it is (over) saturated with water vapour.

The biogas drier package unit used consists of a stainless steel biogas/refrigerant heat exchange, and a refrigerant cooling group with a compressor, a condenser, a storage tank, and an evaporator. The biogas at typically 30-40 °C is cooled to 10-15°C, after which ca. 60-70% of the water vapour (35 g/m3) condenses to water, which is separated from the gas in and after the heat exchanger. The remaining moisture in the biogas is about 10-15 g/m3, and acceptable, considering the fact that the biogas is heated again in the biogas compressor and then cools off to ambient temperature which is higher than 20 °C.

After the biogas drier the biogas is sent to thermal oil boiler and to the power generators with biogas blowers. H_2S and CH_4 content of the biogas are continuously measured in line. For safety and start-up reasons a flare is also foreseen.

ADDITIONAL REQUIREMENTS FOR THE GOLD STANDARD:

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

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

Years	Annual estimation of emission reductions in tonnes of CO2e
2009	41,034
2010	41,034
2011	41,034
2012	41,034
2013	41,034
2014	41,034
2015	41,034
Total emission reductions (tonnes of CO2e)	**287,237**
Total number of crediting years	**7**
Annual average over the crediting period of estimated reductions (tonnes of CO2e)	**41,034**

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

No public funding is involved in the project.

ADDITIONAL REQUIREMENTS FOR THE GOLD STANDARD:
ODA Additionality Screen:

Please refer to Annex 5 for Gold Standard information.

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

The project participants confirm that there is no registered small-scale CDM project activity or an application to register another small-scale CDM project activity with the same project participants and whose project boundary is within 1 km of the project boundary of the proposed small-scale activity at the closest point.

According to Appendix C to the *Simplified Modalities and Procedures for Small-scale CDM Project Activities*, the Project is not a de-bundled component of a large-scale project activity.

SECTION B. Application of a baseline and monitoring methodology

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

Methane avoidance component:

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

Thermal energy generation component:

The approved CDM small-scale baseline and monitoring methodology AMS-I.C- Version 13 "Thermal energy for the user with or without electricity" is applied to the thermal energy generation component of the project activity.

Electrical energy generation component:

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

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

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

General small-scale projects requirements:

Methane avoidance component:

The wastewater would have been treated in an open anaerobic lagoon in the absence of the Project. The project activity refers thus to case (vi) described in Paragraph 1 of AMS-III.H and fulfils the applicability conditions of the respective project category:

"Introduction of a sequential stage of wastewater treatment with methane recovery and combustion, with or without sludge treatment, to an existing wastewater treatment system without methane recovery (e.g. introduction of treatment in an anaerobic reactor with methane recovery as a sequential treatment step for the wastewater that is presently being treated in an anaerobic lagoon without methane recovery)"

- Furthermore, the project also falls under paragraph 2(a); The recovered methane is utilized for thermal or electrical energy generation applications
- The emission reductions to be achieved by the project activity are estimated at 41,034 tCO_2 per year which is lower than 60 $ktCO_2e$ per year over the crediting period.

Thermal energy generation component:

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

- The Project comprises the use of energy derived from renewable biomass (biogas) to supply thermal energy (without electricity generation) that displaces fossil fuel (Heavy fuel oil).
- The thermal generation capacity of the Project is less than 45 MW_{th}

Electricity generation component:

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

- The Project comprises the use of energy derived from renewable biomass (biogas) to supply electricity that displaces electricity from the national grid.
- The capacity of the generator for producing electricity is 1.9 MW which is less than 15 MW_{el}

B.3. Description of the project boundary:

The project boundary is defined as the physical, geographical site where the wastewater and sludge treatment takes place and the site where the renewable energy generation is located (boiler + gas engine).

The project boundary therefore comprises of the methane recovery facility, as opposed to the current anaerobic treatment system using open lagoons (boundary of the baseline) and of the biogas cogeneration system. The anaerobic treatment system includes the biogas tanks, the biogas storage vessel, the methane flaring system, the aeration ponds (aerobic treatment where emissions of methane still occur), and the usage of solid sludge for soil application.

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

	Source	Gas	Justification / Explanation
Baseline	Lagoon	CH_4	Emission from decay of organic matter
	Boiler	CO_2	CO_2 emissions from fossil fuel consumption in the boiler in the absence of the Project
	Electric grid	CO_2	CO_2 emissions from fossil fuel consumption in the thermal power plant from the grid that would have been emitted in the absence of the Project
Project activity	Anaerobic reactor	CH_4	Fugitive emissions on account of inefficiencies in capture systems.
	Anaerobic lagoon	CH_4	Emissions from decay of organic matter in the WWT system not equipped with biogas recovery.
	Flare	CH_4	Emissions due to incomplete flaring.

	Electricity consumption	CO_2	Use of electricity to run equipment used in anaerobic treatment

The project boundary is as follows:

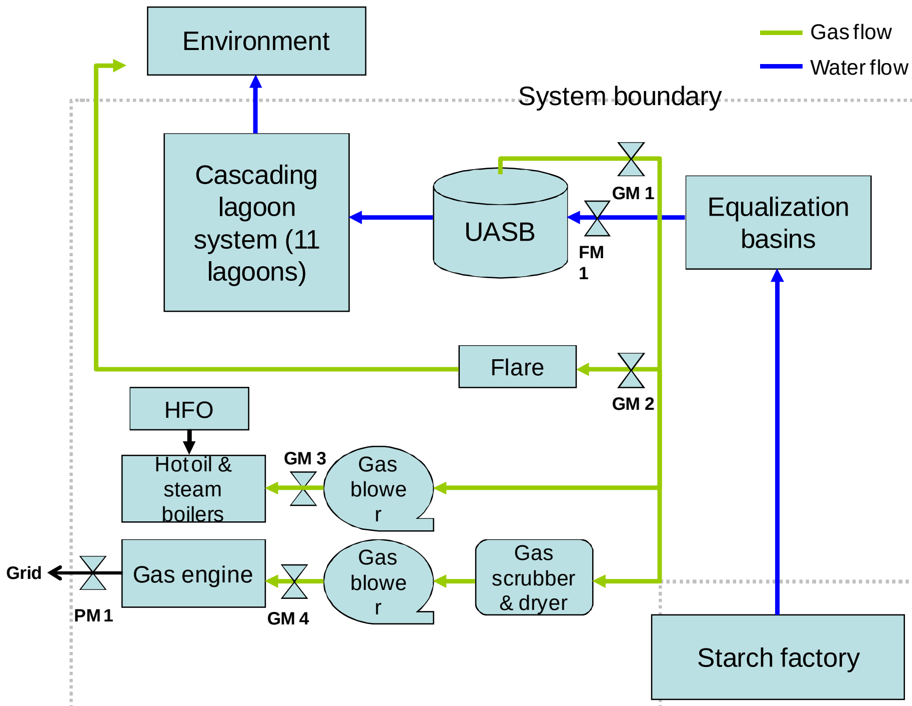

Figure 2. System boundary of the project

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

The baseline of the project activity has been developed by using two categories listed in the simplified modalities and procedure for small-scale CDM project activity:

1. Type III – Other project activities, Category III.H – Methane recovery in wastewater treatment Version 10 (AMS III.H)

   The baseline scenario is described by paragraph 6 (vi) of AMS III.H version 10 as being the existing anaerobic wastewater treatment system without methane recovery. In the project's case, the system is a series of eleven deep open anaerobic lagoons without methane recovery.

2. Type I – Renewable energy projects, Category I.C – Thermal energy for user with or without electricity Version 13 (AMS I.C)

The baseline scenario is (a) where electricity is imported from the grid and steam/heat is produced using fossil fuel. For the project, electricity is drawn from Thai grid system while the heat is produced by Residual Fuel Oil (RFO) boiler.

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

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

Schedule and main events for the project

Date	Event	Comment
June 9, 2003	Chantaburi Starch company is registered as starch factory	Company affidavit
August 21, 2003	Chantaburi Starch is received the operating licese	operating license
December, 2004	Chantaburi Starch starts production	operating record
October 22, 2007	Management decission on implement biogas project and appoint Chantaburi Starch Power,invested by Chantaburi starch,	Minute of meeting
November, 2007	Chantaburi Starch Power consider carbon credit and contract with Papop.	Papop Proposal
December 19, 2007	Chantaburi Starch Power is registered as Limited Company	Company affidavit
January 30, 2008	First payment being paid as consider as constuction start	Reciept from Papop
August 22, 2008	Initial CDM Gold Standard stakeholder consultation	Cooperation between Chantaburi starch Power and South Pole Carbon Asset Management
September 29, 2008	Finising Initial Environmental Evaluation and draft PDD	
October 1, 2008	Submission the Letter of Approval (LOA) request to Thai DNA (Host)	
October 15, 2008	Submission the requesting of Letter of Intense (LOI) to Thai DNA	
November 5, 2008	Receive the acceptance LOI letter from Thai DNA	

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

The project activity conforms to the small scale baseline methodologies of AMS IIIH, AMS IC and AMS ID. The project reduces emission reductions by capturing the fugitive emissions from the waste water and using the biogas to generate heat and power for the industrial facility. The thermal capacity and power generation capacity of facility shall not exceed 45 MW_{th} and 15 MW_{el} respectively.

As per attachment A of Appendix B of the *Simplified Modalities and Procedures for Small-Scale CDM Project Activities*, additionality of the project shall be demonstrated by showing that the project activity would not have occurred anyway due to at least one of the following barriers: (a) investment barrier, (b) technological barrier, (c) barrier due to prevailing practice, and (d) other barriers.

The investment analysis is carried out to demonstrate the additionality of the proposed project activity. For the parameters, the PP has used the details as per the technology proposal to estimate the profitability of project. However for parameters, where the historical data is available from plant records, the same is used for IRR estimation to keep the approach more relevant.

- **Investment Barrier:**

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

The project activity entails high investment and O&M costs and uncertain commercial returns (from the production and use of biogas). CDM revenues coming from CER trade play a key role in overcoming financial barriers to the project, making it financially less risky. CDM revenues have been considered since the beginning of the project and were a major driver for implementing the project[4].

The project viability based on CDM revenues is demonstrated on basis of a benchmark analysis which is further strengthened by a sensitivity analysis that follows it.

Choice of Benchmark: The project proponent uses IRR for benchmark analysis, which is calculated as project IRR. The project proponent has tried to identify the same using two approaches as detailed below.

1. **Expected rate of return based on country specific risk.**

In November 2007 15 years government bond yield rate for Thailand is 5.1%[5]. This is taken for 15 years to match with the project lifetime. To compensate the risk of investing in a private project, long term risk premium for Thailand is applied i.e. 6.41%.[6] The risk premium is based on the estimate of default spread for Thai risk free bond rate, added with the country risk premium based on country risk from Moody. So the suitable benchmark to apply in this case is 5.1 + 6.29 = 11.39%.

Bond Period	Expected Yield	Bond Period	Expected Yield

[4] Technical proposal copies and minutes of board meeting provided.

[5] http://www.thaibma.or.th/ (price&yield → yieldcurve → government)

[6] http://pages.stern.nyu.edu/~adamodar/New_Home_Page/datafile/ctryprem.html

1 month	3.10%	8 year	4.70%
3 months	3.10%	9 year	4.77%
6 months	3.23%	10 year	4.85%
1 year	3.45%	11 year	4.97%
2 year	3.64%	12 year	5.04%
3 year	3.80%	13 year	5.08%
4 year	3.99%	14 year	5.11%
5 year	4.21%	15 year	5.12%
6 year	4.42%	16 year	5.13%
7 year	4.55	17 year	5.14%

Country Risk Premium Compared to US for long term investment.

Country	*Long-Term Rating*	*Adj. Default Spread*	*Equity market risk + Country Risk*	*Country Risk Premium*
Thailand	Baa1	100	6.29%	1.50%
United States	Aaa	0	4.79%	0.00%

2. Weighted Average Cost of Capital (WACC)

Weighted average cost of Capital is defined as expected rate of return on total capital taking into account the cost of debt and equity.

Cost of Debt: Cost of debt is taken as the Minimum Lending Rate for that time period. This shall be easily available in the public domain, as it is published rate by the public bank of host country. Cost of debt for this case is taken as 7.2511%[7].

Cost of equity: Cost of equity is estimated based on country risk and project risk. The approach used is, Expected return on Equity = Risk free rate of return in U.S. (treasury bills) + Country risk premium + Risk premium for specific project type.

U.S. Treasury bills %	4.60%	U.S. Treasury Returns[8]
Market risk Premium (Country premium)	6.29%[6]	Dr. Aswath Damodaran's research.
Project specific risk	5.59%[9]	Considering beta value for risk in specific industry.

Cost of equity = 16.42%

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

[8] http://www.ustreas.gov/offices/domestic-finance/debt-management/interest-rate/yield_historical_2007.shtml

[9] Details provided in excel sheet provided during validation.

Total Cost	**127200000**	**THB**

Loan portion	80,000,000	THB
Loan %	62.9%	
Cost of Loan	7.25%	

Equity portion	47,200,000	THB
Equity %	37.1%	
Cost of equity	16.42%	

WACC	**10.65%**

Out of the two indicators the conservative one is selected to compare with the project IRR. Project IRR is based on following key parameters available at the time of investment decision i.e. November 2007. The basic financial parameters of the project are listed below.

Lifetime WWTP and gas engine (years)	15	Expected lifetime
Total Investment (Euro) - WWTP Total Investment (Euro) - Gas Engine	2,825,411	Done over years separately for WWTP and gas engine systems.
Price of electricity – from grid (THB/kWh)	2.8	Average of electricity consumption invoices.
Price of fuel oil – replaced by biogas (THB/Nm3)	14.5	Biofuel proposal
Exchange Rate(THB/Euro)	45.02	http://www.oanda.com/convert/classic
Annual Biogas generated (Nm3/yr)	4,575,841	Performance + tech details
Amount of Fuel oil used(tonnes)	589.9	Consumption pattern in past
Operation and Maintenance Cost	229,610	Details provided by PP and tech provider

Table 1: The Basic Financial Parameter of the project[10]

As per EB 39 Annex 35 paragraph 3 the maximum equipment lifetime of 15 years is assumed as per the normal industry norms. Based on the financial parameters listed above both, IRR and NPV do not justify the investment decision without CDM benefits.

Develop project activity without CDM revenues	IRR (%)	7.00%
	NPV (Euro)	(401,889)

Table 2: Comparative financial indicators with and without CDM revenues

[10] Reference documents shall be provided during site visit

For NPV estimations this benchmark rate is chosen as the discount rate to arrive at NPV for project activity i.e. with and without CER benefits. The above figures summarize the significance of CER revenues for the project activity to achieve a sound financial performance.

Sensitivity Analysis:

The project IRR and NPV could significantly vary when certain parameters are varied. Savings due to energy displacement and operation costs are increased and decreased by 5% and 10%, respectively. Even considering a 10% rise in HFO prices would not have made the profit above the benchmark. Considering the high initial investment cost, the high project risk and the long operation period before turning into a positive NPV, the project remains financially unattractive without CDM revenues.

Variation in % for the parameter	NPV (Euro) after mentioned change in price of HFO	NPV (Euro) after mentioned change in cost of O&M
-10%	(513,840)	(281,479)
-5%	(457,864)	(341,684)
0%	(401,889)	(401,890)
5%	(345,914)	(462,095)
10%	(289,939)	(522,300)

Variation	IRR after mentioned change in price of HFO	IRR after mentioned change in cost of O&M
-10%	5.89%	8.14%
-5%	6.45%	7.57%
0%	7.00%	7.00%
5%	7.53%	6.41%
10%	8.06%	5.81%

Given the early CDM consideration and the initiation of CDM process at an early stage, and as demonstrated by financial analysis it is clear that the carbon credits revenues play a significant role in overcoming the barrier to raise capital for the project and that the project owner would not have implemented such a project without the possibility to attract investors with an interest in carbon credits. The project is thus additional and reduces CH_4 emissions that would have been emitted by an anaerobic lagoon and CO_2 emissions that would have been emitted by fossil fuel fired electricity plants connected to the Thai power grid and by the usage of fossil fuels for thermal energy generation at the starch factory. Hence, according to Attachment A of Appendix B of the *Simplified Modalities and Procedures for Small-Scale CDM Project Activities*, Paragraph 1 (d), the existing anaerobic lagoon system, representing the baseline scenario, would have led to higher emissions and does not face the barrier described above. Therefore, the project activity is considered to be additional.

ADDITIONAL REQUIREMENTS FOR THE GOLD STANDARD:
Gold Standard Additionality Screen

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

Please refer to Annex 5 for Gold Standard information.

B.6. Emission reductions:

B.6.1. Explanation of methodological choices:

The amount of methane that would be emitted to the atmosphere in the absence of the project activity is estimated according to AMS III.H, Version 10.
For the emission reduction on account of fuel and power savings the applicable methodology is AMS I.C, Version 13 and AMS I.D, Version 13.
This section details the applicable formulas from the methodologies applied to the project activity.

Baseline emissions

Baseline emissions are the sum of emissions from the degradable organic matter in the treated wastewater (calculated according to AMS III.H- Version 10), the emissions due to the displacement of electricity from the grid (calculated according to AMS I.D- Version 13) and the emissions due to fossil fuel replacement for heating (calculated according to AMS I.C- Version 13).

AMS-III.H

$$\mathbf{BE_{y} = BE_{power,y} + BE_{ww,treatment,y} + BE_{s,treatment,y} + BE_{ww,discharge,y} + BE_{s,final,y}} \quad \mathbf{(1)}$$

Where:

BE_{y}	Baseline emissions in the year y (tCO_2e)
$BE_{power,y}$	Baseline emissions from electricity or fuel consumption in year y (tCO_2e)
$BE_{ww,treatment,y}$	Baseline emissions of the wastewater treatment systems affected by the project activity in year y (tCO_2e).
$BE_{s,treatment,y}$	Baseline emissions of the sludge treatment systems affected by the project activity in year y (tCO_2e)
$BE_{ww,discharge,y}$	Baseline methane emissions from degradable organic carbon in treated wastewater discharge into sea/river/lake in year y (tCO_2e). The value of this term is zero for the case 1 (ii).
$BE_{s,final,y}$	Baseline methane emissions from anaerobic decay of the final sludge produced in year

y (tCO_2e). If the sludge is controlled combusted, disposed in a landfill with biogas recovery, or used for soil application in the baseline scenario, this term shall be neglected.

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

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

Where:

$Q_{ww, i, y}$	Volume of wastewater treated in baseline wastewater treatment system *i* in year *y* (m^3).
$COD_{removed, i, y}$	Chemical oxygen demand removed by baseline treatment system *i* in year *y* ($tonnes/m^3$).
$MCF_{ww, treatment, BL, i}$	Methane correction factor for baseline wastewater treatment system *i* (MCF value as per table III.H.l)
i	Index for baseline wastewater treatment system
$B_{o,ww}$	Methane producing capacity of the wastewater (IPCC lower value for domestic wastewater of 0.21 kg CH_4/kg COD)[11]
UF_{BL}	Model correction factor to account for model uncertainties (0.94)[12]
GWP_{CH4}	Global Warming Potential for methane (value of 21).

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

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

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

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

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

AMS-I.C

For steam/heat produced using fossil fuels the baseline emissions are calculated as follows:

$$\mathbf{BE_y = HG_y * EF_{CO2} / \eta_{th}} \quad \mathbf{(4)}$$

Where:

BE_y	the baseline emissions from steam/heat displaced by the project activity during the year y in tCO2e

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

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

HG_y	the net quantity of steam/heat supplied by the project activity during the year y in TJ.
EF_{CO2}	the CO2 emission factor per unit of energy of the fuel that would have been used in the baseline plant in (tCO2 / TJ), obtained from reliable local or national data if available, otherwise, IPCC default emission factors are used.
η_{th}	the efficiency of the plant using fossil fuel that would have been used in the absence of the project activity

AMS-I.D

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

$$\mathbf{BE_y = EG_y * EF_y} \quad \mathbf{(5)}$$

BE_y	the baseline emissions from electricity displaced by the project activity during the year y in tCO_2e
EG_y	the net quantity of electricity generated by the project activity during the year y in TJ.
EF_y	Grid emission factor of Thailand, calculated with the tool to calculate the emission factor of an electricity system, in tCO_2/MWh

Project emissions

AMS III H

Project emissions are the sum of emissions from the wastewater treatment systems affected by the project and not equipped with biogas recovery, methane fugitive emissions on account of inefficiencies in capture systems, methane emissions due to incomplete flaring, CO_2 emissions on account of power and and fuel used by the project activity facilities (calculated according to AMS III.H- Version 10).

The project activity emissions are calculated as follows:

$$\mathbf{PE_y = PE_{y,power} + PE_{ww,\,treatment,\,y} + PE_{s,\,treatment,\,y} + PE_{ww,\,discharge,\,y} + PE_{s,\,final,\,y} + PE_{fugitive,\,y} + PE_{biomass,\,y} + PE_{flaring,\,y}} \quad \mathbf{(6)}$$

Where:

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

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

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

$$PE_{ww, treatment, y} = \sum Q_{ww, j, y} * COD_{removed, PJ, i, y} * MCF_{ww, treatment, PJ, j} * UF_{PJ} * GWP_{CH4} * B_{o, ww} \quad (7)$$

Where:

$Q_{ww, j, y}$	Volume of wastewater treated in the year "y" (m3/yr)
GWP_{CH4}	Global Warming Potential for methane (value of 21 is used)
$B_{o, ww}$	Methane producing capacity of the wastewater (IPCC default value of 0.21 kg CH4/kg COD)[13]
$COD_{removed, PJ, y}$	Chemical oxygen demand removed by project wastewater treatment system in the year "y" (tonnes/m3). It will be estimated as the difference between the inlet and outlet of the lagoon system
$MCF_{ww, treatment, PJ, j}$	Methane correction factor for project wastewater treatment system without biogas recovery.
UF_{PJ}	Model correction for uncertainties (1.06)

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

$$PE_{fugitive, y} = PE_{fugitive, ww, y} + PE_{fugitive, s,y} \quad (8)$$

Where:

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

$$PE_{fugitive, ww,y} = (1 - CFE_{ww}) * MEP_{ww, treatment, y} * GWP_{CH4} \quad (9)$$

Where:

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

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

$$\mathbf{MEP_{ww, treatment, y} = Q_{y, ww} * B_{o, ww} * UF_{PJ} \sum COD_{y, removed, j} * MCF_{ww, treatment, pj, k}} \quad \textbf{(10)}$$

Where:

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

$$\mathbf{PE_{fugitive, s, y} = (1 - CFE_{s}) * MEP_{s, treatment, y} * GWP_{CH4}} \quad \textbf{(11)}$$

Where:

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

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

Where:

$S_{I, PJ, y}$	Amount of untreated sludge generated in the year y (tonnes)
DOC_{F}	Degradable organic content of the final sludge generated by the wastewater treatment in the year "y" (fraction). IPCC default value of 0.09 for industrial sludge (wet basis, assuming dry matter content of 35 percent) will be used
$MCF_{s, treatment, PJI}$	Methane correction factor for the sludge treatment system that will be equipped with methane recovery
UF_{pj}	Model correction for factor to account for model uncertainties (1.06)

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

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

The calculation steps for project emissions are as follows:

STEP 1: Determination of the mass flow rate of the residual gas that is flared

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

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

STEP 5: Determination of methane mass flow rate in the residual gas on a dry basis

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

$$\mathbf{TM_{RG,h} = FV_{RG,h} * fv_{CH4,RG,h} * \rho_{CH4,n,h}} \qquad \textbf{(13)}$$

Where:

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

STEP 6: Determination of the hourly flare efficiency

The determination of the hourly flare efficiency depends on the operation of the flare (e.g. temperature), the type of flare used (open or enclosed) and, in case of enclosed flares, the approach selected by project participants to determine the flare efficiency (default value or continuous monitoring).

In case of open flares and use of the default value for the flare efficiency, the flare efficiency in the hour h ($\eta_{flare,h}$) is 50%, if the flare is detected for more than 20 minutes during the hour h

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

STEP 7: Calculation of annual project emissions from flaring

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

$$\mathbf{PE_{flare,y} = \Sigma\ TM_{RG,h} * (1-\eta_{flare,h}) * GWP_{CH4}/1000} \qquad \textbf{(14)}$$

Where:

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

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

AMS I-D

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

$PE_{power} = EC_y * EF_y$ **(15)**

Where:

EC_y Electricity consumed by the project activity during year y

EF_y Grid emission factor of Thailand.

For Leakage emissions

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

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

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

Data and parameters from the AMS.III.H

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

Data / Parameter:	$B_{o, ww}$
Data unit:	kg CH_4/kg COD
Description:	Methane generation capacity of COD in waste water.
Source of data used:	IPCC default value, corrected as per methodology AMS III-H page – 4, is used for estimation
Value applied:	0.21 kg CH_4/kg COD
Justification of the choice of data or description of measurement methods	IPCC default value

and procedures actually applied :	
Any comment:	As per AMS.III.H Version 10, the IPCC default value of 0.25 kg CH4/kg COD was corrected to 0.21 kg CH4/kg COD to take into account the uncertainties.

Data / Parameter:	UF_{BL}
Data unit:	Factor
Description:	Model correction factor to account of model uncertainties
Source of data used:	AMS.III.H
Value applied:	0.94
Justification of the choice of data or description of measurement methods and procedures actually applied :	Value for the baseline emissions calculation.
Any comment:	The original source of data is: FCCC/SBSTA/2003/Add.2, page 25

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

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

	baseline emissions

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

Data / Parameter:	CFE $_{ww}$
Data unit:	Fraction
Description:	Capture efficiency of the biogas recovery equipment in the wastewater treatment
Source of data used:	IPCC
Value applied:	0.9
Justification of the choice of data or description of measurement methods and procedures actually applied :	In absence of an appropriate value the methodology describes to use an IPCC default value of 0.9
Any comment:	

Data / Parameter:	DOC $_{y, s, final}$
Data unit:	Fraction
Description:	Degradable organic content of the final sludge generated by the wastewater treatment in the year “y”
Source of data used:	IPCC default values for industrial waste
Value applied:	0.09
Justification of the choice of data or description of measurement methods and procedures actually applied :	IPCC default value of 0.09 for industrial sludge (wet basis, assuming dry matter content of 35 percent) will be used
Any comment:	

Data / Parameter:	MCF $_{s, final}$

Data unit:	Fraction
Description:	Methane correction factor of the landfill that receives the final sludge.
Source of data used:	AMS IIIH default values
Value applied:	Default conservative value of 1.0 is used.
Justification of the choice of data or description of measurement methods and procedures actually applied :	The maximum possible value of MCF is assumed for estimation of project emissions.
Any comment:	

Data / Parameter:	$DOC_{y, s, untreated}$
Data unit:	Fraction
Description:	Degradable organic content of the final sludge generated by the wastewater treatment in the year “y” (fraction)
Source of data used:	IPCC
Value applied:	0.09
Justification of the choice of data or description of measurement methods and procedures actually applied :	IPCC default value of 0.09 for industrial sludge (wet basis, assuming dry matter content of 35 percent) will be used
Any comment:	

Data / Parameter:	$MCF_{s, treatment}$
Data unit:	Fraction
Description:	Methane correction factor for the sludge treatment system that will be equipped with methane recovery and combustion/utilization/flare equipment
Source of data used:	IPCC
Value applied:	1.0
Justification of the choice of data or description of measurement methods and procedures actually applied :	The maximum possible value of MCF is assumed for estimation of project emissions.
Any comment:	

Data / Parameter:	$[CH_4]_{y, ww, treated}$
Data unit:	Tones/m^3
Description:	Dissolved methane content in treated waste water.
Source of data used:	Methodology AMS IIIH
Value applied:	$10e^{-4}$
Justification of the	A default value as per the methodology is used to estimate emissions on account

choice of data or description of measurement methods and procedures actually applied :	of dissolved methane in waste water.
Any comment:	

Data and parameters from the AMS.I.C

Data / Parameter:	EF_{CO2}
Data unit:	tCO_2/TJ
Description:	Emission factor of fossil fuel replaced – Residual Fuel oil
Source of data used:	IPCC 2006 default value for residual fuel oil, Volume 2, Chapter 1, 1.23
Value applied:	77.4 tCO2/TJ
Justification of the choice of data or description of measurement methods and procedures actually applied :	IPCC default values used for unavailability of national data. In pre project scenario the residual fuel oil has been main source of thermal energy for the processes.
Any comment:	

Data and parameters from the AMS.I.D

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

B.6.3 Ex-ante calculation of emission reductions:

The following section gives details of ex – ante estimation of CERs for the project activity.
The data sheet of calculations shall be provided to the DOE.

The excel datasheet where the ER calculations were estimated has been provided to the DOE. How the equations have been applied is described in section B.6.1. The main calculation parameters and results are provided below:

Methodology: AMS III H (Methane avoidance component)		
Formula: $BE_y = Q_{y,ww} * \sum(COD_{y,removed} * B_{o,ww} * MCF_{ww,treatment,i} * GWP\_CH_4 * UF_{BL})$		
$Q_{y,ww}$ =	1020000*0.69 Nm^3	Based on 300 t/day starch production, 17m^3/t waste water generation, operation of 200 days. 0.69 is the work load of the starch compare with full capacity in proposal. (As per historical data of operation)
$COD_{y,removed}$ =	98% of inlet value	Test reports available
$COD_{in,treatment}$ =	20000 mg/l	Technical proposal / design values for treatment plant.
$B_{o,ww}$ =	0.21kg CH_4/kg COD	Default value
$MCF_{ww,treatment,i}$ =	0.8	Default value
GWP_CH_4 =	21	Default value
UF_{BL}	0.94	Default value
Calculation: 1020000 X0.69X (20000 X 0.98 / 1000000) X 0.21 X 0.8 X 21 X0.94= **45775 tCO_2 e**		
Methodology: AMS I C (Fuel replacement component)		
Formula: $BE_y = HG_y * EF_{CO2} / \eta_{th}$		
HG_y =	23.832 TJ	Based on historical HFO requirement for starch generation; shall be replaced by biogas.
EF_{CO2}:	77.4 tCO2/TJ	Emission factor of fossil fuel replaced (IPCC 2006 default value for residual fuel oil, Volume 2, Chapter 1, 1.23)
η_{th}:	1	Assumed to be 100% efficient thereby considering the conservative approach.
Calculation: = 23.832 X 77.4 = **1844 tCO2e**		
Methodology: AMS I D (Power generation component) – only after gas engine installation		
Formula: $BE_y = (EG_y + EC_y) * EF_y$		
EG_y =	3.44X10^6 Nm^3 X 20930 KJ/ m3 X 0.381/3600	Based on info available for gas engine and biogas used in combustion process. Efficiency of gas engine and NCV of biogas[14].
EC_y =	0	Based on electricity consumption at the recently treatment plant. Assumed zero for conservativeness
EF_y =	0.521 tCO2/MWh	Grid emission factor – Annex 3
Calculation: = 6874.4 MWh X 0.521 = **3582 tCO_2**		

Baseline Emissions are tabulated as below

[14] http://www.dede.go.th/dede/fileadmin/upload/cc/EleThai110951.pdf (Page - 42)

Year	1	2	3	4	5	6	7
Baseline Emissions	51200	51200	51200	51200	51200	51200	51200
from WWT system	45775	45775	45775	45775	45775	45775	45775
from sludge treatment system	0	0	0	0	0	0	0
from WW discharge	0	0	0	0	0	0	0
from final sludge	0	0	0	0	0	0	0
from fossil replacement - AMS IC	1844	1844	1844	1844	1844	1844	1844
from disp of grid power - AMS ID	3582	3582	3582	3582	3582	3582	3582

Project emissions:

Methodology: AMS III H (Methane avoidance component)		
Emissions in wastewater treatment system without biogas recovery		
Formula: $PE_{ww, treatment, y} = Q_{y, ww} * \sum(COD_{y, removed} * B_{o, ww} * MCF_{ww, treatment, i} * GWP_{CH4} * UF_{PJ})$		
$Q_{y, ww}$ =	1,020,000 X 0.69Nm^3	Based on starch production: 300t/d, WW flow: 17m^3/t, and 200 operating days
$COD_{y, removed}$ =	100% of inlet value	To be conservative
$COD_{in, treatment}$ =	2000 mg/l	
$B_{o, ww}$ =	0.21kg CH_4/kg COD	Default value
$MCF_{ww, treatment, i}$ =	0.8	Default value for anaerobic deep lagoons
GWP_{CH4} =	21	Default value
UF_{PJ}	1.06	Default value
Calculation: 1020000 x 0.69 x (2000 x 0.98/1000000) x 0.21 x 0.8 x 21 x 1.06 = **5162 tCO_2 e**		
Fugitive emissions in wastewater treatment system with biogas recovery		
Formula: $PE_{fugitive, ww, y} = (1 – CFE_{ww}) * MEP_{ww, treatment, y} * GWP_{CH4}$		
CFE_{ww}	0.9	Default value
$MEP_{ww, treatment, y}$	2180 t	Methane emission potential of wastewater treatment systems equipped with biogas recovery: $MEP_{ww, treatment, y} = Q_{y, ww} * B_{o, ww} * UF_{PJ} * \sum COD_{y, removed} * MCF_{ww, treatment, PJ}$, with $COD_{y, removed} = COD_{y, in} * \eta_{BFR} = COD_{y, in} * 0.90$.
Calculation: (1-0.9)*21*2180 = 4740 tCO_2 e		
Methane emissions due to incomplete flaring		
Formula: $PE_{flare, y} = \Sigma TM_{RG, h} * (1- \eta_{flare, h}) * GWP_{CH4}/1000$		
$\eta_{flare, h}$	0.5	Efficiency of the open flare
$\Sigma TM_{RG, h}$	0t	Flare system is designed to used in case of emergency so in this calculation uses 0 t
Calculation: 0*(1-0.5)*21 **=0 tCO_2e**		
Methodology: AMS I D		

Formula: $PE_{power} = EC_y * EF_y$		
EC_y	507 MWh	Based on power capacity installed (96kW), and number of operating days (200).
EF_y	0.521 tCO2/MWh	Grid emission factor of Thailand (Annex 3)
Calculation: 507*0.521=**264 tCO_2e**		

Project Emissions are tabulated as below:

Project Emissions	10166	10166	10166	10166	10166	10166	10166
Emissions due to power consumption in treatment process	264	264	264	264	264	264	264
Emissions in WWT system without biogas recovery	5162	5162	5162	5162	5162	5162	5162
Emissions from sludge treatment	0	0	0	0	0	0	0
Fugitive emissions from use of waste water	4740	4740	4740	4740	4740	4740	4740
Fugitive emissions from use of sludge	0	0	0	0	0	0	0
Project Emissions due to	0	0	0	0	0	0	0
Emissions from flaring	0	0	0	0	0	0	0

No Leakages in this project.

Emission Reductions are:

Year	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Emission Reductions	41,034	41,034	41,034	41,034	41,034	41,034	41,034

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

year	Emission of project activity emissions (tCO2e)	Estimation of baseline emissions (tCO2e)	Estimation of leakage (tCO2e)	Estimation of overall emission reductions (tCO2e)
1	10,166	51,200	0	41,034
2	10,166	51,200	0	41,034
3	10,166	51,200	0	41,034
4	10,166	51,200	0	41,034
5	10,166	51,200	0	41,034
6	10,166	51,200	0	41,034
7	10,166	51,200	0	41,034
Total (tonnes CO2e)	71,165	358,402	0	287,237

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

B.7.1 Data and parameters monitored:

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

Data / Parameter:	$Q_{y, ww}$
Data unit:	m^3
Description:	Volume of wastewater treated in the year y
Source of data to be used:	Measured - Volumetric flow meters
Value of data applied for the purpose of calculating expected emission reductions in section B.5	1,020,000X0.69 Based on 300 t/day starch production, 17 m^3/t waste water generation, and operation of 200 days. 0.69 used as a factor of workload which comes from three year average actual workload of the factory.
Description of measurement methods and procedures to be applied:	The volumetric flow meters with an accepted level of accuracy are installed and integrated with SCADA (Supervisory Control And Data Acquisition system) at the plant.
QA/QC procedures to be applied:	Periodic calibrations of flow meter are ensured via an external agency. This calibration is usually undertaken in off season to ensure data accuracy and sufficiency in operation days.
Any comment:	

Data / Parameter:	$S_{y, final}$
Data unit:	Tonnes
Description:	Amount of final sludge generated by the wastewater treatment in the year y
Source of data to be used:	Measured – all the sludge quantity produced during a monitoring period is measured before final disposal / treatment
Value of data applied for the purpose of calculating expected	0

emission reductions in section B.5	
Description of measurement methods and procedures to be applied:	The project proponent doesn't envisage the generation of any sludge, which would be required to treat an-aerobically.
QA/QC procedures to be applied:	The measurement equipment shall be calibrated on regular basis.
Any comment:	

Data / Parameter:	$COD_{y, in, UASB}$
Data unit:	mg/l
Description:	COD of water entering the UASB treatment process.
Source of data to be used:	Measured – Calorimetric analysis.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	20000 Based on the technical proposal by technology supplier.
Description of measurement methods and procedures to be applied:	The COD content will be analyzed using a colorimetric method in the on-site laboratory of the treatment plant. The results will be logged in the plant operation report on a daily basis.
QA/QC procedures to be applied:	The calorimetric method is well documented and well accepted either by national or international standards.
Any comment:	

Data / Parameter:	$COD_{y, out, UASB}$
Data unit:	mg/l
Description:	COD of water exiting the UASB treatment process.
Source of data to be used:	Measured – Calorimetric analysis.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	2000 This would be monitored during the monitoring period. However for estimation of project emissions for the anaerobic collection of methane, maximum possible value is assumed from 90% efficiency.
Description of measurement methods and procedures to be applied:	The COD content will be analyzed using a colorimetric method in the on-site laboratory of the treatment plant. The results will be logged in the plant operation report on a daily basis.
QA/QC procedures to be applied:	The calorimetric method is well documented and well accepted either by national or international standards.
Any comment:	

Data / Parameter:	$COD_{y, removed, j}$ (here j represents UASB treatment)
Data unit:	tonnes /m^3
Description:	COD removed by waste water treatment facility
Source of data to be used:	Measured – Using the above two measurements
Value of data applied for the purpose of calculating expected emission reductions in section	0.0184

B.5	
Description of measurement methods and procedures to be applied:	The difference between $COD_{y, in, UASB}$ & $COD_{y, out, UASB}$ gives the amount of COD removed by the UASB process.
QA/QC procedures to be applied:	The quality assurance of COD measurement at inlet and outlet point assures the Quality of this parameter.
Any comment:	

Data / Parameter:	$COD_{y, out, lagoon}$
Data unit:	mg/l
Description:	COD of water exiting the lagoon system.
Source of data to be used:	Measured – Calorimetric analysis.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	40 mg/l This would be monitored during the monitoring period. However for estimation of project emissions for anaerobic lagoons, 98% is assumed.
Description of measurement methods and procedures to be applied:	The COD content will be analyzed using a colorimetric method in the on-site laboratory of the treatment plant. The results will be logged in the plant operation report on a daily basis.
QA/QC procedures to be applied:	The calorimetric method is well documented and well accepted either by national or international standards.
Any comment:	

Data / Parameter:	$COD_{y, removed, j}$ (here j represents lagoons)
Data unit:	tonnes/m^3
Description:	COD removed by waste water treatment facility
Source of data to be used:	Measured – Using the above two measurements
Value of data applied for the purpose of calculating expected emission reductions in section B.5	0.0018 Maximum possible anaerobic reduction by lagoon system which is in downstream to UASB process.
Description of measurement methods and procedures to be applied:	The difference between $COD_{y, in, lagoon}$ & $COD_{y, out, lagoon}$ gives the amount of COD removed by the lagoons.
QA/QC procedures to be applied:	The quality assurance of COD measurement at inlet and outlet point assures the Quality of this parameter.
Any comment:	

Data / Parameter:	Q_{biogas}
Data unit:	Nm^3
Description:	Quantity of biogas generated by the anaerobic treatment process.
Source of data to be used:	Measured – Gas flow meter
Value of data applied for the purpose of calculating expected emission reductions in section B.5	$4.57 \times 10e^6$ Based on assumption that biogas contains about 65% of methane.

Description of measurement methods and procedures to be applied:	The gas flow meters with an accepted level of accuracy are installed and integrated with SCADA (Supervisory Control And Data Acquisition system) at the plant.
QA/QC procedures to be applied:	The gas flow meter is calibrated on regular basis from a certified testing agency or institution.
Any comment:	

Data / Parameter:	HG_y
Data unit:	TJ
Description:	Quantity of thermal energy supplied by the biogas i.e. the energy which replaces the usage of residual fuel oil.
Source of data to be used:	Measured
Value of data applied for the purpose of calculating expected emission reductions in section B.5	23.83 TJ NCV of biogas from a national source, and NCV of Fuel oil from IPCC. Ex-ante estimate is based on reverse calculation of Fuel oil consumed in historical production.
Description of measurement methods and procedures to be applied:	The quantity of biogas burnt and methane percentage shall be used to ascertain exact amount of methane used to replace fossil fuel. The methane quantity shall give the amount of energy based on NCV of natural gas for the region. The biogas used in fuel replacement i.e. boiler or heating equipment is measured using the gas flow meters.
QA/QC procedures to be applied:	The gas flow meters are regularly calibrated.
Any comment:	

Data / Parameter:	$Q_{biogas, flare, y}$
Data unit:	Nm^3
Description:	Amount of biogas flared
Source of data to be used:	Measured – Gas Flow meter provided at the inlet of flare system.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	0
Description of measurement methods and procedures to be applied:	The amount of biogas sent to the flare will be continuously measured by means of a cumulative flow meter installed after the blowers and before the flare. Data will be recorded and stored electronically on a continuous basis.
QA/QC procedures to be applied:	Periodic pressure loss tests shall ensure that there is no biogas leakage between the reactor outlet and both points of biogas flow measurements.
Any comment:	

Data / Parameter:	$Q_{biogas, boiler, y}$
Data unit:	Nm^3
Description:	Amount of biogas fired in boiler
Source of data to be used:	Measured - Flow meters provided at the inlet of boiler system.
Value of data applied for the	1.14 X 10e6 Nm^3

purpose of calculating expected emission reductions in section B.5	Base on average HFO consumption.
Description of measurement methods and procedures to be applied:	The flow meters are integrated with Supervisory Control And Data Acquisition system (SCADA).
QA/QC procedures to be applied:	Periodic pressure loss tests shall ensure that there is no biogas leakage between the reactor outlet and both points of biogas flow measurements.
Any comment:	

Data / Parameter:	$Q_{biogas, gas engine, y}$
Data unit:	Nm^3
Description:	Amount of biogas used for power generation in gas engine
Source of data to be used:	Measured - Flow meters provided at the inlet of gas engine to monitor the biogas supplied to gas engine
Value of data applied for the purpose of calculating expected emission reductions in section B.5	3.44 X $10e^6$ Nm^3
Description of measurement methods and procedures to be applied:	The amount of biogas produced by the digester will be calculated as the sum of the biogas flows at the inlet of the boiler and of the flare system. These flow meters are integrated with Supervisory Control And Data Acquisition system (SCADA).
QA/QC procedures to be applied:	Periodic pressure loss tests shall ensure that there is no biogas leakage between the reactor outlet and both points of biogas flow measurements.
Any comment:	

Data / Parameter:	$\%CH_4$
Data unit:	%
Description:	Methane content in biogas
Source of data to be used:	Measured – Online system to monitor % of methane in biogas.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	65% As per technology provider specifications.
Description of measurement methods and procedures to be applied:	Monitored onsite using online gas analyzer equipment.
QA/QC procedures to be applied:	
Any comment:	

Parameter:	T_{flame}
Unit:	°C
Description:	Flame temperature of the flare
Source of data:	Supervisory Control And Data Acquisition system (SCADA)

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

ADDITIONAL REQUIREMENTS FOR THE GOLD STANDARD:
Data to be collected in order to monitor the project's performance on the sustainable development indicators:

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

Please refer to Annex 5 for Gold Standard information.

B.7.2 Description of the monitoring plan:

1. Monitoring Management

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

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

3. On-site Procedures
The operations software creates daily logs of plant performance which are printed out and recorded electronically for periodic download onsite or remote transfer for further processing.
Procedures for Calibration of Equipment

The plant operator carries out calibration according to international standards.

4. Data Storage and Filing – Electric Workbook
All relevant data is stored electronically with the process control computer unit, external storage media and transferred. A daily log is printed.

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

Completion date: 15/09/2008

Patrick Bürgi
South Pole Carbon Asset Management Ltd.
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CH-8005 Zurich
Switzerland

SECTION C. Duration of the project activity / crediting period

C.1 Duration of the project activity:

C.1.1. Starting date of the project activity:

01/02/08 (Construction start date)

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

15 years

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

C.2.1. Renewable crediting period

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

01/04/2009

C.2.1.2. Length of the first crediting period:

7 years

C.2.2. Fixed crediting period:

C.2.2.1. Starting date:

NA

C.2.2.2. Length:

NA

SECTION D. Environmental impacts

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

The project is not considered to create significant environmental impacts. On the contrary, the project activity will result in more efficient wastewater treatment, avoiding contamination of local water streams and contributing to water conservation. The project will also alleviate odour emissions from existing lagoons.

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

The proposed project is not required to undertake an Environmental Impact Assessment according to the Thailand regulations (http://www.onep.go.th/eia/). No negative environmental effects are expected from the implementation of the project as a result of Initial Environmental Evaluation required by Thai DNA.

ADDITIONAL REQUIREMENTS FOR THE GOLD STANDARD:
EIA Requirements

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

Please refer to Annex 5 for Gold Standard information.

SECTION E. Stakeholders' comments

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

Procedure followed to invite stakeholder comments

A. Public hearing for local stakeholders:

Invitation procedure

The Gold Standard Initial Stakeholder Consultation has been conducted by the project owner Chantaburi Starch Power Limited with assistance from South Pole Carbon Asset Management Limited (Switzerland based company responsible for CDM project development) and Papop Limited (Thai engineering company response for implementation of the wastewater treatment plant).

Stakeholder groups as defined in the Gold Standard procedures have been identified and informed through oral and written means about the meeting. The invitation letter was sent by fax to participants located a long distance from the project, by regular mail to participants without access to a fax and there was an announcement of this meeting posted at the community hall for people who had not received an invitation letter. This invitation process was done 2 weeks before the meeting date. An example of the invitation letter can be seen in annex I.

Place and date of the meeting
The initial stakeholder consultation was held at a meeting room within Chantaburi Starch factory which is located 400m away from the wastewater treatment plant, on 22 august 2008.

Meeting Participants
The mentioned meeting was attended by local residents and representatives from the following stakeholder categories:

1. Local residents
2. Local government representatives
3. Local entrepreneurs
4. Employees
5. Local farmers

From the overall participants of 104 people, there are only 67 participants have followed the invitation, attended the meeting and returned the questionnaire.

Language
Documentation and meeting was held in Thai which is the local language.

Meetings procedure

- Opening (15 min)
- Purpose of the consultation (5 min)
- Description of the project and environmental impacts (20 min)
- Questions and Answers session (10 min)
- Completing checklists (Appendix E to the Gold Standard Project Deloper's Manual) (20 min)
- General feedback (15 min)

Meeting documents and protocols
On completion of the various meetings, the following documents were collected and attested by the signatures of the stakeholders that were present at the venue:

1. Presence list with name, address and occupation.(Annex II)
2. Non-technical description of the project (Annex III)

3. Documentation on environmental impacts of the project (Annex III)
4. Filled out Appendix E of Gold Standard (checklist) (Annex III)
5. Notes for additional comments on the project activity (part of checklist for gold standard (Annex III))

These documents are available as hardcopies and will be handed over to the designated operational entity (DOE) conducting the Gold Standard validation process.

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

Invitation procedure
An invitation was sent to representatives of Gold Standard supporting organizations in Thailand and international Gold Standard Supporters on August 8^{th} 2008. The invitation included a short introduction of the project and the date and location of the scheduled initial stakeholder consultation. No reply was received.

Period of email consultation
8 August 2008 to 22 August 2008.

ADDITIONAL REQUIREMENTS FOR THE GOLD STANDARD:
Public Consultation Process

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

Please refer to Annex 5 for Gold Standard information.
.

E.2. Summary of the comments received:

Compilation of comments received

A. Public hearing for local stakeholders:

The overall response to the Project, from 104 participating local stakeholders, was encouraging and positive. The greatest asset achieved by the project appears to be the positive effect on the environment. Stakeholders acknowledge that the improvement of wastewater treatment technology will reduce odors released to the surrounding area, which previously was a major concern for the surrounding community like other cases of tapioca starch factory. This project is viewed as a positive environmental plan that is important for local water resources and the community's quality of life. The project is considered to be one of the leading projects in developing covered lagoons for tapioca starch manufacture, where currently the wastewater is considered as a major odor and methane producer. This project is considered a financially risky plan due to the required investment and rate of return.

To sum up the sustainability of the project, the various benefits (as reported by local stakeholders) are listed below.

1. The installed technology contributes to clean soil, water and reduced odors.
2. Use of biogas represents a sustainable way for generating energy.
3. While the system operates within strict environmental standards there will be no negative impacts to the environment due to the plant.
4. The project is well designed, returning clean water to the environment and not producing additional pollution.
5. The plant will create new jobs at the plant.

37 questionnaires were not received. Some of these people declared that they could not read and write and other did not return their questionnaires back. No negative comments or reactions to the project have been received during the oral hearing.

5 participants left general comments and asked questions related to the project:

1. Village leader asked if there are any toxics contaminated in the treated wastewater.
   The representative from Papop, project developer, explained that the Tapioca starch process do not contain any toxics because tapioca starch is used as food and in the treatment process does not contain any toxic chemicals.
2. One local resident doubted about the safety of the biogas system.
   Comment by project developer:"The nature of biogas is lighter than air so if it leaks from the system, it will flow upward to the sky. So in normal situation, it is difficult to cause fire. In order to sell these CERs, company needs to have the leak detector to protect the gas leakage from system."
3. Vice mayor also asked for the uses of methane.
   Plant manager explained that the uses of methane in this plant are for Boiler and Gas Engine to produce electricity. The electricity is sold to Local Electricity Authority. The amount of electricity, made from this plant, will be enough for 3 villages around the Factory.
4. Local resident raised the issue of dust from the plant operation
   Project developer explained that there is no dust expected from the operation of this plant.
5. Last question was asked by other resident. He wondered where the UASB tower is.
   Plant manger explains that UASB tower is located at the area next to the already existing wastewater treatment ponds. It is located behind the factory building. This location cannot be seen from outside because it is quite a distance from the entrance of the factory to the UASB tower.

The Gold Standard questionnaire (Appendix E to the Gold Standard Manual for CDM Project Developers) has been presented in Thai. It consisted of 23 questions that were to be answered.

The following 5 questions were answered with "yes" by some of the participants:

1. **Question 1: Will construction, operation or decommissioning of the Project use or affect natural resources or ecosystems, such as land, water, forests, habitats, materials or, especially any resources which are non-renewable or in short supply?**

Answer by project owner: The aim of the project is avoiding any harm or threat to the environment or people. The construction of this project is under the supervision by the professional experienced company which has been working for this type of wastewater treatment system for over ten years. The construction has operated under international standard in order to ensure safety to employees and local residents around the area.

2. **Question 15: Will there be any risk of accidents during construction or operation of the Project which could affect human health?**
   Answer by project owner: The construction and operation of the plant is carried out in accordance with relevant safety standards and procedures. Accident risks are mitigated to the extent that can be influenced by the project owner.

3. **Question 16: Will the Project result in social changes, for example, in demography, traditional lifestyles, employment?**
   Answer by project owner: Given the overall very positive response to the project, it is assumed that the answers above highlight the beneficial social impacts of the project, as there was no explicit negative remark. The construction of this plant does not need so many people, so it would have the influence on a culture change. During plant operation, more employees will be needed to operate this section. This aspect will lead to positive effect to the community.

4. **Question 19: Is the project in a location where it is likely to be highly visible to many people?**
   Answer by project owner: The plant is located next to the factory building, which is one kilometre from the local road and the closest communities around the factory area are located three kilometres away from the site. The surrounding areas are used to plant cassava and longan. This makes it very difficult to see the UASB and Biogas container. All the people who answer "yes" consider that this plant is visible for them if they were in the meeting room, which is located close to treatment plant.

5. **Question 20: Are there existing or planned land uses on or around the location e.g. homes, gardens, other private property, industry, commerce, recreation, public open space, community facilities, agriculture, forestry, tourism, mining or quarrying which could be affected by the project?**
   Answer by project owner: This development uses only the area in Chantaburi Strach Factory. Wastewater treatment plant is located next to the recent wastewater treatment ponds which are in the middle of factory area. The construction and operation of this plant would use only the area within factory boarder.

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

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

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

As no major environmental concerns were raised during the entire initial stakeholder consultation process, it was neither necessary to make any changes to the Project design nor to incorporate any additional measures to limit or avoid negative environmental impacts. The same applies to socio-economic concerns, which have not been raised at all.

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

Annex 1

CONTACT INFORMATION ON PARTICIPANTS IN THE PROJECT ACTIVITY

Organization:	Chantaburi Starch Power Co., Ltd.
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Represented by:	
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Annex 2

INFORMATION REGARDING PUBLIC FUNDING

No public funding is involved in the project

Annex 3

BASELINE INFORMATION

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

Unit : GWh

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

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

Low-cost/must run resources
Unit : GWh

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

Simple OM emission factor (EF OM,y)

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

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

Fuel consumption for electric generation to national grid

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

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

Fuel consumption for electric generation to national grid (tons)

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

Remark: density of fuel

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

CO2 emission coefficient of fuel 'i' , COEF i

Parameter	Fuel Oil	Diesel Oil	Coal & Lignite	Natural Gas
NCV i (TJ/Gg)	40.4	43.0	11.9	48.0
EF CO2,i (kg/TJ)	77,400	74,100	101,000	56,100
OXID i	1	1	1	1
COEF i (tCO2/ton)	**3.13**	**3.19**	**1.20**	**2.69**

Remark

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

Calculation of (Fi,j,y * COEFi,j)

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

Simple OM emission factor (EF OM,y)

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

Build Margin emission factor (EF BM,y)

Powerplants that have been built most recently

Plant name (sample group m)	Commercial Operation Date COD	Plant Capacity (MW)	Generation in 2006 (GWh)	Type of Fuel	Efficiency (Btu/kWh)	Energy (TJ)	EF CO2,i (tCO2/TJ)	Emissions (tCO2)	EF BM,y (tCO2/MWh)
Krabi	Aug 2003	340.0	1,126	Fuel oil	8,918	10,592	77.40	819,817	
Ratchaburi, Cogeneration	April 2002	2,041.0	15,002	Natural Gas	7,214	114,155	56.10	6,404,103	
EPEC	Mar 2003	350.0	2,385	Natural Gas	7,020	17,660	56.10	990,737	
Glow	Jan 2003	713.0	5,425	Natural Gas	6,979	39,936	56.10	2,240,402	
BLCP	Aug 2006	673.3	4,024	Coal	8,910	37,819	101.00	3,819,682	
Total			**27,962**					**14,274,740**	**0.51**
Total grid generation			138,742						
Generation of group m is part of total grid generation			**20.2%**						

Remark

6. Source: Electric Power in Thailand 2006 Report, DEDE, Table 8, page 10 and Table 18 page 22

The Baseline Emission Factor EFy

Parameter		Emission Factor (tCO2/MWh)	Weights
Simple OM	EF OM,y	0.53	0.50
Bulid Margin	EF BM,y	0.51	0.50
Combined Margin	**EF y**	**0.521**	