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	(a) The Board agreed to revise the CDM SSC PDD to reflect guidance and clarifications provided by the Board since version 01 of this document. (b) 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	(c) 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:

Eiamrungruang Waste Water Treatment and Biogas Utilization Project
Version: 2.4
Date: 08/08/2012

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

"Eiamrungruang Waste Water Treatment and Biogas Utilization", hereafter referred to as 'the Project' is being implemented by Eiam Rung-Ruang Renewable Co.,Ltd (ERR) at a tapioca starch processing plant in Nakornratsima province, located in the north-east of Thailand. The starch factory has a maximum production capacity of 350 tons of starch per day.

The purpose of the project activity is to treat the wastewater from the starch factory and generate biogas for further utilization as a renewable fuel for energy generation purposes. The project activity entails the installation of an anaerobic wastewater treatment facility, based on an "Up-flow Anaerobic Sludge Blanket" (UASB) system. The UASB system is designed to handle a wastewater volume of about 6,000 m^3/day[1] and is expected to operate during 240 days per year. The UASB system has been commissioned[2] in January 2011. In the absence of the project activity, the wastewater from the starch plant would have been treated in open anaerobic lagoons, which would have generated methane – a greenhouse gas. The baseline scenario is further detailed in section B.4.

The implementation of the project activity will enable the generation and capture of biogas which will be used for electricity and thermal energy generation at the project site. The biogas will be fed to new gas engines for power generation and to the thermal oil boiler (installed capacity of 4.651MW_{th}) for the starch drying process. The thermal oil boiler with a dual fuel burner for combustion of biogas and heavy fuel oil, was purchased and installed since the operation of the starch factory started in November 2009. Biogas is used as a fuel in the boiler since February 2011, replacing heavy fuel oil, which was the only fuel source prior to the project activity. One gas engine with a capacity of 1,560 kW_{el} will be fully operational by the end of November 2011. One additional gas engine with the same capacity will be installed in 2012.

The project activity will therefore contribute significantly to the reduction of GHG emission by using biogas, which is rich in methane and would have been emitted to the atmosphere in the absence of the project activity. Furthermore, the electricity generated by the gas engine will be used in the biogas plant and the rest will be exported to the national grid under a firm power purchase agreement of 2.8 MW_{el} under the Very Small Power Producer (VSPP) scheme, thereby displacing electricity generated from fossil fuels from the grid. The biogas utilized in the thermal oil boiler will replace the usage of heavy fuel oil thereby contributing further in the reduction of GHG emissions. In the case of an emergency or excess biogas production, biogas will be flared in an enclosed flare system with an installed capacity of 1,000 m^3/hr.

Sustainable Development Benefits of the Project

[1] Source: Technical proposal for biogas system

[2] The status is updated in September 2011

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

Natural Resources and Environmental benefits

- The project activity reduces greenhouse gas emissions through the methane avoidance from the anaerobic open lagoon system and the carbon dioxide emissions from electricity generation in the grid and thermal energy generation in the thermal boilers using fossil fuels. The project activity will utilize biogas (a renewable fuel for energy generation).
- The project activity reduces offensive odors which would have occurred if the wastewater was treated in the open lagoons;
- The project activity will reduce air pollution by regularly monitoring stack emissions as a result of CDM;
- The project activity also leads to implementation of a technologically more advanced and reliable method of wastewater treatment compared to the baseline;
- The project activity will recycle water thereby contributing to water conservation.

Social Indicators

- The project activity invited local people to provide comments[4] on the project. This ensured participation from the local public and provided opportunity to understand the technology and benefits resulting from the project;

Development and/or technology transfer indicators

- The project activity contributes significantly to technology development and transfer. The UASB system and the bio scrubber are supplied by Papop Co.,Ltd., a local technology provider. The gas engine is manufactured by MWM GmbH, a German technology provider.
- The technology suppliers will provide the necessary training for the operation and maintenance of the equipments in the project activity, which will further enhance the skills set of the local employees.
- The capacity of the employees will also increase by learning/adopting good practices for monitoring and data management.

Economic benefits

- The project activity contributes to the expansion of the renewable energy sector in Thailand.
- The project activity increases employment opportunities for the local people by setting up an industrial unit in the area. This will directly promote other related income generation sources like local suppliers, manufacturers, small shops etc.
- The project activity contributed to the employment of local people both in the skilled and semi-skilled category during the construction phase. Further, the project activity also generates direct permanent employment opportunities[5] for at least 7 people.

A.3. Project participants:

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

[4] Please refer to section E for more details.

[5] Please refer to section B.7.2 for more details.

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)	Eiam Rung-Ruang Renewable Co.,Ltd. (private entity)	No
Switzerland	Swiss Carbon Assets 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.:

Nakornratsima province

A.4.1.3. City/Town/Community etc:

Nonghuarat subdistrict, Nongbunmak district

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

Physical address of site:
Eiam Rung-Ruang Renewable Co.,Ltd.
129 Moo1 Nonghuarat subdistrict, Nongbunmak district, Nakornratsima, Thailand

The exact coordinates of the project are:
- Latitude: 14.731417
- Longitude: 102.393208

Figure 1: Maps showing the location of the project activity

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

Categories of project activity:

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:	Methane Recovery in wastewater treatment
Sectoral Scope 13:	Waste handling and disposal

Heat generation component:

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

Electricity generation component:

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

Technology to be employed by the project activity:

The project activity is implemented next to a starch factory to treat the wastewater generated by the factory. The starch factory has a maximum production capacity of 350 tons of starch per day. The starch factory and the biogas plant (the project) are located adjacent to each other. The exact location is provided in section A.4.1.4.

Under the Project activity, the effluent from the starch factory will be fed to the anaerobic digester with biogas recovery. This entails the installation of an anaerobic wastewater treatment facility, based on an "Up-flow Anaerobic Sludge Blanket" (UASB) system that is described in more detail below:

Pre-treatment

The wastewater from the starch factory's separator process first passes through a screen extractor where coarse particles are removed such as roots, pulp, and peels. After the screening, the wastewater flows into an acidification pond where bacteria convert the organic matter into Volatile Fatty Acids (VFA) that can be easily digested in the next step. This also results in the pH of the wastewater dropping significantly. The wastewater from the acidification pond then 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 under the pH adjustment process with hydrated lime. Lime powder is directly added in a lime-mixing tank, which receives the wastewater from the acidification process.

Anaerobic treatment

In the UASB, the wastewater rises through an expanded bed of anaerobic active methanogenic sludge (the so called "sludge blanket") undergoing an anaerobic biological process, where organic matter is converted into biogas. An internal device at the top of the reactor separates the mixed liquor into clarified wastewater, biogas and sludge. The UASB system has a total volume of 10,260 m^3 and is designed to handle a wastewater volume of about 6,000 m^3/day. With an average inlet COD of 18,500 mg/l and a COD removal efficiency of 95%, the production of biogas is expected to be around 42,180 m^3 per day[6] (with the methane percentage in the biogas being around 65%).

Biogas handling

The project activity plans to utilize the biogas for thermal and power generation purposes. A part of the biogas captured will be combusted to generate heat for the starch drying process in an existing thermal oil boiler. The thermal oil boiler is designed with a rated capacity of 4.651 MW_{th}. In order to utilize the biogas for electricity generation, it will be treated in a bio-scrubber to reduce its sulphur content. Once the H_2S is removed, the biogas will be sent to the gas engine(s). The gas engines, installed in two phases, have a total installed capacity of 3.120 MW_{el} (2 x 1.560 MW_{el}). The electricity generated will be used within the biogas plant and the remaining will be exported to the grid. In addition, there is a gas storage system at the site to ensure a steady supply of biogas in the event of fluctuations in biogas production volumes. The excess biogas, if any, will be flared in an enclosed flaring system with an installed capacity of 1,000 m^3/hr.

Post-treatment system

[6] Page 1 and 13 of the technical proposal by Papop Co.,Ltd.

Effluent from the UASB system is discharged to the sump before sending the treated wastewater to the anaerobic ponds which were used prior to implementation of the project activity. The treated wastewater from the last open pond will be used either for washing of raw tapioca or for irrigation purpose within the plant's boundary.

Technology transfer and training:
The UASB system and bioscrubber are provided by Papop Co.,Ltd., a local technology provider in Thailand, whereas several of the sub-components in the biogas and energy utilization systems (such as several monitoring, instrumentation and control devices) are imported. The biogas gas engine is manufactured by MWM GmbH, a German supplier, and the flaring system (automatic enclosed flare) is designed and manufactured by a local technology provider (BKE Co., Ltd.). Overall, the project activity contributes to transfer of technology from developed countries to Thailand. Furthermore, all the suppliers will provide necessary training for the operation and maintenance of the equipments in the project activity, which will further enhance the skill set of the local operators.

Environmentally safe and sound technology:
The approval process by local authorities, which has been already successfully concluded by the project activity, includes a general assessment of compliance by the project activity with the safety norms and regulations of the host country. Furthermore, all involved technology providers have a strong track record and experience with the relevant technologies, ensuring that all the equipments come with proper provisions for safety in line or even exceeding local regulations. The critical parameters for smooth operation of the system will be monitored as per the recommendations of the technology provider. The project activity has many provisions to guarantee safety and some of these include safety components such as pressure controller, gas analyzer, automatic blowout, a flame arrestor and safety switches. The operation manual for the project activity includes procedures on safety that will make sure that the operators are fully aware of preventive maintenance measures as well as emergency procedures.

Table 1: Summary of the technical specifications

Equipment	Capacity	Source
UASB	6,000 m^3/day	Technical proposal for biogas system
Thermal oil boiler	4.651 MW_{th}	Technical specification of thermal oil boiler
Gas engine	3.120 MW_{el} (2 units x 1.56 MW_{el})	Technical specification of gas engine
Enclosed biogas flare system	1,000 m^3/hr	Technical specification of flare system

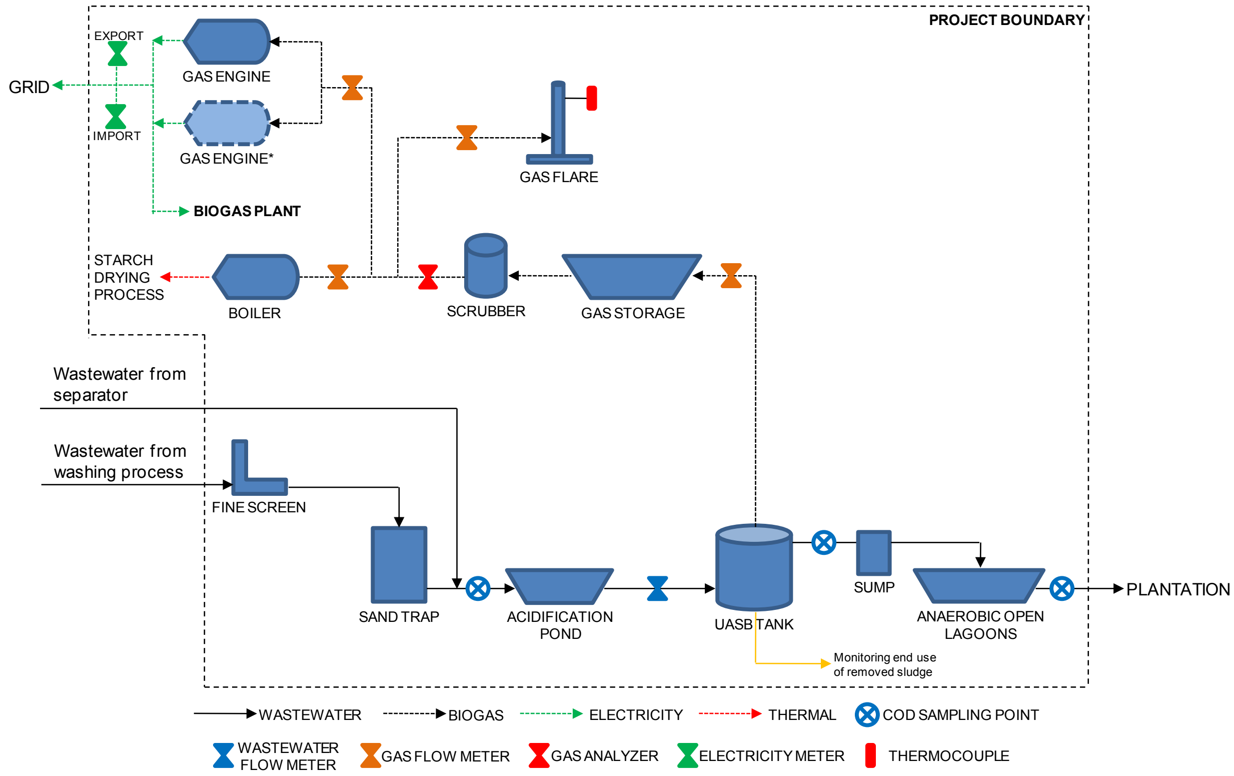

Figure 2: Process Flow Diagram

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

A seven year renewable crediting period has been selected for the project activity. The estimated emission reductions over the chosen crediting period are as follows:

Years[7]	**Estimation of annual emission reductions in tonnes of CO_2e**
Year 2012	56,248
Year 2013	56,248
Year 2014	56,248
Year 2015	56,248
Year 2016	56,248
Year 2017	56,248
Year 2018	56,248
Total emission reductions (tonnes of CO_2e)	393,733

[7] "Year" means a complete year starting from the start date of crediting period (for e.g. 'Year 2016' covers the period 1st June 2016 till 31st May 2017). The start date of crediting period is determined based on C.2.1.1.

Total number of crediting years	**7**
Annual average the estimated reductions over the crediting period (tCO_2e)	56,248

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

The Project receives no public funding from Annex I Parties.

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

In reference to the "Guidelines on assessment of debundling for SSC project activities", version 03, EB54 (Annex 13)"

"A proposed small-scale project activity shall be deemed to be a debundled component of a large project activity if there is a registered small-scale CDM project activity or an application to register another small-scale CDM project activity:

(a) With the same project participants;

(b) In the same project category and technology/measure; and

(c) Registered within the previous 2 years; and

(d) Whose project boundary is within 1 km of the project boundary of the proposed small- scale activity at the closest point."

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. Hence the project activity 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:

The following methodologies are applicable to the project activity:

Methane avoidance component:

AMS III.H: "Methane Recovery in Wastewater Treatment" (Version 16)

Thermal displacement component:
AMS I.C: "Thermal energy production with or without electricity" (Version 19)

Electricity generation component:

AMS I.D: "Grid connected renewable electricity generation" (Version 17)

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

The latest version of the following tools will also be used in this Project activity:

- "Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion", version 02.
- "Tool to calculate baseline, project and/or leakage emissions from electricity consumption", version 01;
- "Tool to determine project emissions from flaring gases containing methane", version 01;
- "Tool to calculate the emission factor for an electricity system", version 02.2.1;

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

In the following section, it is demonstrated that the approved methodology AMS III.H. (Version 16), AMS.I.C (Version 19), and AMS I.D. (Version 17) are applicable following to applicability conditions described in Table 2, Table 3 and Table 4, respectively.

Table 2: Applicability of AMS III.H.

	Applicability Criteria	Project eligibility
1	*This methodology comprises measures that recover biogas from biogenic organic matter in wastewater by means of one or a combination, of the following options:* ***(a)*** *Substitution of aerobic wastewater or sludge treatment systems with anaerobic systems with biogas recovery and combustion;* ***(b)*** *Introduction of anaerobic sludge treatment system with biogas recovery and combustion to wastewater treatment plant without sludge treatment;* ***(c)*** *Introduction of biogas recovery and combustion to sludge treatment system;* ***(d)*** *Introduction of biogas recovery and combustion to an existing anaerobic wastewater treatment system such as anaerobic reactor, lagoon, septic tank or an on site industrial plant;* ***(e)*** *Introduction of anaerobic wastewater treatment with biogas recovery and*	In the absence of the project activity the wastewater would have been treated in open anaerobic lagoons (all with depth greater than 2 meters) under anaerobic condition without biogas recovery. Please refer to section B.4 for further details. The project activity involves the installation of a UASB (Up flow Anaerobic Sludge Blanket) system to treat high COD concentration of wastewater generated and to capture biogas. Therefore, the project activity involves the introduction of a sequential stage of wastewater treatment with biogas recovery and combustion without sludge treatment, to an anaerobic wastewater treatment system without biogas recovery and hence satisfies the applicability criterion (f).

	Applicability Criteria	Project eligibility
	combustion, with or without anaerobic sludge treatment, to an untreated wastewater stream; ***(f) Introduction of a sequential stage of wastewater treatment with biogas recovery and combustion, with or without sludge treatment, to an anaerobic wastewater treatment system without biogas recovery (e.g. introduction of treatment in an anaerobic reactor with biogas recovery as a sequential treatment step for the wastewater that is presently being treated in an anaerobic lagoon without methane recovery).***	
2	*In cases where baseline system is anaerobic lagoon the methodology is applicable if:* (a) *The lagoons are ponds with a depth greater than two meters, without aeration. The value for depth is obtained from engineering design documents, or through direct measurement, or by dividing the surface area by the total volume. If the lagoon filling level varies seasonally, the average of the highest and lowest levels may be taken;* (b) *Ambient temperature above 15°C, at least during part of the year, on a monthly average basis;* (c) *The minimum interval between two consecutive sludge removal events shall be 30 days.*	In the baseline scenario, the wastewater would have been treated in open anaerobic lagoons. - The depth of the lagoons is greater than two meters and do not have any aeration[8]. - On monthly average basis the ambient temperature[9] in Nakornratsima is above 15°C. - No sludge has been removed from the baseline anaerobic lagoons till date[10] and if any sludge would have been removed, the minimum interval between two consecutive removals would have been definitely greater than 30 days. As mentioned above, the project activity satisfies the conditions for the anaerobic lagoons for the baseline system.
3	*The recovered biogas from the above measures may also be utilised for the following applications instead of combustion/flaring:* (a) ***Thermal or electrical energy generation directly; or*** (b) *Thermal or electrical energy generation after bottling of upgraded biogas; or* (c) *Thermal or electrical energy generation after*	The project activity satisfies the condition (a) The recovered biogas from the project activity will be utilized for thermal and electrical energy generation. The thermal energy will be generated using biogas in the thermal oil boiler and electrical energy will be generated in gas engines. The thermal energy will be utilized in the

[8] The design document for open anaerobic lagoon system is available

[9] The average ambient temperature of Province by the Energy Policy and Planning Office, Ministry of Energy. Available from: http://www.e-report.energy.go.th/weather.html

[10] The starch factory has been operating since November 2009. Until now, no sludge has been removed, as there has been no need to do so.

Applicability Criteria		Project eligibility
	upgrading and distribution: (i) *Upgrading and injection of biogas into a natural gas distribution grid with no significant transmission constraints; or* (ii) *Upgrading and transportation of biogas via a dedicated piped network to a group of end users; or* (iii) *Upgrading and transportation of biogas (e.g. by trucks) to distribution points fir end users* (d) *Hydrogen production.* (e) *Use as fuel in transportation application after upgrading*	starch drying process in the starch factory and electricity will be exported to the grid.
4	*If the recovered biogas is used for project activities covered under paragraph 3 (a), that component of the project activity can use a corresponding category under type I.*	The recovered biogas will be used as per the paragraph 3(a) above. The methodologies AMS.I.C and AMS.I.D will be used for the thermal and electrical components respectively.
5	*For project activities covered under paragraph 3(b), if bottles with upgraded biogas are sold outside the project boundary, the end-use of the biogas shall be ensured via a contract between the bottles biogas vendor and the end-user. No emission reductions may be claimed from the displacement of fuels from the end use of bottled biogas un such situations. If however the end use of the bottled biogas is included by the displacement of fossil fuel can be claimed under the corresponding Type I methodology, e.g. AMS I-C "Thermal energy production with or without electricity".*	This is not applicable since the captured biogas will be used on-site for energy generation purposes or flaring.
6	*For project activities covered under paragraph 3 (c) (i), emission reduction from the displacement of the use of natural gas are eligible under this methodology, provided the geographical extent of the natural gas distribution grid is within the host country boundaries.*	This is not applicable since the captured biogas will be used on-site for energy generation purposes or flaring.
7	*For the project activities covered under paragraph 3 (c) (ii), emission reductions for the displacement of the use of fuels can be claimed following the provision in the corresponding Type I methodology, e.g. AMS I.C*	This is not applicable since the captured biogas will be used on-site for energy generation purposes or flaring.
8	*In particular, for the case of 3 (b) and (c) (iii), the physical leakage during storage and transportation of upgraded biogas, as well as the emissions from fossil fuel consumed by vehicles for transporting biogas shall be considered. Relevant procedures in*	This is not applicable since the captured biogas will be used on-site for energy generation purposes or flaring.

Applicability Criteria		Project eligibility
	paragraph 11 of Annex 1 of AMS-III.H "Methane recovery in wastewater treatment" shall be followed in this regard.	
9	*For project activities covered under paragraph 3 (b) and (c), this methodology is applicable if the upgraded methane content of the biogas is in accordance with relevant national regulations (where these exist) or, in the absence of national regulations, a minimum of 96% (by volume).*	This is not applicable since the captured biogas will be used on-site for energy generation purposes or flaring.
10	*If the recovered biogas is utilized for the production of hydrogen (project activities covered under paragraph 3 (d)), that component of the project activity shall use the corresponding methodology AMS-III.O "Hydrogen production using methane extracted from biogas".*	This is not applicable since the captured biogas will be used on-site for energy generation purposes or flaring.
11	*If the recovered biogas is used for project activities covered under paragraph 3 (e), that component of the project activity shall use corresponding methodology AMS-III.AQ Introduction of Bio-CNG in road transportation.*	This is not applicable since the captured biogas will be used on-site for energy generation purposes or flaring.
12	*New facilities (Greenfield projects) and project activities involving a change if equipment resulting in a capacity addition of the wastewater or sludge treatment system compared to the designed capacity of the baseline treatment system are only eligible toapply this methodology if they comply with the relevant requirements in the General guidelines to SSC CDM methodologies. In addition the requirements for demonstrating the remaining lifetime of the equipment replaced, as described in the general guidelines shall be followed.*	The starch factory itself was constructed and started operation in parallel to the development of the project activity. The project is therefore considered a Greenfield project. It complies with the "General guidelines to SSC CDM methodologies" as described in further detail in section B.4.
13	*The location of the wastewater treatment plant shall be uniquely defined as well as the source of generating the wastewater and described in the PDD.*	The location of the project activity and the source of wastewater are clearly identified in section A.4.1.4.
14	*Measures are limited to those that result in aggregate emission reductions of* ***less than or equal to 60 kt CO_2*** *equivalent annually from all type III components of the project activity.*	The annual emission reductions from all *type III* component of the project activity is calculated at 45,744 tCO_2e which is below the limit of 60kt CO_2.

Table 3: Applicability of AMS I.C.

Applicability Criteria		Project eligibility
1	*This methodology comprises renewable energy technologies that supply users with thermal energy that displaces fossil fuel use. These units include technologies such as solar thermal water heaters*	The project activity will capture biogas (a renewable fuel) from the project's wastewater treatment system and utilize a part of it for thermal energy generation to

Applicability Criteria		Project eligibility
	and dryers, solar cookers, energy derived from renewable biomass and other technologies that provide thermal energy that displaces fossil fuel.	substitute fossil fuel in the drying process of the starch factory. Therefore, the project activity meets this applicability criterion.
2	*Biomass-based cogeneration systems are included in this category. For the purpose of this methodology "cogeneration" shall mean the simultaneous generation of thermal energy and electrical energy in one process. Project activities that produce heat and power in separate processes (for example, heat from a boiler and electricity from a biogas engine) do not fit under the definition of cogeneration project.*	This is not applicable to the project activity. The project is not considered a cogeneration process since heat and power are produced in separate processes (heat from a boiler and electricity from biogas engines).
3	*Emission reduction from a biomass cogeneration system can accrue from one of the following activities:* *(a) Electricity supply to a grid* *(b) Electricity and/or thermal energy (steam or heat) production for on-site consumption or for consumption by other facilities;* *(c) Combination of (a) and (b)*	This is not applicable to the project activity. The project is not considered a cogeneration process since heat and power are produced in separate processes (heat from a boiler and electricity from biogas engines).
4	*The total installed/rated thermal energy generation capacity of the project equipment is equal to or less than 45 MW thermal.*	The thermal generation capacity of the thermal oil boiler is 4.651 MW_{th} which is less than 45 MW_{th} as per applicability criteria.
5	*For co-fired systems, the total installed thermal energy generation capacity of the project equipment, when using both fossil and renewable fuel shall not exceed 45 MW thermal.*	The thermal oil boiler is a duel fuel boiler capable of firing bunker oil and biogas. The total installed thermal energy generation capacity is 4.651 MW_{th} which is less than 45MW_{th}.
6	*The following capacity limits apply for biomass cogeneration units:* *(a) If the project activity includes emission reductions from both the thermal and electrical energy components, the total installed energy generation capacity (thermal and electrical) of the project equipment shall not exceed 45 MW thermal. For the purpose of calculating this capacity limit the conversion factor of 1:3 shall be used for converting electrical energy to thermal energy (i.e. for renewable energy project activities, the maximal limit of 15 MW (e) is equivalent to 45 MW thermal output of the equipment or the plant);* *(b) If the emission reduction of the cogeneration project activity are solely on account of thermal energy production (i.e. no emission reduction accrue from*	This is not applicable to the project activity. The project is not considered a cogeneration process since heat and power are produced in separate processes (heat from a boiler and electricity from biogas engines).

Applicability Criteria		Project eligibility
	electricity component), the total installed thermal energy production capacity of the project equipment of the cogeneration unit shall not exceed 45 MW thermal; *(c) If the emission reductions of the cogeneration project activity are solely on account of electrical energy production (i.e. no emission reductions accrue from thermal energy component), the total installed energy generation capacity of the project equipment of the cogeneration unit shall not exceed 15 MW*	
7	*The capacity limits specified in the above paragraphs apply to both new facilities and retrofit projects. In the case of project activities that involve the addition of renewable energy units at an existing renewable energy facility, the total capacity of the units added by the project should comply with capacity limits in paragraphs 4 to 6, and should be physically distinct from the existing units.*	The project activity is a new facility and does not represent a retrofit or capacity expansion project. The project activity is within the capacity limits of 45 MW_{th}.
8	*Project activities that seek to retrofit or modify an existing facility for renewable energy generation are included in this category.*	The project activity does not involve any retrofit or modification of an existing renewable energy facility; thus this criterion is not relevant.
9	*New Facilities (Greenfield projects) and project activities involving capacity additions compared to the baseline scenario are only eligible if they comply with the related and relevant requirements in the "General Guidelines to SSC CDM methodologies".*	The project activity utilizes a part of biogas in the thermal oil boiler in the starch factory for supplying heat to the starch drying process. The starch factory itself was constructed and started operation in parallel to the implementation of the project activity, hence the usage of biogas in the boiler is considered in the context of a Greenfield project. The same is demonstrated in section B.4 based on the General Guidelines to SSC CDM methodologies.
10	*If solid biomass fuel (e.g. briquette) is used, it shall be demonstrated that it has been produced using solely renewable biomass and all project or leakage emissions associated with its production shall be taken into account in the emissions reduction calculation.*	This is not applicable to the project activity since there is no use of solid biomass fuel in the project.
11	*Where the project participant is not the producer of the processed solid biomass fuel, the project participant and the producer are bound by a contract that shall enable the project participant to*	This is not applicable to the project activity since there is no use of solid biomass fuel in the project.

Applicability Criteria		Project eligibility
	monitor the source of the renewable biomass to account for any emissions associated with solid biomass fuel production. Such a contract shall also ensure that there is no double-counting of emission reductions.	
12	*If electricity and/or steam/heat produced by the project activity is delivered to a third party i.e. another facility or facilities within the project boundary, a contract between the supplier and consumer(s) of the energy will have to be entered into that ensures there is no double-counting of emission reductions.*	The project activity doesn't deliver electricity or heat to a third party within the project boundary. Both the starch factory and the biogas plant belong to the same shareholders; hence the starch factory cannot be considered a third party.
13	*If the project activity recovers and utilizes biogas for power/heat production and applies this methodology on a stand alone basis i.e. without using a Type III component of a SSC methodology, any incremental emissions occurring due to the implementation of the project activity (e.g. physical leakage of the anaerobic digester, emissions due to inefficiency of the flaring), shall be taken into account either as project or leakage emissions.*	The project activity also involves a Type III component of a SSC methodology, as the introduction of a wastewater treatment with biogas recovery of the project activity is applicable under the methodology AMS III.H.
14	*Charcoal based biomass energy generation project activities are eligible to apply the methodology only if the charcoal is produced from renewable biomass sources provided:* *(a) Charcoal is produced in kilns equipped with methane recovery and destruction facility; or* *(b) If charcoal is produced in kilns not equipped with a methane recovery and destruction facility, methane emission from the production of charcoal shall be considered. These emissions shall be calculated as per the procedures defined in the approved methodology AMS III.K. Alternatively, conservative emission factor values from peer reviews literature or from a registered CDM project activity can be used, provided that it can be demonstrated that the parameters from these are comparable e.g. source of biomass, characteristics of biomass such as moisture, carbon content, type of kiln, operating conditions such as ambient temperature.*	This is no applicable to the project activity since there is no use of charcoal in the project activity.

Table 4: Applicability of AMS I.D.

	Applicability Criteria	Project eligibility
1	*This methodology comprises renewable energy generation units, such as photovoltaic, hydro, tidal/wave, wind, geothermal and renewable biomass:* *(a) Supplying electricity to a national or a regional grid; or* *(b) Supplying electricity to an identified consumer facility via national/regional grid through a contractual arrangement such as wheeling.*	The project activity will use a part of the biogas (a renewable fuel), which is captured from the methane avoidance component of the project activity to generate electricity in gas engines. The electricity generated will be exported to the national grid. Therefore, the project activity satisfies the applicability condition (a).
2	*Illustration of respective situations under which each of the methodology (i.e. AMS-I.D, AMS-I.F and AMS-I.A) applies is included in Table 2*	The project activity will use a part of biogas (a renewable fuel) to generate electricity in the gas engine and the electricity generated will be exported to the national grid. Therefore, the project activity satisfies the applicability of AMS-I.D included in Table 2.
3	*This methodology is applicable to project activities that: (a) Install a new power plant at a site where there was no renewable energy power plant operating prior to the implementation of the project activity (Greenfield plant); (b) Involve a capacity addition; (c) Involve a retrofit of (an) existing plant(s); or (d) involve a replacement of (an) existing plant(s).*	The project activity will install a power plant at a site where there was no renewable energy power plant operating prior to the implementation of the project. Therefore, the project activity satisfies the applicability condition (a).
4	*Hydro power plants with reservoirs that satisfy at least one of the following conditions are eligible to apply this methodology:* *- The project activity is implemented in a n existing reservoir with no change in the volume of reservoir;* *- The project activity is implemented in an existing reservoir, where the volume of reservoir is increased and the power density of the project activity, as per definitions given in the Project Emission section, is greater than 4 W/m2* *- The project activity results in new reservoirs and the power density of the power plant, as per definitions given in the Project Emission section, is greater than 4 W/m2*	Not applicable since the project is not a hydro power plant.
5	*If the new unit has both renewable and non-renewable components (e.g., a wind/diesel unit), the eligibility limit of 15 MW for a small-scale CDM project activity applies only to the renewable component. If the new unit co-fires fossil fuel, the capacity of the entire unit shall not exceed the limit of 15 MW.*	The project activity is based on the installation of gas engines, which operate on biogas only. Therefore, the project has only a renewable electricity generation component with a total generation capacity of 3.120 MW_{el} (2 x 1.560 MW), which is below the threshold of 15MW.
6	*Combined heat and power (co-generation) systems*	The project activity is not considered a co-

Applicability Criteria		Project eligibility
	are not eligible under this category.	generation system since electricity and thermal energy are produced in two separate and totally independent systems.
7	*In the case of project activities that involve the addition of renewable energy generation units at an existing renewable power generation facility, the added capacity of the units added by the project should be lower than 15 MW and should be physically distinct from the existing units.*	The project activity does not involve addition of renewable energy generation at an existing renewable power generation facility. The project activity implements a new gas engine at a location where there was no power generation.
8	*In the case of retrofit or replacement, to qualify as a small-scale project, the total output of the retrofitted or replacement unit shall not exceed the limit of 15 MW.*	The project activity does not represent a retrofit or replacement project.

B.3. Description of the project boundary:

As per the AMS III.H, AMS I.C and AMS I.D., the Project boundary shall respectively include the following:

Project boundary for *AMS III.H* is given as per the paragraph 15 of the methodology:

"The project boundary is the physical, geographical site where the wastewater and sludge treatment takes place in baseline and project situation. It covers all facilities affected by the project activity including sites where the processing, transportation and application or disposal of waste products as well as biogas takes place."

According to a part of paragraph 16 of the methodology:

"Implementation of the project activity at a wastewater and/or sludge treatment system will affect certain sections of the treatment systems while others may remain unaffected."

The wastewater treatment system that would have been affected will be the open anaerobic lagoon system. The wastewater from the starch factory would not be fed directly in the open anaerobic lagoons. The wastewater will be first treated in the biogas reactor before being fed to the open lagoons. The COD levels entering the open lagoons in the project activity will be much lower than those in the baseline scenario. The resulting methane emissions will be considered under the project emissions. Furthermore, the electricity consumption in the baseline and project wastewater treatment system will also be affected. These emission sources are also dealt separately in the baseline and project emission calculations. In the project activity, the pre-treatment process unit, the biogas system and the subsequent open lagoon system (post treatment) including the utilization or recycling of effluent are all within the project boundary. With regards to sludge generation, it is not expected that the project will produce significant amounts but the sludge production, usage and/or final disposal will be monitored during the crediting period. The sludge management is included within the boundary. Further considerations with regards to the project boundary definition and its impact on GHG reductions calculations are justified and further elaborated in Section B 6.3.

Project boundary for *AMS I. C* as per paragraph 15 of the methodology is given as:

"The spatial extent of the project boundary encompasses:

(a) All plants generating power and/or heat located at the project site, whether fired with biomass, fossil fuels or a combination of both;
(b) All power plants connected physically to the electricity system (grid) that the project plant is connected to;
(c) Industrial, commercial or residential facility, or facilities, consuming energy generated by the system and the processes or equipment affected by the project activity;
(d) The processing plant of biomass residues, for project activities using solid biomass fuel (e.g. briquette), unless all associated emissions are accounted for as leakage emissions;
(e) The transportation itineraries, if the biomass is transported over distances greater than 200 kilometres, unless all associated emissions are accounted for as leakage emissions;
(f) The site of the anaerobic digester in the case of project activity that recovers and utilizes biogas for power/heat production and applies this methodology on a stand alone basis i.e. without using a Type III component of a SSC methodology."

With the above reference of AMS I.C, the boundary of this project is limited to the dual-fuel fired boiler installed at the starch factory where the heat is produced for starch drying.

Project boundary for *AMS I.D* as per paragraph 9 in the methodology is given as:

"The spatial extent of the project boundary includes the project power plant and all power plants connected physically to the electricity system that the CDM project power plant is connected to."

Table 5: The GHG gases considered in the analysis

	Source	**Gas**		**Justification / Explanation**
Baseline	Wastewater treatment processes	CH_4	Included	Major source of emissions in the baseline from open lagoons (decay of organic matter under anaerobic conditions).
		N_2O	Excluded	Excluded for simplification. This is conservative.
		CO_2	Excluded	Excluded for simplification. This is conservative.
	Electricity consumption Electricity generation	CO_2	Excluded (AMS.III.H) Included (AMS.I.D)	AMS.III.H component: Baseline emissions from electricity consumption for the baseline wastewater treatment system are excluded as this will be a very small quantity. Further, it is conservative to not include the baseline emissions from this source. AMS.I.D component: The project activity involves the installation of a new grid-connected renewable power unit, whereas the baseline scenario is the electricity delivered to the grid that, in the absence of the project, would have been generated by the operation of grid-connected power plants and by the addition of new generation sources.
		CH_4	Excluded	Excluded for simplification. This is

	Source	Gas		Justification / Explanation
				conservative.
		N_2O	Excluded	Excluded for simplification. This is conservative.
	Thermal energy generation	CO_2	Included	The thermal energy will be generated by biogas under the project activity displacing fossil fuels, which would have been used in the baseline scenario.
		CH_4	Excluded	Excluded for simplification. This is conservative.
		N_2O	Excluded	Excluded for simplification. This is conservative.
Project activity	Wastewater treatment processes	CH_4	Included	The treatment of wastewater under the project activity may cause following methane project emissions: (i) Methane emissions from secondary treatment (open lagoons) (ii) Physical leakage of methane from the digester system (iii) Methane emissions from flaring
		CO_2	Excluded	Excluded for simplification. This is conservative.
		N_2O	Excluded	Excluded for simplification. This is conservative.
	On-site electricity use	CO_2	Included	If the biogas reactor uses electricity generated from the biogas fired gas engine, this will be excluded. However, if the electricity is sourced from the grid, this will be included.
		CH_4	Excluded	Excluded for simplification.
		N_2O	Excluded	Excluded for simplification
	On-site fossil fuel consumption	CO_2	Included	Fossil fuel used in the dual-fuel fired boiler for thermal energy generation shall be monitored and considered in emission reduction calculations.
		CH_4	Excluded	Excluded for simplification.
		N_2O	Excluded	Excluded for simplification.

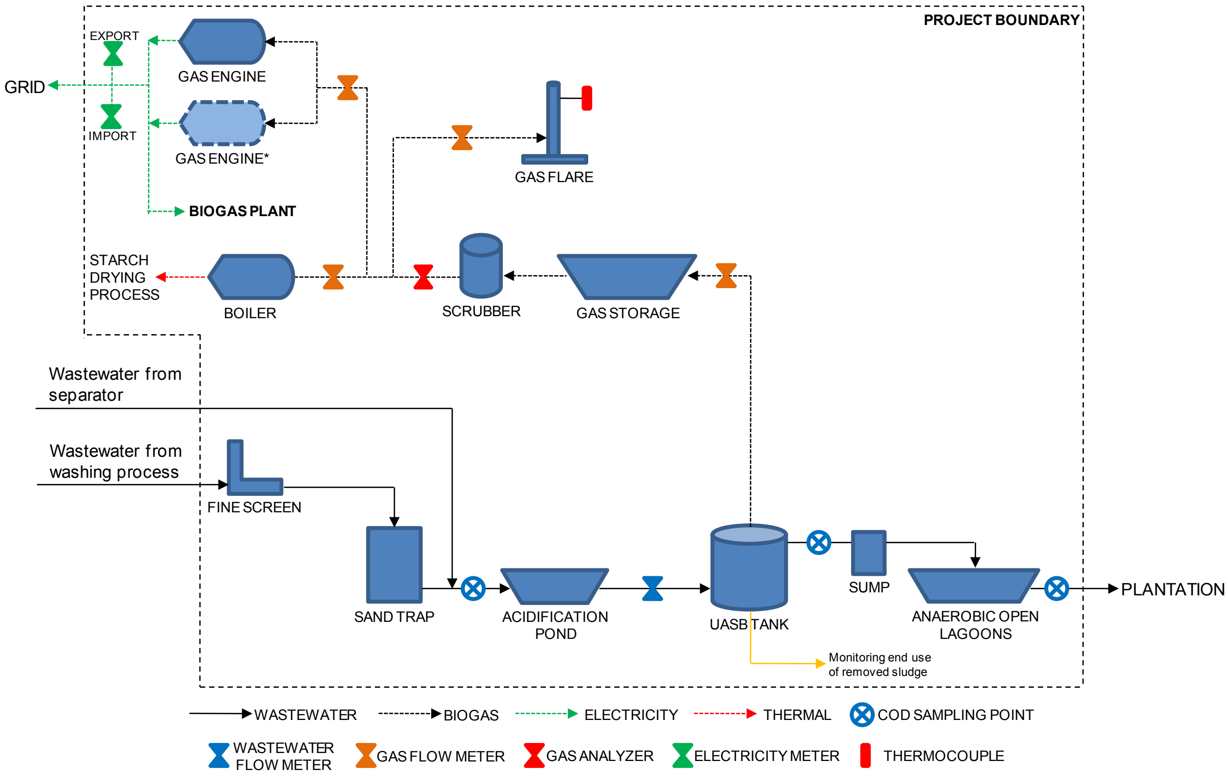

Figure 3: Project boundary

B.4. Description of baseline and its development:

Methane avoidance component:
As per paragraph 12 of the methodology AMS-III.H, Greenfield project activities shall comply with the relevant requirements in the "General guidelines to SSC CDM methodologies" version 17[11]. Since, the project activity is implemented in a Greenfield location; the project activity should follow guidance given in the paragraph 19. The demonstration should include the assessment of the alternatives of the project activity using the following steps:

Step 1: *Identify the various alternatives available to the project proponent that deliver comparable level of service including the proposed project activity undertaken without being registered as a CDM project activity.*

The main output or service of this component of the project activity is the treatment of effluent waste water, which in turns leads to generation and capture of biogas. The by-products of the project activity arising from the utilisation of biogas captured are the production of heat and electricity.

[11] EB61, Annex 21.

Therefore, the alternative scenarios that are available to the project participant and that provide outputs or services with comparable quality, properties and application as the proposed small-scale CDM project activity are:

Alternative 1: Methane recovery using anaerobic digester and utilisation for energy generation (proposed project without CDM revenues)
Alternative 2: Open anaerobic lagoon based wastewater treatment system (business as usual scenario)
Alternative 3: Aerobic wastewater treatment system
Alternative 4: Direct discharge to water bodies
Alternative 5: Methane recovery using anaerobic digester and flaring

Step 2: *List the alternatives identified per Step 1 in compliance with the local regulations (if any of the identified baseline is not in compliance with the local regulations, then exclude the same from further consideration).*

Alternatives 1, 2, 3 and 5 are in compliance with current laws and regulations in Thailand, which allow the use of open lagoon systems and other wastewater treatment technologies for wastewater treatment. The effluent standard in Thailand is regulated by the "Notification of the Ministry of Science, Technology and Environment, No. 3, B.E.2539 (1996)"[12] published in the Royal Government Gazette, Vol. 113 Part 13 D, dated February 13, B.E.2539 (1996). According to this regulation the COD of released wastewater is not allowed to exceed 120 mg/litre and the 5-day BOD (BOD_5) shall not exceed 20 mg/litre. However there is an exception for starch plants, which stipulates that BOD_5 should not exceed 60 mg/litre[13]. These regulations only apply if the starch factory releases wastewater outside its premises, which is not the case in the project activity.

There is no other regulatory requirement for the implementation of a specific wastewater treatment technology, such as an anaerobic digester or aerobic treatment system, at tapioca starch processing plants.

Alternative 4 is not in compliance with the effluent discharge standards set by the laws and regulations of Thailand. Therefore, alternative 4 cannot be considered as the baseline and is excluded from further assessment.

Step 3: *Eliminate and rank the alternatives identified in Step 2 taking into account barrier tests specified in attachment A to Appendix B of the simplified modalities and procedures of SSC CDM.*

The additionality of the project activity has been demonstrated using only the "access to finance" barrier. For the baseline determination, we feel it's appropriate to also discuss "technical barrier". However, the main focus is on "access to finance" barrier. Further details can be found in section B.5.

Technical barrier

Alternative 1 is seen as a high-risk alternative with limited performance guarantee on biogas generation and quality. The performance of this alternative depends on the quantity and quality of biogas generated, starting up and maintaining the anaerobic digester at optimal conditions. Anaerobic digestion systems are

---

[12] Ministry of Science, Technology and Environment. Thailand (1996). Notification the Ministry of Science, Technology and Environment, No. 3, B.E.2539 (1996). Cited at: http://infofile.pcd.go.th/law/3_4_water.pdf (Document in Thai)

[13] Pollution Control Department. Thailand (2004). Industrial effluents standards. Cited at http://www.pcd.go.th/info_serv/en_reg_std_water04.html (Document in English)

unstable systems and require several control loops to keep the digester parameters within appropriate levels. There are different parameters, such as the COD load of the wastewater, the pH-value, TSS (total suspended solids) and the temperature, which have an impact on the performance of the digester[14]. An anaerobic digestion system is a biological system, which has to be balanced constantly to provide best conditions for the anaerobic bacteria. Therefore the proper operation of the control system is essential for the output of biogas.

Improper operation of the digester or the wrong use of chemical substances harm the bacteria and lead very often to the collapse of the reactor system[15]. Poor performance of the digester affects adversely the quantity and the methane content of the biogas. However, for electricity generation the methane content of the biogas is crucial. In Thailand, there are limited technical capabilities for operation of such anaerobic reactor technology in the starch sector. The lack of technical knowledge is often related to the fact that technologies have been developed abroad without proper technology or know-how transfer. There is also a lack of skilled and trained operators for biogas plants in Thailand, which is often related to the remote location of biogas plants and the lack of qualified professionals in rural areas. This is another reason why operators of starch factories hesitate to use this technology. Staff has to be trained to ensure an uninterrupted handling of the wastewater treatment system and continuous generation of biogas for heat and electricity generation[16].

The project proponent has no prior experience in operating and maintaining an anaerobic digestion process with a methane recovery system. As discussed above the biogas plants require sophisticated operation procedures to manage the complicated biological, gaseous and electrical components of the project, specific and detailed training of employees is required, which is a significant challenge for the project proponent. It is clear that this alternative faces many technical barriers. In addition to potential technical barriers, the project activity faces other barriers, which are discussed in more detail in Section B.5. Therefore, Alternative 1 is not excluded at this stage.

Alternative 2 has been a common practice of handling wastewater from tapioca starch production in Thailand for the last thirty years[17]. The related requirements in terms of technology, skills and labor required for such lagoon systems are far below the requirements of anaerobic reactor systems and are readily available in Thailand. The risk level associated with such lagoon systems are considered as very low because of their extremely simple and robust operation principles, as well as their history and the expertise available in the agricultural sector in Thailand. For the implementation of a lagoon system large areas of land are necessary on which several ponds are dredged. Through gravity, the effluent flows directly from one lagoon to the next. Due to a long residence time of wastewater in the lagoons, the biological process is less efficient but more robust, delivering ultimately the required effluent quality

[14] Effect of temperature on the anaerobic digestion of palm oil mill effluent, Electronic Journal of Biotechnology. - http://www.ejbiotechnology.info/index.php/ejbiotechnology/article/view/v10n3-7/124

[15] The microbiology of anaerobic digester (2003). M. H. Gerardi. Wastewater microbiology series. – Page 102 - http://uctm-biotechnology.org/The_Microbiology_of_Anaerobic_Digesters.pdf

[16] IP-Institut für Projektplanung GmbH on behalf of GTZ (1997). Environmental Management Guideline for the Palm Oil Industry, Thailand. – Chapter 6 review of suitable wastewater treatment technologies. Cited at: http://galeon.com/densidadaceite/guiapalma.pdf

[17] Rajbhandari, B.K., Annachhatre, A.P. 2004, Anaerobic ponds treatment of starch wastewater: case study in Thailand. Bioresource Technology 95 (2004) 135–143. - http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6V24-4BX7B3M-3&_user=10&_coverDate=11%2F30%2F2004&_rdoc=1&_fmt=high&_orig=gateway&_origin=gateway&_sort=d&_docanchor=&view=c&_searchStrId=1670841409&_rerunOrigin=google&_acct=C000050221&_version=1&_urlVersion=0&_userid=10&md5=71d828bbd614951f13b186fab9fa8aeb&searchtype=a

levels as per Thai environmental regulations. Open anaerobic lagoons require extremely limited operation and maintenance due to the self-regulatory nature of the systems. Hence, lagoons are a very cost-effective solution, do not require advanced technology and are easy to operate and maintain[18]. Therefore, almost all starch plants in Thailand use or have used (prior to implementation of biogas reactors as CDM projects) open lagoon systems for the treatment of wastewater. This scenario is therefore in line with the business as usual scenario, which is further elaborated under Step 4 below. It can be concluded that Alternative 2 does not face technical barriers.

Alternative 3 is well established and commonly used for both domestic and industrial wastewater treatment in many parts of the world. However, aerobic treatment is commonly used for wastewater with low COD content. There is no reference to or experience with this type of technology in the tapioca starch industry in Thailand and no starch factory operator is considering the use of this technology at this point in time. Furthermore aerobic treatment requires also skilled operators and sophisticated systems for control and is considered costly due to the high energy demand and the large volume of sludge that will be produced. Oxygen is supplied to the system through air compression which consumes a lot of electricity, The necessary requirements, both in terms costs and skills to operate and maintain such systems is much higher than the use of an anaerobic lagoon. Furthermore, a significant amount of sludge generated by aerobic systems must be disposed of, which adds to operational complexity and costs.
Considering lack of interest in this technology, technical barriers are deemed less important than access-to-finance barriers, which are discussed in more detail below.

Alternative 4 is already excluded.

Alternative 5 is not considered by project operators due to commercial reasons as it creates no benefits in form of biogas utilization and is not required by law. Technical reasons are deemed irrelevant.

Access-to-finance barriers

Alternative 1 entails high investment and O&M costs and uncertain commercial returns (from the production and use of biogas).

According to the *Energy Conservation and Renewable Energy Division* and *Energy Policy and Planning Division* of the Ministry of Environment, Government of Thailand *“Most of the tapioca starch plants choose to retain wastewater in their open lagoons because of insufficient knowledge /confidence in the technology, high investment cost compared to cheap land price, the resulting operating cost throughout the treatment life*”[19]. Therefore penetration of other advanced wastewater treatment technologies is very low in Thailand and biogas projects are considered highly risky by the financiers. Hence, financing of biogas project in starch industry is regarded as a constraint[20]. Due to high risks associated with such kind

---

[18] Cinara, 2004 “Waste stabilization ponds for wastewater treatment, International Water and Sanitation Centre” http://www.irc.nl/page/8237

[19] The Promotion of Biogas from Wastewater as An Alternative Energy and for Environmental Improvement, published by the Energy Conservation and Renewable Energy Division and Energy Policy and Planning Office (EPPO), 2007 Page no. 47. - http://www.eppo.go.th/encon/report/BioGasMartBook/index.html

[20] Renewable Energy in Asia: The Thailand Report. An overview of the energy systems, renewable energy options, initiatives, actors and opportunities in Thailand, 2005. Australian Business Council for Sustainable Energy, Page No. 5. - http://www.lowcarbonoptions.net/resources/Policy-&-Measures/Policies-and-Measures--Thailand/Renewable_energy_Thailand.pdf

of projects even, with subsidies, it is very difficult to obtain a loan approval[21]. This was also evident from the difficulties faced by the project proponent in securing loan for the project activity (see Section B.5 for more details).

In recent years (2003- 2005), Ministry of Environment started a pilot demonstration of biogas system in starch industry in four different wastewater treatment technologies. Nine factories were selected and received financial support from the Energy Conservation Promotion Fund (ENCON)[22]. Furthermore, it has been demonstrated that access to finance is the main barrier which makes the projects unviable. As analyzed in detail in Section B.5, the project activity faces prohibitive access-to-finance barriers and could not have been implemented without CDM. Given the outcome of Section B.5, Alternative 1 (the project activity without CDM) can be excluded.

Alternative 2 creates acceptable operational costs to achieve compliance with domestic effluent regulation. The anaerobic open lagoon technology is a well-established technology. Open anaerobic lagoons require very low investment and have lower operation and maintenance costs[23], as compared to alternative systems such as anaerobic reactors and aerobic systems. Given the significantly lower investment cost, it is clear that Alternative 2 does not face significant financial barriers and represents a plausible baseline scenario.

Alternative 3 entails high investment and very high O&M costs[24] in comparison to alternatives 1 and 2. The major reason for high O&M costs for treating wastewater with high organic content in aerobic systems is the very high electricity demand for forced aeration and high costs associated to sludge disposal as compared to anaerobic treatment systems. Due to high investment and O&M costs and the lack of commercial returns from energy production, it is clear that Alternative 3 would face similar or even stronger access-to-finance barriers as the project activity (see Section B.5 for more details). Therefore, the alternative can be excluded from further analysis.

Alternative 4 is already excluded.

Alternative 5, anaerobic digester with methane recovery and flaring, also entails high investment and O&M costs and no returns as the produced biogas is destroyed without use. There will be no expected revenue generation from the project activity and therefore, this alternative is not considered a practical option because it would face even greater access-to-finance barriers as the project activity. Therefore, the alternative is excluded from further analysis.

Alternatives scenarios 3 and 5 are prevented by at least one barrier as shown above. Therefore, these scenarios are eliminated from further consideration. No barriers have been identified for Alternative 2

---

[21] Prasertsan, S. B. Sajjakulnukit (2006). Biomass and biogas energy in Thailand: Potential, opportunity and barriers. Renewable Energy 31:599–610 - http://www.thaiscience.info/Article%20for%20ThaiScience/Article/3/Ts-3%20biomass%20and%20biogas%20energy%20in%20thailand%20potential,%20opportunity%20and%20barriers.pdf.

[22] Energy Policy and Planning Office, Ministry of Energy, Seminar on the Promotion of Production of Biogas from Wastewater as an Alternative Energy and for Environmental Improvement, At Ballroom, Sirikit Convention Centre 29 August 2007, pp.46-47 - http://www.eppo.go.th/encon/report/BioGasMartBook/index.html (Document with translation of relevant part is available)

[23] Cinara, 2004 "Waste stabilization ponds for wastewater treatment, International Water and Sanitation Centre" - http://www.irc.nl/page/8237

[24] http://cdn.intechweb.org/pdfs/14547.pdf

(Open anaerobic lagoon based wastewater treatment system). Alternative 1 (proposed project without CDM assistance) is discussed in detail in Section B.5., where it is concluded that the project activity would not be implemented without support from CDM. Therefore, Alternative 1 is ruled out as potential baseline scenario.

Step 4:

Only one alternative remains (Alternative 2), which is not the proposed project activity undertaken without being registered as a CDM project activity and is considered as the most plausible baseline scenario. The Alternative 2 - open anaerobic lagoon based wastewater treatment system also corresponds to the baseline scenario (f) of AMS.III.H; the project activity is eligible under the methodology.

Conclusion:
In the assessment above, it has been demonstrated that the wastewater would have been treated in open anaerobic lagoons in the absence of the project activity. The starch factory was already using open anaerobic lagoons before the implementation of the project activity. This further strengthens the fact that open anaerobic lagoons would have been the chosen option in the baseline. The project activity therefore fulfills the applicability condition of the applicable methodology AMS.III.H.

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

Explanation and justification of key assumptions for baseline scenario:

As per paragraph 28 of the methodology AMS III.H, '*In the case of Greenfield projects, one of the following procedures shall be used to determine the baseline emissions:*

Paragraph 2– For Greenfield and capacity expansion projects, one of the following procedures shall be used:

a) Values obtained from a measurement campaign in a comparable existing wastewater treatment plant i.e. having similar environmental and technological circumstances for e.g. treating similar type of wastewater. Average values from the measurement campaign shall be used and the result shall be multiplied by 0.89 to account for the uncertainty range (30% to 50%) associated with this approach.

b) Value provided by the manufacturer/designer of a Greenfield wastewater treatment plant using the same technology, demonstrated to be conservative, e.g. average values from the top 20 percent plants with lowest emission rate per ton COD removed among the plants installed in the last five years designed for the same country/region to treat the same type of wastewaters as the project activity.

Option (a) has been selected and data based on a 10-day campaign has been used from the starch factory itself. During the delay of construction of the wastewater treatment system for the project activity, the wastewater was treated in the open anaerobic lagoon system without methane recovery for 10 months approximately. These open lagoons represent typical lagoons, which would have been used by any new

starch plant. Therefor, it was possible to conduct a 10-day campaign to determine the efficiency of the baseline open anaerobic lagoons in the same starch factory. The campaign data is provided in PDD Annex-III.

Thermal displacement component:

The project activity generates biogas in the wastewater treatment system equipped with biogas recovery. A part of this biogas will be sent to the thermal oil boiler to generate heat for the starch drying process. In the absence of the project activity, the starch drying process would have obtained heat from the thermal oil boiler using heavy fuel oil in the absence of the project activity. The biogas generated in the project activity will displace heavy fuel oil used in the thermal oil boiler. However, the thermal oil boiler has a history of operation of less than one year; detailed records on fuel consumption and output are not available as per the requirements of the methodology. Furthermore, construction of the starch factory started in parallel to the implementation of the project activity; therefore, the most plausible energy supply source is established in accordance with the guidance on Greenfield projects in the general guidelines to SSC CDM methodologies[25].

As per paragraph 19 of the above mentioned guideline, the most plausible baseline scenario is established using the following steps:

Step 1: *Identify the various alternatives available to the project proponent that deliver comparable level of service including the proposed project activity undertaken without being registered as a CDM project activity.*

The alternatives available to the project proponent are:

Alternative 1: To utilise fuel oil to generate heat in the thermal oil boiler (prevailing practice in the industry)
Alternative 2: To use coal to generate heat in the thermal oil boiler
Alternative 3: To use biomass to generate heat in the thermal oil boiler
Alternative 4: To use biogas, the proposed project activity without being registered as a CDM project activity.

Step 2:
All the above-mentioned alternatives are in compliance with the local regulations.

Step 3:
The alternatives as identified in step 1 above are eliminated taking into account barrier test specified in attachment A to Appendix B of the simplified modalities and procedures of SSC CDM. As per the attachment A to Appendix B, the project proponent can eliminate alternatives by using any one of the following barriers:

a) Investment barrier
b) Technological barrier
c) Barrier due to prevailing practice
d) Other barriers

[25] EB61 Annex 21

Option (c) – Barrier due to prevailing practice has been selected to eliminate alternatives.

It is a prevailing practice in Thailand to use fuel oil almost exclusively for heat generation especially in the food industry, which includes tapioca starch industry as well. If we look at the share of energy consumption in Thailand as a whole, this was dominated by oil having a share of 42%, natural gas being 38% and coal at only 11% in 2007[26]. If we look at the share of coal consumption in the manufacturing sector, food-processing industry consumes less than 1%[27] of the total coal consumption in the manufacturing sector. Tapioca industry being part of the food-processing sector, consumes only a negligible amount of coal for its energy requirements. If we look at information from the Department of Alternative Energy Development and Efficiency (DEDE)[28], Ministry of Energy Thailand, majority of coal consumption is in the power sector (81%) and the rest is used by the industrial sector (19%) ranked by consumption as cement, paper, fibre, food, lime tobacco, metal, battery and others. It is clear that food sector (including tapioca starch production) consumes a negligible amount of coal to meet its energy requirements. The fact that fuel oil is almost exclusively used in the Tapioca industry is further highlighted by an assessment by Thai Tapioca Starch Association (TTSA)[29] which mentions that fuel oil is used to generate heat for the drying process in the starch manufacturing.

From the above discussion, the prevailing practice is to use fuel oil in starch industry. Options like coal (option 2) and biomass (option 3) are not a preferred option to generate heat in the starch manufacturing process in Thailand and are therefore excluded from further analysis. Alternative 4, which is about the use of biogas is already eliminated as per the discussion under the methane avoidance component in this section and in section B.5. The biogas will be available only if the wastewater treatment as per the project activity is implemented. In the absence of the project activity, there would not be any biogas available as a fuel option in the thermal boiler. Therefore, alternative 1 is the only alternative which is not prevented due to the prevailing practice barrier and therefore is not eliminated. This is also strengthened by the fact that the starch factory was already using fuel oil in the thermal boiler before the implementation of the project activity and generation of biogas.

Step 4:
Only one alternative is remaining after the Step 3, which is not the proposed project activity and it also corresponds to one of the baseline scenarios provided in the methodology.

Therefore, "Alternative 1 – To utilise fuel oil to generate heat in the thermal boiler" represents the baseline scenario for the project activity's heat component.

Electricity generation component:

In accordance to Paragraph 10 of the methodology AMS I.D. (Version 17):

> *"The baseline scenario is the electricity delivered to the grid by the project activity would have otherwise been generated by the operation of grid-connected power plants and by the addition of new generation sources into the grid."*

---

[26] Page 5- http://www.egcfe.ewg.apec.org/publications/proceedings/CFE/Xian_2007/1-3_Suksumek.pdf

[27] Page 7 - http://www.egcfe.ewg.apec.org/publications/proceedings/CFE/Xian_2007/1-3_Suksumek.pdf

[28] http://www3.dede.go.th/dede/index.php?id=701

[29] http://www.thaitapiocastarch.org/article01.asp

The project activity involves the installation of a new grid-connected renewable power plant and therefore, the baseline scenario is the equivalent amount of electricity that would have been generated by the operation of grid-connected power plants and by the addition of new generation sources. Furthermore, the baseline emissions shall be calculated using Paragraph 11 in the methodology:

> *"The baseline emissions are the product of electrical energy baseline* $EG_{BL,y}$ *expressed in MWh of electricity produced by the renewable generating unit multiplied by the grid emission factor."*

The emission factor is calculated following the approach given in paragraph 12 (a) of the methodology.

> "*12 (a) A combined margin (CM), consisting of the combination of operating margin (OM) and build margin (BM) according to the procedures prescribed in the 'Tool to calculate the emission factor for an electricity system"*

More details on the establishment of the combined margin (CM) emission factor for the national grid in Thailand is provided in Annex 3 to this PDD.

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:

Demonstration that the proposed project activity is additional

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 providing an explanation to show 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.

Furthermore, in reference to the "**Non-binding best practice examples to demonstrate additionality for SSC project activities**", Annex 34, EB35[30], project participants shall provide an explanation to show that the project activity would not have occurred due to at least one of the following barriers:

(a) **Investment barrier:** a financially more viable alternative to the project activity would have led to higher emissions
(b) **Access to finance barrier:** the project activity could not access appropriate capital without consideration of the CDM revenues
(c) **Technology barrier:** a less technologically advanced alternative to the project activity involves lower risks due to the performance uncertainty or low market share of the new technology adopted for the project activity and so would have led to higher emissions
(d) **Barrier due to prevailing practices:** prevailing practice or existing regulatory or policy requirements would have led to implementation of a technology with higher emissions
(e) **Other barriers** such as institutional barriers or limited information, managerial resources, organizational capacity, or capacity to absorb new technologies.

In line with the above guidance, the additionality is demonstrated using option (b) **Access to finance barrier**.

[30] Source: http://cdm.unfccc.int/Reference/Guidclarif/ssc/methSSC_guid05.pdf

Access to Finance barrier

Industry-specific background information with regards to availability of finance

The tapioca processing industry is considered to be one of the largest food processing industrial sector in Thailand. However, the growth of the tapioca starch industry has resulted in heavy water pollution as it generates large amount of solid waste and wastewater with high organic content.

Government of Thailand is promoting renewable energy based on the investment subsidy mechanism in various sectors. Following the initial biogas promotion in the livestock sector, the Ministry of Energy expanded its biogas campaign into the agro-industrial sector, and focused on the tapioca starch sub-sector. During 2003–2005, pilot demonstrations of biogas system in the starch industry were carried out by receiving financial support from the Energy Conservation Promotion Fund (ENCON). As per the report there has been insufficient knowledge / confidence in the available technology. Besides, wastewater treatment technology comes together with high investment cost and high operating cost. As a result, most of manufacturers choose to retain wastewater in open ponds within their factory. The treatment of wastewater in the open lagoons is the least cost option with minimum operating costs.

Therefore penetration of advanced wastewater treatment technologies (for e.g. UASB) is difficult in Thailand and biogas projects are considered high risk propositions by financiers.

It is important to note that private investment in the renewable/clean technology sector in Thailand faces some key challenges. The following is the outcome of the Investment plan[31] for The Clean Technology Fund (CTF)[32].

The key challenge in stimulating private investment in cleaner technology is overcoming institutional, technical, market, and financial barriers considered as high by investors. Although there is ample liquidity in the domestic financial market, lending to renewable energy projects remain limited. ***Access to affordable financing is a key barrier to investors***, suggesting there are structural rigidities in the renewable power generation development market. Key factors include: (i) lack of knowledge (e.g., limited familiarity and experiences of such projects among lenders and borrowers); and (ii) lack of demonstrated successes (e.g., project designs, deal flows, and business models for such investment projects have not yet been widely demonstrated). As a result financial institutions perceive lending to these projects as risky, resulting in higher costs of project development and debt financing.

Furthermore, the following instances reflect the views of two banks:

TMB Bank Public Co. Ltd (a major Thai bank) states “Access to financial resources and Low priority projects” as the major barriers faced by projects in the wastewater treatment sector[33].

---

[31] Paragraph 36, 71, 88, 94: Clean Technology fund investment plant for Thailand, http://www.nesdb.go.th/Portals/0/home/interest/09/Final_Draft_CTF_InvestmentPlan_Oct09.pdf

[32] The Clean Technology Fund (CTF) invests in projects and programs that contribute to the demonstration, deployment and transfer of low carbon technologies with a significant potential for long-term greenhouse gas emissions savings. The CTF Trust Fund Committee oversees the operations of the Fund. The World Bank (IBRD) is the Trustee of the Fund.

[33]Slide no - 6 and 7
http://www.google.co.th/url?sa=t&source=web&cd=9&ved=0CDwQFjAI&url=http%3A%2F%2Fwww.cd4cdm.org%2FAsia%2FFifth%2520Regional%2520Workshop%2FID%26developCDM-Thailand_Prapasawad.ppt&rct=j&q=financial%20barrier%20%2B%20clean%20technology%20%2B%20thailand&ei=cX6ETLmoNInksQOvvez2Bw&usg=AFQjCNG4YY-blMPmMvEg1Ud-sp9miPCNnQ&cad=rja

Furthermore, the same view has been highlighted explicitly for the biogas projects by PROPARCO[34] (private sector financing arm of French Development Agency – AFD) as follows:

- High transaction cost – size rather small to attract commercial lenders
- New technologies, less experienced developers
- Capital intensive: projects extremely sensitive to the structure & conditions of capital cost financing
- High level of uncertainty – related to the level of activities of the host companies creates a difficult risk profile, including difficulty in guaranteeing cash flows

The issues highlighted above lead to a complicated and time-consuming process from lender's point of view.

It is therefore, clear that biogas project face sever access to finance barrier both from the point of view of a local commercial bank and development agencies and additional benefits from CDM play a crucial role in successful implementation of such projects.

<u>Project-specific situation with regards to access to finance</u>

The access to finance barrier has been further demonstrated in an objective manner following the guidance available in the *"Guidelines for Objective Demonstration and Assessment of Barriers"*, Annex 13, EB 50 as follows:

Guideline	Guideline Details	Project-specific situation
General Guideline		
1	While demonstrating barriers related to the lack of access to capital, technologies and skilled labour, the project proponents shall provide information on the nature of the companies and entities involved in the financing and implementation of the project.	Given the access to finance barrier faced by the project activity, ***guideline 1*** is relevant for the project situation and information on the nature of the companies and entities involved in the financing and implementation of the project are provided below.
2	The barrier test in Step 3 of the Tool for the demonstration and assessment of additionality states that *"If the CDM does not alleviate the identified barriers that prevent the proposed project activity from occurring, then the project activity is not additional."*	Based on the additionality assessment presented below, it is clear that CDM played a decisive role in overcoming the access to finance barrier faced by the project activity.
Guideline to demonstrate specific barriers		
3	In order to make an objective claim for a specific barrier, the PDD confirms the existence of the barrier by using evidence sources listed in the Tool for the demonstration and assessment of additionality and the Combined tool to identify the baseline	The discussion presented above regarding industry specific background information demonstrates that wastewater treatment projects with biogas recovery face access to finance barrier in Thailand.

[34] Slide no – 9 and 10 http://www.setatwork.eu/events/thailand/25%20Paper/Working%20session%203.5_Proparco.pdf

Guideline	Guideline Details	Project-specific situation
	scenario and demonstrate additionality, by demonstrating, for each of the barrier, that in similar circumstances (in similar industries/sectors, in companies of similar size and ownership structure, in similar projects) the barriers actually prevented the implementation of other project(s).	
4	Barriers that can be mitigated by additional financial means can be quantified and represented as costs and should not be identified as a barrier for implementation of project while conducting the barrier analysis, but rather should be considered in the framework of investment analysis.	This guidance relates to non-availability of trained labour or technical know or other problems which could be mitigated by additional financial means. The project activity is demonstrating additionality based on access to finance barrier. Therefore, this guidance is not directly relevant to the project activity.
5	Barriers related to increased risks of damage (i.e. that the equipment is damaged due to technological barriers, lack of know-how etc.) can be quantified by the calculation of probability of loss and loss expenses, if the underlying data and assumptions can be objectively and transparently justified.	The project activity is demonstrating additionality based on access to finance barrier. This guideline is therefore not directly relevant to the discussion.
6	In case the PPs make the claim for investment barriers, they should demonstrate in the PDD that the financing of the project was assured only due to the benefit of the CDM. Therefore, it should be demonstrated that the loan approval (or other significant financing decision(s)) by the lender takes explicitly the CDM registration into account.	***Guideline 6*** is applied in the context of the project activity by demonstrating that CDM consideration represents a decisive factor in the loan approval process.
Guideline regarding Least Developed Countries		
7	For projects in Least Developed Countries it is sufficient to transparently describe the relevant barriers, as less stringency is needed with regards to data availability in the actual demonstration of barrier, as compared to the projects in other countries. Projects in Least Developed Countries are not bound by the provisions in this guideline and may use other approaches that are more adapted to the local circumstances.	Not applicable since the project situation is not located in a Least Developed Country.

The following section therefore presents project specific information on "access to finance barrier" in an objective manner as required by the relevant guidelines in the table above.

Guideline 1 states that:

“While demonstrating barriers related to the lack of access to capital, information should include nature of company, organization and its ownership and, financial information”.

(i) Nature of company, organization and its ownership and financial information

The project participant – “Eiam Rung-Ruang Renewable Company Limited” is a private limited company incorporated on 8th December 2008 with a registered capital of 50 million THB[35]. The main business of the company is to implement the biogas plant and generate electricity[36]. Eiam Rung-Ruang Renewable Company is a subsidiary of Eiam Rungruang Industry Company Limited whose core business is to produce and sell tapioca starch in Thailand.

Neither Eiam Rungruang Industry Company nor Eiam Rung-Ruang Renewable Company is a subsidiary of a multinational group. This can be verified based on ownership details of the company.

The project proponent had been looking for financial resources to invest in the project activity since the early stages of the project activity. The first discussion with the bank was held in November 2007. The following shows the documented evidences for securing finance for the project activity from banks:

- June - August 2008[37] – During this period, the project proponent continued discussions with Kasikorn Bank, which after a long consideration, rejected the loan for the biogas plant.
- September 2009[38] – Almost a year later, Krung Thai Bank approved the loan under consideration of CDM and including CDM benefits as a guarantee.

Given the information provided above, it is evident that the project proponent faced problems in securing the loan and it took more than a year from project’s start date in May 2008 to finally get it approved with the Krung Thai Bank. It is worth mentioning that Kasikorn Bank initially showed keen interest but later refused to finance the project due to risks associated to the production output of the starch factory, which has an impact on the wastewater available for the biogas plant, and due to the risk of underperformance of the biogas plant and the nature of underlying technology.

The project proponent was aware of problems in accessing finance for the project activity at the time of investment decision. This is demonstrated based on active CDM consideration in the decision making (please refer the project timeline below) of the project activity and the fact that the project proponent was talking to the bank since November 2007. The technology provider had already included the proposal for CDM services when they submitted the technical proposal for the implementation of the biogas system. Given that, the parent company “Eiam Rungruang Industry Co.,Ltd” was established only in May 2007, it is reasonable to assume that neither the parent company nor the project proponent had any operational history or attractive financial performance to back up a loan from the banks. It is therefore very difficult for a newly established company to convince banks in securing loans, particularly within the context of biogas energy projects, as demonstrated in industry specific background provided earlier. This is precisely the reason why loan negotiations in such cases take longer and involve complex negotiations. This is evident in the case of the project activity.

---

[35] Company affidavit of Eiam Rung-Ruang Renewable Co.,Ltd.

[36] Company affidavit of Eiam Rung-Ruang Renewable Co.,Ltd.

[37] The confirmation letter for the application and rejection of the loan are available.

[38] The loan application and the loan approval are available.

The delay in loan approval also delayed payments to the technology supplier and timely implementation of the project activity. The first payment was made only in May 2009 which is one year after the contract was signed with the technology supplier and less than four months before the final loan approval by Krung Thai Bank in September 2009. It is important to note that prior to loan approval, the project proponent only paid 18.74mTHB[39] to the technology provider. This represents only 13% of the overall project cost, which as of May 2011[40] was about 141m THB. It is important to note also that the initial payment to the technology provider represents a part of the equity investment by the project proponent and that such an up-front commitment was absolutely necessary to show that the project is real.

The project proponent also obtained subsidy from the Energy Policy and Planning Office (EPPO), Ministry of Energy in December 2008. As a result, EPPO approved and provided the project with the maximum eligible subsidy amount of 10 million THB. The subsidy granted by the government further demonstrated that the project proponent is fully committed in setting up the project activity.

In order to put the project-specific situation in a broader perspective, it is important to highlight that the difficulties in securing a loan faced by the project proponent is a real and common problem faced by small and medium enterprises (SMEs) in Thailand. This can be verified by a detailed analysis provided by the Bank of Thailand's discussion paper on "*A Cross-Country Survey on SME Financial Access and implications for Thailand*"[41]. The paper clearly outlines common barriers as perceived by SMEs and financial institutions.

The project company falls clearly under the SME category based on the number of employee and fixed assets (excluding land). The list of employees[42] and the annual financial statement[43] by the certified public accountant of the project company shows that the project proponent is classified as SME and fits under the criteria as mentioned in the table below for the manufacturing sector[44]:

	Small		**Medium**	
	Number of Employee	**Fixed Assets excluding land (million THB)**	**Number of Employee**	**Fixed Assets excluding land (million THB)**
Manufacturing	50 or less	50 or less	51 - 200	> 50 to 200
Services	50 or less	50 or less	51 - 200	> 50 to 200
Wholesale	25 or less	50 or less	26 - 50	> 50 to 100
Retail	15 or less	30 or less	16 - 30	> 30 to 60

Guideline 1 of the "Guidelines for objective demonstration and assessment of barrier" further states that:

[39] 18mTHB includes 3mTHB as money from subsidy provided by EPPO. Therefore only 15mTHB, which is shareholder's equity, was spent from project proponent's own pocket.

[40] Document is available

[41] Page 2, 3 – section 2.2 Challenges in SME financing
http://www.bot.or.th/Thai/EconomicConditions/Publication/Documents/dp032010_SME.pdf

[42] The list of employees is available

[43] The reports are available

[44] Presentation provided by SME Development Bank of Thailand, Slide no. 8
http://www.fsa.go.jp/frtc/kenkyu/event/20080430/08e.pdf

"A company that is a subsidiary of a multinational group may have different access to capital, technologies or skilled labour than a local SME company."

The project proponent is not a subsidiary of a multinational group and clearly has a different access to capital due to its size and the local financial environment.

The above discussion indicates the existence of **access to finance** barrier faced by the project proponent in an objective manner.

(ii) Financial closure achievement through CDM

As per paragraph 9, ***Guideline 6*** from the "Guidelines for objective demonstration and assessment of barrier" it is mentioned that:

> *"In case the PPs make the claim for investment barriers, they should demonstrate in the PDD that the financing of the project was assured only due to the benefit of the CDM. Therefore, it should be demonstrated that the loan approval (or other significant financing decision(s)) by the lender takes explicitly the CDM registration into account"*

As mentioned above, the project participant faced problems in accessing finance for the project activity. After applying to banks, the loan was finally approved by Krung Thai bank which also considered benefits from CDM[45]. The bank has also confirmed[46] that CDM has played a crucial role in the loan approval process for the project activity. There is no doubt that the bank considered revenues from the carbon credits crucial while approving the loan and hence, financing of the project was assured only due to CDM. This is an objective demonstration of access to finance barrier as per the guideline 6 mentioned above.

The above discussion demonstrates in an objective manner that the project activity faced access to finance barrier which could overcome only due to the additional benefits from CDM.

Demonstration of prior consideration of the CDM

Based on the definition of project start date according to the "*Glossary of CDM Terms*", Version 5, the project start date is defined as the date of signature of the technical-commercial agreement between the project owner and the technology provider on 17 May 2008. According to paragraph 6 of the "*Guidelines on the Demonstration and Assessment of Prior Consideration of the CDM (version 04)*" from EB 62, Annex 13, project activities with a start date before 2 August 2008, are required to demonstrate that the CDM was seriously considered in the decision to implement the project activity.

The following table gives an overview of the timeline of the key milestones in project implementation and CDM consideration up to the start of the CDM validation process.

[45] Loan approval document

[46] Confirmation letter from the bank

Table 6: Schedules and main events of the Project

Date	Event	Evidence/ Comment
May 1, 2007	Establishment of Eiam Rungruang Industry Co.,Ltd. for producing native starch	Company registration
November, 2007	First loan discussion with the bank	Confirmation from the bank
December 6, 2007	Technical proposal from Papop Co.,Ltd., to Eiam Rung-Ruang Biotech Co.,Ltd. including CDM application services **(Proof of early consideration)**	Signed technical proposal/ The technical proposal from Papop Company
February 12, 2008	Meeting to discuss the implementation of biogas project under consideration of CDM	Minutes of meeting
May 17, 2008	Signing contract for the project activity between Papop Co.,Ltd and Eiam Rung-Ruang Biotech Co.,Ltd. including CDM application services **(Project start date)**	Contract for designing, building and starting-up the biogas system
December 8, 2008	Establishment of Eiam Rung-Ruang Renewable Co.,Ltd. for biogas operation	Company registration/ Registration of a new company for biogas project
December 16, 2008	Contract with EPPO for subsidy	Copy of contract is available.
January, 2009	Amendment to the contract signed on May 17, 2008 for changing the project owner of the project activity from Eiam Rung-Ruang Biotech to Eiam Rung-Ruang Renewable Co.,Ltd.	Signed amendment to the signed contract for the project activity between Papop Co.,Ltd and Eiam Rung-Ruang Biotech Co.,Ltd.
February 4, 2009	South Pole Carbon Asset Management Ltd. submitted a first CDM proposal to Eiam Rung-Ruang Biotech Co.,Ltd[47]. for purchase of CERs.	Communication between Eiam Rung-Ruang Biotech Co.,Ltd. and South Pole Carbon Asset Management Ltd.
May 15, 2009	First Payment paid to Papop Co.,Ltd. for construction of the biogas system	Receipt from Papop Co.,Ltd.
September 30, 2009	Loan approval with benefits from CDM considered by the bank	Loan agreement
January 26, 2010	Proposal for CDM consulting services from CDM Consultant Company	Proposal
June 30, 2010	Second proposal for developing the project under CDM from South Pole Carbon Asset Management Ltd.	Proposal
November 18, 2010	Signing purchase agreement between Eiam Rung-Ruang Renewable Co.,Ltd. and Swiss Carbon Assets Ltd., a subsidiary of South Pole Carbon Asset	ERPA

[47] Although Eiam Rung-Ruang Renewable Co Ltd (the project participant) was established in Dec 2008, South Pole sent their proposal in the name of Eiam Rung-Ruang Biotech Co Ltd as they were not aware that a new company was established.

Date	Event	Evidence/ Comment
	Management Ltd.	
January 18, 2011	Commissioning of the biogas system	Operation record
June 8, 2011	Initial CDM Gold Standard stakeholder consultation	Cooperation between Eiam Rung-Ruang Renewable Co.,Ltd., South Pole Carbon Asset Management Ltd. (as Swiss Carbon Assets Ltd.) and Papop Co.,Ltd.
June 14, 2011	Signing proposal for the validation services	Signed proposal for Validation Services of a GS CDM project
July 9, 2011	PDD webhosted on UNFCCC	Confirmation email from UNFCCC

The proof for CDM consideration is evident from the technical proposal and the contract between project owner and the technology provider. Internal documentation available before the contract date also proves serious CDM consideration as a part of project revenue.

The documents and information mentioned above are in line with paragraphs 8 (a), (b) and (c) of the "Guidelines on the Demonstration and Assessment of Prior Consideration of the CDM (version 04)" from EB62, Annex 13. The verified documents mentioned in the table above are applicable evidences to prove that (a) the project participants were aware of the CDM prior to the project activity start date, and that the benefits of the CDM were a decisive factor in the decision to proceed with the project; and (b) that continuing and real actions were taken to secure CDM status for the project in parallel with its implementation. There is no gap bigger than two years between relevant actions to secure CDM status.

B.6. Emission reductions:

B.6.1. Explanation of methodological choices:

The emission reductions from the methane avoidance component of the project activity are calculated as per the guidance given in the methodology (version 16 of AMS.III.H). The emission reductions from thermal and electrical components are calculated as per the guidance given in the methodologies (version 19 of AMS.I.C and version 17 of AMS.I.D) respectively. The following sections outline in detail the methodological choices made for each component.

Baseline emissions (BE_y)

1. Baseline emissions for the methane avoidance component (AMS III.H):
Baseline emissions for the systems affected by the project activity may consist of:

(i) Emissions on account of electricity or fossil fuel used ($BE_{power,y}$);
(ii) Methane emissions from baseline wastewater treatment systems ($BE_{ww,treatment,y}$);
(iii) Methane emissions from baseline sludge treatment systems ($BE_{s,treatment,y}$);
(iv) Methane emissions on account of degradable organic carbon in the treated wastewater discharged into river/lake/sea ($BE_{ww,discharge,y}$);
(v) Methane emissions from the decay of the final sludge generated by the baseline treatment systems ($BE_{s,final,y}$).

$$BE_y = \{BE_{power,y} + BE_{ww,treatment,y} + BE_{s,treatment,y} + BE_{ww,discharge,y} + BE_{s,final,y}\}$$ **Eq-1**

Where:

Parameter	Details
BE_y	Baseline emissions in 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 discharged into sea/river/lake in year y (tCO_2e)
$BE_{s,final,y}$	Baseline methane emissions from anaerobic decay of the final sludge produced in year y (tCO_2e)

(i) BE $_{power,y}$ - Baseline emission from electricity and fuel consumptions

The baseline emissions from electricity consumption are not considered as the electricity consumption of the open anaerobic lagoons in the baseline scenario is very low. Furthermore, it is conservative to neglect this emission source. The baseline emissions from fuel consumption are zero as no fossil fuels have been consumed in the operation of the open anaerobic lagoons in the baseline scenario.

Therefore, **BE $_{power,y}$** is assumed zero and removed from further consideration.

(ii) BE $_{ww,treatment,y}$ - Baseline emissions of the wastewater treatment systems affected by the project activity

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 as per the paragraph 20 of AMS III.H., version 16. The following equation is used.

$$BE_{ww,treatment,y} = \sum_i (Q_{ww,i,y} * COD_{inflow,i,y} * \eta_{COD,BL,i} * MCF_{ww,treatment,BL,i}) * B_{o,ww} * UF_{BL} * GWP_{CH4}$$

Eq-2

Where:

Parameter	Details
$Q_{ww,i,y}$	Volume of wastewater treated in baseline wastewater treatment system i in year y (m^3)
$COD_{inflow,i,y}$	Chemical oxygen demand of the wastewater inflow to the baseline treatment system *i* in year y (t/m^3). Average value may be used through sampling with the confidence/precision level 90/10
$\eta_{COD,BL,y}$	COD removal efficiency of the baseline treatment system *i*
$MCF_{,ww,treatment,BL,i}$	Methane correction factor for the baseline anaerobic wastewater treatment i (MCF values as per table III.H.1)
i	Index for baseline wastewater treatment system
$B_{o,ww}$	Methane producing capacity of the wastewater (IPCC value of 0.25 kg CH_4/kg COD)

UF_{BL}	Model correction factor to account for model uncertainties (0.89)[48]
GWP $_{CH4}$	Global warming potential (value of 21)

As the baseline treatment system is different from the treatment system in the project scenario, the monitored values of COD inflow during the crediting period will be used to calculate the baseline emissions ex-post. The outflow COD of the baseline system will be estimated using the removal efficiency of the baseline treatment system. The COD removal efficiency of the baseline system has been measured ex-ante through a measurement campaign.

(iii) BE $_{s, treatment, y}$ - Baseline emissions of the sludge treatment systems affected by the project activity

There is no baseline sludge treatment system. Therefore, this baseline emission source is excluded from further consideration.

(iv) BE $_{ww, discharge, y}$ - Baseline methane emissions from degradable organic carbon in treated wastewater discharged into sea/river/lake

In the baseline treatment system the wastewater is not discharged into a sea/lake/river, therefore this baseline emission source is excluded from further consideration.

(v) BE $_{s, final, y}$ - Baseline methane emissions from anaerobic decay of the final sludge produced

The baseline treatment system did not generate any sludge. Therefore, this baseline emission source is excluded from further consideration.

Therefore, the baseline emissions from methane avoidance component applicable to the project activity are given as:

$$BE_y = BE_{ww,treatment,y} \quad \textbf{Eq-3}$$

2. $BE_{thermal,CO2,y}$ - Baseline emissions for the thermal displacement component (AMS I.C):

As per AMS IC, paragraph 22 of AMS I.C., version 19, for heat[49] produced using fossil fuels the baseline emissions are calculated as follows:

$$BE_{thermal,CO_2,y} = (EG_{thermal,y} / \eta_{BL,thermal}) * EF_{FF,CO_2} \quad \textbf{Eq-4}$$

Where:

Parameter	Details
$BE_{thermal,CO2,y}$	The baseline emissions from steam/heat displaced by the project activity during the year *y* (tCO_2)
$EG_{thermal,y}$	The net quantity of heat supplied by the project activity during the year *y* (TJ)
$EF_{FF,CO2}$	The CO_2 emission factor of the fossil fuel that would have been used in the baseline plant obtained from reliable local or national data if available, alternatively, IPCC default emission factors are used (tCO_2/TJ)
$\eta_{BL,thermal}$	The efficiency of the plant using fossil fuel that would have been used in the absence

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

[49] The biogas will be utilized partly in the thermal boiler to generate heat.

	of the project activity

$$EG_{thermal,y} = Q_{oil,y} \cdot \rho_{oil} \cdot (T_{out} - T_{in}) \cdot LHC_{oil} \cdot \frac{4.1868}{10^{12}}$$ **Eq-5**

Where:

Parameter	Details
$EG_{thermal,y}$	The net quantity of heat supplied by the project activity during the year *y* (TJ)
$Q_{oil,y}$	Quantity of the thermic fluid from boiler to the process plant (m^3)
T_{out}	Temperature of thermic fluid leaving the boiler for heat transfer (deg C)
T_{in}	Temperature of thermic fluid entering the boiler after heat transfer (deg C)
LHC_{oil}	Liquid heat capacity (cal/g-^oC)
ρ_{oil}	Density of thermic fluid (kg/m^3)
4.1868	Conversion factor (J/cal)

The efficiency of the boiler using bunker oil that would have been used in the absence of the project activity shall be determined according to paragraph 30 of AMS.I.C, Version 19,

3. $BE_{elec,y}$ - Baseline emission for the electricity generation component (AMS I.D):
As per AMS I.D., paragraph 11, the baseline is the MWh produced by the renewable generating unit multiplied by an emission coefficient as follows:

$$BE_{elec,y} = EG_{BL,y} * EF_{CO2,grid,y}$$ **Eq-6**

Where:

Parameter	Details
$BE_{elec,y}$	Baseline Emissions from electricity generation during the year y (tCO_2)
$EG_{BL,y}$	The net quantity of electricity exported to the grid by the project activity during the year *y* (MWh)
$EF_{CO2,\ grid,\ y}$	Thailand National Grid emission factor (tCO_{2e}/MWh)

The detailed calculation of the grid emission factor is provided in Annex 3.

Project emissions (PE_y)

4. Project activity emission for the methane avoidance component (AMS III.H):
Project activity emissions from the systems affected by the project activity are:

(i) CO_2 emissions on account of power and fuel used by the project activity facilities ($PE_{power,\ y}$);
(ii) Methane emissions from wastewater treatment systems affected by the project activity, and not equipped with biogas recovery in the project situation ($PE_{ww,\ treatment,\ y}$);
(iii) Methane emissions from sludge treatment systems affected by the project activity, and not equipped with biogas recovery in the project situation ($PE_{s,\ treatment,\ y}$);
(iv) Methane emissions on account of inefficiency of the project activity wastewater treatment systems and presence of degradable organic carbon in treated wastewater ($PE_{ww,\ discharge,\ y}$);
(v) Methane emissions from the decay of the final sludge generated by the project activity treatment systems ($PE_{s,\ final,\ y}$);

(vi) Methane fugitive emissions on account of inefficiencies in capture systems ($PE_{fugitive,\ y}$);
(vii) Methane emissions due to incomplete flaring ($PE_{flaring,\ y}$);
(viii) Methane emissions from biomass stored under anaerobic conditions which would not have occurred in the baseline situation ($PE_{biomass,y}$).

$$PE_{CH4,y} = \begin{Bmatrix} PE_{power,y} + PE_{ww,treatment,y} + PE_{s,treatment,y} + PE_{ww,discharge,y} + PE_{s,final,y} + \\ PE_{fugitive,y} + PE_{biomass,y} + PE_{flaring,y} \end{Bmatrix} \quad \textbf{Eq-7}$$

Where:

Parameter	Details
$PE_{CH4,y}$	Project activity emissions from methane avoidance component in the year *y* (tCO_2e)
$PE_{power,y}$	Emissions from electricity or fuel consumption in the year *y* (tCO_2e). These emissions shall be calculated as per paragraph 20, for the situation of the project scenario, using energy consumption data of all equipment/devices used in the project activity wastewater and sludge treatment systems and systems for biogas recovery and flaring/gainful use
$PE_{ww,treatment,y}$	Methane emissions from wastewater treatment systems affected by the project activity, and not equipped with biogas recovery, in year *y* (tCO_2e).
$PE_{s,treatment,y}$	Methane emissions from sludge treatment systems affected by the project activity, and not equipped with biogas recovery, in year *y* (tCO_2e).
$PE_{y,ww,discharge}$	Methane emissions from degradable organic carbon in treated wastewater in year *y* (tCO_2e).
$PE_{s,final,y}$	Methane emissions from anaerobic decay of the final sludge produced in year *y* (tCO_2e).
$PE_{fugitive,y}$	Methane emissions from biogas release in capture systems in year *y*, calculated as per paragraph 28 (tCO_2e)
$PE_{flaring,y}$	Methane emissions due to incomplete flaring in year *y* as per the "Tool to determine project emissions from flaring gases containing methane"(tCO_2e)
$PE_{biomass,y}$	Methane emissions from biomass stored under anaerobic conditions.

(i) $PE_{power,\ y}$ - Emissions from electricity consumption

The project activity (primarily the biogas plant and some parasitic load associated with the gas engine) will consume electricity generated in the gas engine using biogas which is a renewable fuel. However, in the case of emergencies when the gas engine is not operating, some electricity may be imported from the grid.

Project emissions due to electricity consumption attributed to the project activity, can be calculated based on two different approaches. The first approach is based on paragraph 19 of the methodology, whereas $PE_{power,y}$ shall be estimated according to the "Tool to calculate baseline, project and/or leakage emissions from electricity consumption". The second approach is based on the monitoring section of AMS.III.H Version 16, paragraph 37, monitoring parameter No. 9, whereas a simpler approach based on a conservative estimation of electricity consumption using the rated capacity of auxiliary equipment is suggested as alternative. This second approach is more conservative than the first one (based on actual measurement of electricity consumption in the project) and shall be used mainly for ex-ante estimation of emission reductions. The second approach can be used as a backup option for ex-post emission reduction calculation in case of non-availability or problems with monitoring data for electricity consumption measurement.

i. *Calculation of $PE_{power,y}$ as per "Tool to calculate baseline, project and/or leakage emissions from electricity consumption":*

The scenario **A: Electricity consumption from the grid** as per tool will be applied to the project activity for the amount of electricity imported from the grid. The generic approach is used to calculate the project emissions as follows:

$$PE_{EC,y} = \sum EC_{PJ,j,y} \times EF_{EL,j,y} \times (1 + TDL_{j,y}) \qquad \textbf{Eq-8}$$

Where:

Parameter	Details
$PE_{EC,y}$	Project emissions from grid electricity consumption in year y (tCO_2)
$EC_{PJ,j,y}$	Quantity of grid electricity consumed by the project electricity consumption source j in year y (MWh)
$EF_{EL,j,y}$	Emission factor for electricity generation source j in year y (tCO_2/MWh)
$TDL_{j,y}$	Average technical transmission and distribution losses for providing electricity to source j in year y.
j	Source of electricity consumption in the project

Determination of emission factor for the electricity generation ($EF_{EL,j,y}$)
Option A1 has been used to determine emission factor. This option proposes to calculate the combined margin emission factor of the applicable electricity system, using the procedures in the latest approved version of the "*Tool to calculate the emission factor for an electricity system*" ($EF_{EL,j,y} = EF_{CO2,grid,y}$).
The grid emission factor calculation details are further explained in Annex 3.

The value of $EF_{EL,j,y}$ (or $EF_{CO2,grid,y}$) is fixed ex-ante for the entire crediting period in line with the ex-ante option referred in Step 3 of "Tool to calculate emission factor for an electricity system".

Determination of average technical transmission and distribution losses
For the sake of simplicity, a default factor of 20% shall be used for $TDL_{j,y}$. in line with the "*Tool to calculate baseline, project and/or leakage emissions from electricity consumption*".

ii. *Calculation of $P_{power,y}$ as per AMS.III.H Version 16, paragraph 37, monitoring parameter No. 9:*

As mentioned above this alternative approach shall be used mainly for ex-ante estimation of emission reductions and for ex-post emission reduction calculation only in cases of non-availability or problems with monitoring data for electricity consumption measurement required for the first approach described above. Under these circumstances, $PE_{Power,y}$ shall be calculated as follows:

$$\mathbf{PE_{power,y} = EC_{rated\ capacity,y} * EF_{CO2,\ grid,y}} \qquad \textbf{Eq-9}$$

Where:

Parameter	Details
$EC_{rated\ capacity,y}$	Electricity consumed by the project activity during year y based on rated capacity
$EF_{CO2,grid,y}$	Grid emission factor of Thailand

For calculation of $EC_{rated\ capacity,y,}$ it shall be assumed that all relevant electrical equipment operates at full rated capacity, plus 10% to account for distribution losses, for 8,760 hours per annum[50]. For this alternative of annual electricity consumption for this project activity is calculated as follows:

$EC_{rated\ capacity,y}$ = Total rated power capacity[51] * 1.1 * 8,760/ 1,000 **Eq-10**

The determination of $EF_{CO2,grid,y}$ is calculated in the same manner as under the first PE_{power} approach described above(in line with the "Tool to calculate baseline, project and/or leakage emissions from electricity consumption", using the "Tool to calculate the emission factor for an electricity system".

(ii) $PE_{ww,treatment,\ y}$ - Emissions from wastewater treatment systems affected by the project activity, and not equipped with biogas recovery in the project situation.

Methane emissions from wastewater treatment systems affected by the project activity, which in case of the project activity represent the secondary treatment system after biogas reactor, are calculated as per equation 2 given in paragraph 21 of AMS III.H:

$$PE_{ww,treatment,y} = \sum (Q_{ww,k,y} * COD_{removed,PJ,k,y} * MCF_{ww,treatment,PJ,k}) * B_{o,ww} * UF_{PJ} * GWP_{CH4} \quad \textbf{Eq-11}$$

Where:

Parameter	Details
$Q_{,ww,k,y}$	Volume of wastewater treated in system affected by the project activity in year y (m^3)
$COD_{removed,PJ,k,y}$	Chemical oxygen demand removed by project wastewater treatment system *k* in year *y* (t/m^3), measured as the difference between inflow COD and the outflow COD in system *k*
$B_{o,ww}$	Methane producing capacity of the wastewater (IPCC default value of 0.25 kg CH_4/kg COD)
$MCF_{,ww,treatment,PJ,k}$	Methane correction factor for project wastewater treatment system *k* (MCF values as per Table III.H.1)
UF_{PJ}	Model correction factor to account for model uncertainties (0.89)[52]
GWP_{CH4}	Global Warming Potential for methane (value of 21)

(iii) $PE_{s,treatment,y}$ - Methane emissions from sludge treatment systems affected by the project activity, and not equipped with biogas recovery.

There is no sludge treatment system prior to the implementation of the project activity. Therefore, this parameter is not applicable in the calculations and has been excluded from further consideration.

(iv) $PE_{ww,discharge,y}$ - Methane emissions from degradable organic carbon in treated wastewater.

In the project activity, the treated wastewater will not be discharged into to a river, sea or lake. Therefore, project emissions from this component have not been included in the assessment.

(v) $PE_{s,final,y}$ - Emissions from anaerobic decay of the final sludge produced

---

[50] Per methodology AMS-III.H version 16, paragraph 37, monitoring parameter No. 9

[51] According to the list of all auxiliary drives in the project activity

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

It is not expected that the project activity will generate a significant amount of sludge. The excess sludge may be used for starting up other systems equipped with biogas recovery or for soil application. Therefore, as per the methodology paragraph 29, this term is neglected ex-ante.

The final disposal of sludge shall be monitored during the crediting period. In case the application of sludge cannot be monitored, as a conservative measure, it will be assumed that the sludge would have decayed in anaerobic manner. The emissions will be accounted as per equation 7 in paragraph 25 of the methodology.

(vi) $PE_{,\,fugitive\ y}$ - Emissions on account of inefficiencies in capture systems
Project activity emissions from methane release in capture systems are determined as per paragraph 30 of AMS III.H as follows:

$$PE_{fugitive,y} = PE_{fugitive,ww,y} + PE_{fugitive,s,y} \qquad \textbf{Eq-12}$$

Where:

Parameter	Details
$PE_{fugitive\ ww,\ y}$	Fugitive emissions through capture inefficiencies in the anaerobic wastewater treatment in the year y (tCO_{2e})
$PE_{fugitive,s,\ y}$	Fugitive emissions through capture inefficiencies in the anaerobic sludge treatment systems in the year y (tCO2e)

$PE_{fugitive,ww,\ y}$

These emissions are calculated as follows:

$$PE_{fugitive,ww,y} = (1 - CFE_{ww}) * MEP_{ww,treatment,y} * GWP_{CH4} \qquad \textbf{Eq-13}$$

Where:

Parameter	Details
CFE_{ww}	Capture efficiency of the biogas recovery equipment in the wastewater treatment systems (a default value of 0.9 shall be used)
$MEP_{ww,\ treatment,\ y}$	Methane emission potential of wastewater treatment systems equipped with biogas recovery system in year *y* (t)

Further,

$$MEP_{ww,treatment,y} = Q_{ww,y} * B_{o,ww} * UF_{PJ} * \sum_k COD_{removed,PJ,k,y} * MCF_{ww,treatment,PJ,k} \qquad \textbf{Eq-14}$$

Where:

Parameter	Details
$COD_{removed,\ PJ,k,y}$	The chemical oxygen demand removed[53] by the treatment system *k* of the project activity equipped with biogas recovery in the year *y* (t/m^3)

53 Difference between the inflow COD and the outflow COD.

$MCF_{ww,treatment,PJ,k}$	Methane correction factor for the project wastewater treatment system *k* equipped with biogas recovery equipment (MCF values as per Table III.H.1)
UF_{PJ}	Model correction factor to account for model uncertainties (1.12)

$PE_{fugitive,s,y}$

There is no anaerobic sludge treatment in the project activity. Therefore, this source of emissions is excluded from further consideration.

Thus, the fugitive emissions through capture inefficiencies in the anaerobic wastewater treatment systems are given as:

$$PE_{fugitive,y} = PE_{fugitive,ww,y}$$ **Eq-15**

(vii) $PE_{flaring\ y}$ - Methane emissions due to incomplete flaring

The project activity uses an enclosed flare system to burn the excess biogas not used in boiler and gas engines for useful purposes.

For ex-ante calculations, in line with paragraph 29 of AMS.III.H, it shall be assumed that excess biogas beyond the capacity of the biogas engines and the boiler to use biogas for energy generation purposes is flared. This shall be calculated based on the total expected biogas generation as per baseline emissions calculation in comparison to the need for biogas in the engines and in the boiler.

The ex post emission reduction shall be calculated as per the "*Tool to determine project emissions from flaring gases containing methane*".

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. As per the guidance of the tool, a simplified approach will be used and only the volumetric fraction of methane will be measured, the difference is considered to be 100% Nitrogen.

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 ($\rho_{CH4,n}$) in the same reference conditions (normal conditions and dry or wet basis).
Considering that the gas is cooler than 60 degrees Celsius, the reported density is expressed on dry basis already.

$$TM_{RG,h} = FV_{RG,h} * fv_{CH4,RG,h} * \rho_{CH4,n}$$ **Eq-16**

Where:

Parameter	Details
$TM_{RG,h}$	Mass flow rate of methane in the residual gas in the hour h (kg/h)
$FV_{RG,h}$	Volumetric flow rate of the residual gas in dry basis at normal conditions in hour h

	(m3/h)
$fv_{CH4, RG,h}$	Volumetric fraction of methane in the residual gas on dry basis in hour h
$\rho_{CH4,n}$	Density of methane at normal condition (0.716 kg/m3)

As per Step 6 of the flaring tool for determination of the hourly flare efficiency, a default value of 90% is used, provided the flare is operational. The temperature in the exhaust gas of the flare (T_{flare}) is above 500°C for more than 40 minutes during the hour (h) and the manufacturer's specification on proper operation of the flare are met continuously during the hour (h).

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

$$PE_{flare,y} = \sum_{h=1}^{8760} TM_{RG,h} * (1 - \eta_{flare-h}) * GWP_{CH4} / 1000 \quad \textbf{Eq-17}$$

Where:

Parameter	Details
$TM_{RG,h}$	Mass flow rate of methane in the residual gas in the hour h (kg/h)
$\eta_{flare-h}$	Flare efficiency in hour h
GWP_{CH4}	Global Warming Potential of methane valid for the commitment period (tCO_2e/tCH_4)

(viii) PE $_{biomass, y}$ - Methane emissions from biomass stored under anaerobic conditions

There is no biomass storage in the project activity. Therefore, this source of emissions has been excluded from further consideration.

5. Project emission for The thermal displacement component (AMS I.C):

As per AMS I. C., paragraph 45, CO_2 emissions from on-site consumption of fossil fuels due to the project activity shall be calculated using the latest version of "*Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion*". Although the project activity is expected to generate sufficient biogas which can replace 100% of fuel oil in the boiler, usage of fuel oil cannot be ruled out completely during biogas shortage or shut-down periods for example. Therefore, based on Option B from the *"Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion*", CO_2 emissions from fossil fuel consumption in the boiler are calculated as:

$$PE_{boiler,y} = FC_{k,y} \cdot NCV_{k,y} \cdot EF_{CO2,k,y} \quad \textbf{Eq-18}$$

Where:

Parameter	Details
$FC_{k,y}$	Quantity of fossil fuel type k combust in the thermal oil boiler during the year y (mass or volume unit/yr)
$NCV_{k,y}$	Net calorific value of fossil fuel type k, GJ/mass or volume unit)
$EF_{CO2,k,y}$	CO_2 emission factor of fuel type k in the year y (tCO_2/GJ)

6. Project emission for the electricity generation component: (AMS I.D):

As per paragraph 20 of AMS-I.D, project emissions due to electricity generation from renewable energy projects are considered to be zero (except for potential emissions from geothermal power plants and hydropower plants with reservoirs, which are not applicable to the project activity).

Leakage (LE_y)

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

All the equipment used in the project activity for power generation and heat generation is either brought for purpose of project activity or already existed at the project site (i.e. existing thermal oil boiler). No shifting or transfer of existing equipment from other activities outside the project boundary takes place. There is also no collection/processing/transportation of biomass residues outside the project boundary. The leakage shall be considered as nil for the AMS I.C and I.D portions.

Emission Reductions (ER_y)

Overall emission reductions are calculated as the sum of all three project components under methodologies AMS-III.H, AMS-I.C and AMS-I.D described below.

Emission reductions from the methane avoidance component of the project activity based on AMS.III.H ($ER_{CH4,y}$)

As per the guidance given in the paragraph 33 of the methodology AMS III.H, *ex post* emission reductions shall be based on the lowest value of the following:

(i) The amount of biogas recovered and fuelled or flared (*MDy*) during the crediting period, that is monitored *ex post*;
(ii) *Ex post* calculated baseline, project and leakage emissions based on actual monitored data for the project activity.

Therefore, as per paragraph 34,

$$ER_{CH4,y} = \min\begin{pmatrix} \left(BE_{CH4,y} - PE_{EC,y} - PE_{ww,treatment,y} - PE_{fugitive,y} - PE_{flare,y}\right), \\ \left(MD_y - PE_{EC,y}\right) \end{pmatrix} \quad \textbf{Eq-19}$$

As per paragraph 35 in AMS III.H., *In the case of flaring/combustion MD_y will be measured using the conditions of the flaring and combustion process:*

$$MD_y = W_{CH4} * D_{CH4} * GWP_{CH4} * [(BG_{flare,y} * FE) + (BG_{combusted,y} * DE)] \quad \textbf{Eq-20}$$

Where:

Parameter	Details

$w_{CH4,y}$	Methane content of the biogas in the year *y* (volume fraction)
D_{CH4}	Density of methane at the temperature and pressure of the biogas in the year *y* (tonnes/m^3)
GWP_{CH4}	Global warming potential of methane, 21
$BG_{flare,y}$	Amount of biogas flared during the year y, Nm^3/year
$BG_{combusted,y}$	Biogas combusted for gainful use in year y, Nm^3/year
FE	Flare efficiency (fraction)
DE	Destruction efficiency of biogas combusted for a gainful use (100%)

Emission reductions from the thermal and electricity generation components

As per the paragraph 49 of AMS-I.C, and paragraph 23 of AMS-I.D, emission reductions are estimated based on the formulas described in baseline, project and leakage emissions sections above, as follows:

$$ER_y = BE_y – PE_y - LE_y \quad \textbf{Eq-21}$$

Where:
ER_y Emission reductions in year *y* (tCO_2e)
BE_y Baseline emissions in year *y* (tCO_2e)
PE_y Project emissions in year *y*(tCO_2e)
LE_y Leakage emissions in year *y* (tCO_2e)

After calculating the ER_y under each project component, the sum of all three values amounts to total emission reductions achieved by the project activity.

Calculation of all three components as described above and elimination of terms assumed to be zero leads to following equation whereas the denomination "*CH_4*" represents the AMS.III.H component, "*thermal*" the AMS.I.C component and "*elec*" the AMS.I.D component of the project activity:

$$ER_y = BE_{CH4,y} + BE_{thermal,CO2,y} + BE_{elec,y} - PE_{CH4,y} - PE_{thermal,y} \quad \textbf{Eq-22}$$

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

Data and parameters from AMS.III.H

Data / Parameter:	**GWP_{CH4}**
Data unit:	-
Description:	Global warming potential of methane gas
Source of data used:	Default value from AMS III.H.
Value applied:	21
Justification of the choice of data or description of measurement methods and procedures	IPCC default value

actually applied :	
Any comment:	-

Data / Parameter:	$\mathbf{B_{o,\,ww}}$
Data unit:	kg CH_4/kg COD
Description:	Methane producing capacity of the COD in wastewater
Source of data used:	IPCC default value, as per methodology AMS III.H
Value applied:	0.25 kg CH_4/kg COD
Justification of the choice of data or description of measurement methods and procedures actually applied :	IPCC default value
Any comment:	-

Data / Parameter:	$\mathbf{UF_{BL}}$
Data unit:	Factor
Description:	Model correction factor to account for model uncertainties
Source of data used:	AMS III.H., Version 16
Value applied:	0.89
Justification of the choice of data or description of measurement methods and procedures actually applied :	-
Any comment:	-

Data / Parameter:	$\mathbf{UF_{PJ}}$
Data unit:	Factor
Description:	Model correction factor to account for model uncertainties
Source of data used:	AMS III.H., Version 16
Value applied:	1.12
Justification of the choice of data or description of measurement methods and procedures actually applied :	-
Any comment:	-

Data / Parameter:	$\mathbf{MCF_{ww,\,treatment,BL,i}}$
Data unit:	-
Description:	Methane correction factor for the baseline anaerobic wastewater treatment systems
Source of data used:	Table III.H.1. of AMS III.H., Version 16
Value applied:	0.8

Justification of the choice of data or description of measurement methods and procedures actually applied :	The baseline wastewater treatment system consists of a succession of anaerobic deep lagoons (depth more than 2 metres) therefore the MCF value is chosen as 0.8
Any comment:	IPCC Default values from chapter 6 of volume 5 page no 6.21. Waste in 2006 IPCC Guidelines for National Greenhouse Gas Inventories.

Data / Parameter:	$\mathbf{MCF_{ww, treatment, PJ,k}}$
Data unit:	-
Description:	Methane correction factor for project wastewater treatment system k
Source of data used:	Table III.H.1. of AMS III.H., Version 16
Value applied:	0.8
Justification of the choice of data or description of measurement methods and procedures actually applied :	In the project scenario the post treatment of wastewater treatment system without biogas recovery consists of a succession of lagoons, with depth greater than 2 metres, thus the value of 0.8 has been chosen.
Any comment:	IPCC Default values from chapter 6 of volume 5 page no 6.21. Waste in 2006 IPCC Guidelines for National Greenhouse Gas Inventories.

Data / Parameter:	$\boldsymbol{\eta}_{COD, BL, y}$
Data unit:	%
Description:	COD removal efficiency of the baseline treatment
Source of data used:	Measurement campaign in the baseline wastewater system for 10 days
Value of data applied for the purpose of calculating expected emission reductions:	87.27% - Used for ex-ante estimation of baseline emissions.
Justification of the choice of data or description of measurement methods and procedures actually applied :	The COD removed value is based on COD campaign data and multiplied by a factor of 0.89 to account of uncertainty due to data from the campaign measurement. This is in line with the guidance given in paragraph 27 which requires a measurement campaign of the baseline wastewater treatment system for at least 10 days and comparison to all other available COD removal data. Further details of the campaign are provided in Annex 3.
Any comment:	-

Data / Parameter:	$\mathbf{CFE_{ww}}$
Data unit:	Fraction
Description:	Capture efficiency of the biogas recovery equipment in the wastewater treatment systems.
Source of data used:	AMSIIIH version 16
Value applied:	0.9
Justification of the choice of data or	Default value as per AMS III.H.

description of measurement methods and procedures actually applied :	
Any comment:	-

Data / Parameter:	**DE_{engine}**
Data unit:	%
Description:	Destruction efficiency of the electricity generator
Source of data used:	Default value, paragraph 35 AMSIIIH
Value applied:	100%
Justification of the choice of data or description of measurement methods and procedures actually applied :	Default value based on guidance given in paragraph 35 of AMSIIIH.
Any comment:	-

Data / Parameter:	**DE_{boiler}**
Data unit:	%
Description:	Destruction efficiency of the boiler
Source of data used:	Default value, paragraph 35 AMSIIIH
Value applied:	100%
Justification of the choice of data or description of measurement methods and procedures actually applied :	Default value based on guidance given in paragraph 35 of AMSIIIH.
Any comment:	-

Data and parameters from AMS.I.D

Data / Parameter:	**$EF_{CO2,grid,y}$**
Data unit:	tCO_2/MWh
Description:	CO_2 emission factor for grid power
Source of data used:	TGO - Thailand greenhouse gas management organisation (Thai DNA)
Value applied:	0.5812 – fixed ex-ante
Justification of the choice of data or description of measurement methods and procedures actually applied :	The emission factor is calculated according to the “Tool to calculate the emission factor for an electricity system” (version 02.2.1) by the Thai DNA (TGO). The values are provided in the Annex-3.

Any comment:	The emission factor was published by TGO on 29th June 2011 – http://www.tgo.or.th/index.php?option=com_content&view=article&id=122:thailand-grid-emission-2009-report&catid=62:tgo-research&Itemid=29

Data and parameters from AMS.I.C

Data / Parameter:	$\mathbf{EF_{CO2,k,y}}$
Data unit:	tCO_2/TJ
Description:	CO2 emission factor of fossil fuel type k combusted in the boiler, where type k is heavy fuel oil
Source of data used:	2006 IPCC
Value applied:	77.40 – for fuel oil
Justification of the choice of data or description of measurement methods and procedures actually applied :	The IPCC default value of the CO2 emission factor of fuel oil is applied as per Table 1.4, "Default CO2 emission factor for combustion" (IPCC 2006, volume 2-chapter 1). Local values are not available.
Any comment:	-

Data / Parameter:	$\mathbf{NCV_{k,y}}$
Data unit:	GJ/tonne
Description:	Net calorific value of fossil fuel type k combusted in the boiler, where type k is heavy fuel oil
Source of data used:	2006 IPCC
Value applied:	40.4 – for heavy fuel oil
Justification of the choice of data or description of measurement methods and procedures actually applied :	The IPCC default value of the Net Calorific value of fuel oil is applied as per Table 1.2 (IPCC 2006, volume 2-chapter 1). Local values are not available.
Any comment:	-

Data / Parameter:	$\eta_{BL,thermal}$
Data unit:	%
Description:	Efficiency of the heavy fuel oil fired boiler that would have been used in the absence of the project activity
Source of data used:	AMS-I.C v19
Value applied:	100%
Justification of the choice of data or description of measurement methods and	Default value as per option c in paragraph 30 of the AMS-I.C v19

procedures actually applied :	
Any comment:	-

Data / Parameter:	**LHC_{oil}**
Data unit:	cal/g-°C
Description:	Liquid heat capacity of thermic fluid
Source of data used:	http://www.nirmalenergy.com/therminol_55.pdf
Value applied:	0.686 cal/g-°C
Justification of the choice of data or description of measurement methods and procedures actually applied :	Value as per technical specification of thermic fluid used in the boiler at the project activity.
Any comment:	As per thermic fluid specification at 293°C, whereas the maximum supply temperature of the boiler is 300°C.

Data / Parameter:	**ρ_{oil}**
Data unit:	kg/m^3
Description:	Density of thermic fluid used for heating purposes
Source of data used:	http://www.nirmalenergy.com/therminol_55.pdf
Value applied:	677 kg/m^3
Justification of the choice of data or description of measurement methods and procedures actually applied :	Value as per technical specification of thermic fluid used in the boiler at the project activity.
Any comment:	As per thermic fluid specification at 293°C, whereas the maximum supply temperature of the boiler is 300°C.

Data / Parameter:	**NCV_{biogas}**
Data unit:	MJ/Nm^3
Description:	NCV of biogas
Source of data used:	See footnote.
Value applied:	23.27
Justification of the choice of data or description of measurement methods and procedures actually applied :	Based on a NCV of methane[54] = 35.8 MJ/m3 and a methane percentage of 65%

[54] www.agroparistech.fr/IMG/pdf/syn08-eng-Bonnier.pdf

Any comment:	-

Data / Parameter:	ρ_{CH4}
Data unit:	kg/m^3
Description:	Density of methane at normal temperature and pressure
Source of data used:	Tool to determine project emissions from flaring gases containing methane.
Value applied:	0.716
Justification of the choice of data or description of measurement methods and procedures actually applied :	CDM EB as per EB28 Meeting report (Annex 13).
Any comment:	-

Data / Parameter:	ρ_{FO}
Data unit:	Kg/m3
Description:	Density of fossil fuel used on the thermal boiler
Source of data used:	Thai local value (PTT)
Value applied:	0.95
Justification of the choice of data or description of measurement methods and procedures actually applied :	http://www.pttplc.com/Files/Document/Pdf/energy/nc_en_ee-01_01.pdf
Any comment:	-

B.6.3 Ex-ante calculation of emission reductions:

Baseline emissions (BE_y)

The ex-ante estimation of the baseline emissions can be given as per the equations 3, 4 and 5 in section B.6.1.

$$BE_y = BE_{CH4,y} + BE_{thermal,CO2,y} + BE_{elec,y} \quad \textbf{Eq-23}$$

Where:

$$BE_{CH4,y} = BE_{ww,treatment,y}$$

$$BE_{thermal,CO_2,y} = (EG_{thermal,y} / \eta_{BL,thermal}) * EF_{FF,CO_2}$$

$$BE_{elec,y} = EG_{BL,y} * EF_{CO2,grid,y}$$

The following section gives details of ex–ante estimation of baseline emissions:

Methodology: AMS III. H. (Methane avoidance component)		
Formula: $BE_{ww,treatment,y} = \sum_i (Q_{ww,i,y} * COD_{inflow,i,y} * \eta_{COD,BL,i} * MCF_{ww,treatment,BL,i}) * B_{o,ww} * UF_{BL} * GWP_{CH4}$		
$Q_{ww,i\,y}$	1,080,000 m^3	Based on: wastewater treatment of 6,000 m^3/day, operation of 240 days per year and load factor 75%
$COD_{inflow,i,y}$	0.01694 ton/m^3	Base on: COD campaign 10 days
$\eta_{COD,BL,y}$	87%	
$MCF_{ww,treatment,BL,i}$	0.8	Default value for anaerobic deep lagoons (as per Table III.H.1)
$B_{o,ww}$	0.25kg CH_4/kg COD	Default value - IPCC
UF_{BL}	0.89	Model correction factor from AMS III. H.
GWP_{CH4}	21	Default value
Calculation: $BE_{CH4,y} = BE_{ww,treatment,y}$ = 1,080,000 x 0.01694 x 0.87 x 0.8 x 0.25 x 0.89 x 21 = **59,682 tCO_2e**		

Methodology: AMS I. C. (Thermal displacement component)		
Formula: $BE_{thermal,CO_2,y} = (EG_{thermal,y} / \eta_{BL,thermal}) * EF_{FF,CO_2}$		
$EG_{thermal,y}$	80.1 TJ	Based on the biogas sent to thermal oil boiler. Calculation can be found in the calculation spreadsheet.
$EF_{FF,CO2}$	77.40 tCO2/TJ	For fuel oil – 2006 IPCC.
$\eta_{BL,thermal}$	100%	Default value as per paragraph 30 of AMS-I.C v19
Calculation: $BE_{thermal,CO_2,y}$ = (80.1 / 1.00) x 77.40 = **6,198 tCO_2e**		

Methodology: AMS I. D (Electricity generation component)		
Formula: $BE_{elec,y} = EG_{BL,y} * EF_{CO2,grid,y}$		
$EG_{BL,y}$	7,407.55MWh	Based on the biogas available for power generation per year and the efficiency of gas engine.
$EF_{CO2,grid,y}$ =	0.5812 tCO2/MWh	Thai DNA[55]
Calculation: $BE_{elec,y}$ = 7,407.55 x 0.5812 = **4,305 tCO_2e**		

Project emissions

The ex-ante estimation of the project emissions are given as follows from the methane avoidance component of the project activity:

$$PE_{CH4,y} = PE_{power,y} + PE_{ww,treatment,y} + PE_{fugitive,y} + PE_{flare,y} \qquad \textbf{Eq-24}$$

[55] http://www.tgo.or.th/index.php?option=com_content&view=article&id=122:thailand-grid-emission-2009-report&catid=62:tgo-research&Itemid=29

$PE_{power,y}$ and $PE_{flare,y}$ will be accounted ex-post depending on the usage of grid electricity and the amount of biogas flared respectively. The ex-ante value for $PE_{power,y}$ is calculated based on the rated power of auxiliary equipment as explained under Section B.6.3. There are no additional project emissions from the electrical component (AMS.I.D) of the project activity. The project emissions from the thermal component (AMS.I.C), $PE_{thermal,y}$ will be accounted ex-post in case there is any fossil fuel usage in the boiler. For ex-ante estimations, it is assumed that the generated biogas is sufficient to cover the thermal energy demand for the starch drying process. It is also assumed that all biogas is used for energy generation purposes, leaving no biogas to be flared. Therefore, the ex-ante project emissions are only given for $PE_{ww,treatment,y}$ and $PE_{fugitive,y}$ as follows:

Methodology: AMS III H (Methane avoidance component)		
Emissions in wastewater treatment system without biogas recovery		
Formula: $PE_{ww,treatment,y} = \sum (Q_{ww,k,y} * COD_{removed,PJ,k,y} * MCF_{ww,treatment,PJ,k}) * B_{o,ww} * UF_{PJ} * GWP_{CH4}$		
$Q_{ww,k,y}$	1,080,000 m^3	Based on: wastewater treatment of 6,000 m^3/day, operation of 240 days per year and load factor 75%
$COD_{removed,PJ,k,y}$	0.00085 ton/m^3	
$MCF_{ww,treatment,PJ,k}$	0.8	Default value as per Table III.H.1 of AMS III.H.
$B_{o,ww}$	0.25 kg CH_4/kg COD	Default value as per AMS III.H
UF_{PJ}	1.12	Default value as per AMS III.H
GWP_{CH4}	21	Default value as per AMS III.H
Calculation: $PE_{ww,treatment,y}$ = 1,080,000 x 0.00085 x 0.8 x 0.25 x 1.12 x 21 = **4,303 tCO_2e**		
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 as per AMS III.H.
$MEP_{ww,treatment,y}$	3,893	Detailed calculations are available in the calculation sheet.
GWP_{CH4}	21	Default value
Calculation: $PE_{fugitive,ww,y}$ = 3,893 x (1-0.9) x 21= **8,175 tCO_2e**		
Emissions due to grid electricity consumption by auxiliary equipment of wastewater treatment system (based on ex-ante approach described in Section B.6.1)		
Formula: $PE_{power,y} = EC_y * EF_{CO2}$		
EC_y	2,509.6 MWh	Based on power capacity installed (260 kW), and assuming that all relevant electrical equipments

		operate at full capacity, plus 10% to account for distribution losses and 8760 hours[56].
EF_{CO2}	0.5812 tCO_2/MWh	Grid emission factor of Thailand (Annex 3)
Calculation: $PE_{power,y}$ = 2,509.6 * 0.5812 = **1,459 tCO_2e**		

Leakage

As explained under Section B.6.1, leakage is considered to be zero for the proposed project activity.

Emission Reduction Summary:

To summarise ex-ante baseline and project emissions are given as follows:

As per equation 20, total baseline emissions are given as:

BE_y = 70,185 tCO_2/year

As per equation 21, the total project emissions are given as:

PE_y = 13,938 tCO_2/year

Therefore, the ex-ante estimates on emissions reductions are given as:

ER_y = 56,248 tCO_2/year

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

AMS.III.H (Methane avoidance component)

Year[57]	Emission of project activity emissions (tonnes CO_2e)	Estimation of baseline emissions (tonnes CO_2e)	Estimation of leakage (tonnes CO_2e)	Estimation of overall emission reductions (tonnes CO_2e)
Year 2012	13,938	59,682	-	45,744
Year 2013	13,938	59,682	-	45,744
Year 2014	13,938	59,682	-	45,744
Year 2015	13,938	59,682	-	45,744
Year 2016	13,938	59,682	-	45,744
Year 2017	13,938	59,682	-	45,744
Year 2018	13,938	59,682	-	45,744

[56] AMS-III.H., monitoring parameter No. 9, alternative way to estimate the electricity consumption is applied. It shall be assumed that all relevant electrical equipment operate at full rated capacity, plus 10% to account for distribution losses, for 8760 hours per annum.

[57] "Year" means a complete year starting from the start date of crediting period (for e.g. 'Year 2016' covers the period 1st June 2016 till 31st May 2017). The start date of crediting period is determined based on C.2.1.1.

Total (tonnes CO_2e)	**97,564**	**417,772**	**-**	**320,208**

AMS.I.C (Thermal energy component)

Year[58]	Emission of project activity emissions (tonnes CO_2e)	Estimation of baseline emissions (tonnes CO_2e)	Estimation of leakage (tonnes CO_2e)	Estimation of overall emission reductions (tonnes CO_2e)
Year 2012	-	6,198		6,198
Year 2013	-	6,198	-	6,198
Year 2014	-	6,198	-	6,198
Year 2015	-	6,198	-	6,198
Year 2016	-	6,198	-	6,198
Year 2017	-	6,198	-	6,198
Year 2018	-	6,198	-	6,198
Total (tonnes CO_2e)	**-**	**43,388**	**-**	**43,388**

AMS.I.D (Electricity generation component)

Year[59]	Emission of project activity emissions (tonnes CO_2e)	Estimation of baseline emissions (tonnes CO_2e)	Estimation of leakage (tonnes CO_2e)	Estimation of overall emission reductions (tonnes CO_2e)
Year 2012	-	4,305	-	4,305
Year 2013	-	4,305	-	4,305
Year 2014	-	4,305	-	4,305
Year 2015	-	4,305	-	4,305
Year 2016	-	4,305	-	4,305
Year 2017	-	4,305	-	4,305
Year 2018	-	4,305	-	4,305
Total (tonnes CO_2e)	**-**	**30,137**	**-**	**30,137**

Overall Emission Reductions

[58] "Year" means a complete year starting from the start date of crediting period (for e.g. 'Year 2016' covers the period 1st June 2016 till 31st May 2017). The start date of crediting period is determined based on C.2.1.1.

[59] "Year" means a complete year starting from the start date of crediting period (for e.g. 'Year 2016' covers the period 1st June 2016 till 31st May 2017). The start date of crediting period is determined based on C.2.1.1.

Year[60]	Emission of project activity emissions (tonnes CO_2e)	Estimation of baseline emissions (tonnes CO_2e)	Estimation of leakage (tonnes CO_2e)	Estimation of overall emission reductions (tonnes CO_2e)
Year 2012	13,938	70,185	-	56,248
Year 2013	13,938	70,185	-	56,248
Year 2014	13,938	70,185	-	56,248
Year 2015	13,938	70,185	-	56,248
Year 2016	13,938	70,185	-	56,248
Year 2017	13,938	70,185	-	56,248
Year 2018	13,938	70,185	-	56,248
Total (tonnes CO_2e)	**97,564**	**491,297**	**-**	**393,733**

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. The values provided in this section are the ones for the ex-ante estimation of the emissions reductions provided in this PDD.

Data / Parameter:	$Q_{ww,i,y}$
Data unit:	m^3/month
Description:	Volume of wastewater treated in the project treatment system during the year *y*
Source of data to be used:	Measured using wastewater flow meter Data recorded manually from log sheets shall be used for estimation of the emission reductions
Value of data applied for the purpose of calculating expected emission reductions in section B.5	1,080,000 m^3 per annum
Description of measurement methods and procedures to be applied:	The operator in charge takes the readings directly from the meter and records into the log sheets. The data from log sheets is transferred to excel sheet. Also the flow meter is integrated with Supervisory Control And Data Acquisition system (SCADA). The accuracy of the measuring equipment as per manufacturer's specification is ±0.5%[61].

[60] "Year" means a complete year starting from the start date of crediting period (for e.g. 'Year 2016' covers the period 1st June 2016 till 31st May 2017). The start date of crediting period is determined based on C.2.1.1.

[61] https://portal.endress.com/wa001/dla/50000000584/000/03/TI093DEN_1109.pdf

QA/QC procedures to be applied (if any):	The wastewater flow meter is calibrated at least once every three years in line with the manufacturer's recommendation[62] and the latest EB guidelines for small-scale project. http://cdm.unfccc.int/Reference/Guidclarif/ssc/methSSC_guid06.pdf This calibration is usually undertaken in off-season to ensure data accuracy and sufficiency in operation days.
Any comment:	The data will be stored for the crediting period + 2 years.

Data / Parameter:	$COD_{ww,untreated,\ y}$
Data unit:	$tCOD/m^3$
Description:	COD of the wastewater before entering the project system)
Source of data to be used:	Measured using colorimeter Data recorded manually from log sheets shall be used for estimation of the emission reductions
Value of data applied for the purpose of calculating expected emission reductions in section B.5	16.940
Description of measurement methods and procedures to be applied:	The COD content will be analyzed using a closed reflux colorimetric method in the on-site laboratory of the treatment plant. The results will be recorded in the log sheets on a daily basis. The proponent plans to do COD monitoring by taking three samples per shift (three shifts per day). The collected three-sample will be mixed together and analyzed in each shift. In case COD is measured using representative sampling, samples and measurements shall ensure a 90/10 confidence precision level. The accuracy of the measuring equipment as per manufacturer's specification is ±0.24%[63].
QA/QC procedures to be applied (if any):	The colorimetric method is well documented and well accepted either by national or international standards. A standard solution is used for analysis, for which test certificates are available. The equipment shall be sent for preventive maintenance and check at least once a year in line with manufacturer's recommendation[64].
Any comment:	The data will be stored for the crediting period + 2 years.

Data / Parameter:	$COD_{ww,treated,y}$
Data unit:	$tCOD/m^3$
Description:	COD of wastewater after the treatment system (UASB) of the project activity equipped with biogas recovery in the year *y*
Source of data to be used:	Measured using colorimeter Data recorded manually from log sheets shall be used for estimation of

[62] Document is available

[63] Document is available. The accuracy in the specifications of the equipment is mentioned in nm of wavelength. Therefore, the accuracy used is estimated from a wavelength accuracy of ±1 nm and the lowest value of wavelength range (for Model DR/890) of 420 nm.

[64] Document is available.

	the emission reductions
Value of data applied for the purpose of calculating expected emission reductions in section B.5	847
Description of measurement methods and procedures to be applied:	The COD content will be analyzed using a closed reflux colorimetric method in the on-site laboratory of the treatment plant. The results will be recorded in the log sheets on a daily basis. The proponent plans to do COD monitoring by taking three samples per shift (three shifts per day). The collected three-sample will be mixed together and analyzed in each shift. In case COD is measured using representative sampling, samples and measurements shall ensure a 90/10 confidence precision level The accuracy of the measuring equipment as per manufacturer's specification is ±0.24%[65].
QA/QC procedures to be applied:	The colorimetric method is well documented and well accepted either by national or international standards. A standard solution is used for analysis, for which test certificates are available. The equipment shall be sent for preventive maintenance and check at least once a year in line with manufacturer specifications.
Any comment:	The data will be stored for the crediting period + 2 years.

Data / Parameter:	$S_{final,PJ,y}$
Data unit:	t (tonnes)
Description:	Amount of dry matter in final sludge generated by the project wastewater treatment in the year y
Source of data to be used:	Plant record - measurement of total quantity of sludge on a wet basis. The volume (m^3) and density or direct weighing may be used to determine the sludge amount (wet basis).
Value of data applied for the purpose of calculating expected emission reductions in section B.5	0 – initial assumption
Description of measurement methods and procedures to be applied:	All the sludge if transported out of the project site shall be monitored for quantity and end use. Project proponent plans to use all the sludge for soil application in the plant premises. The weighbridge is used for all the sludge transported outside project premises. Representative samples are taken to determine the moisture content to calculate the total sludge amount on dry basis to ensure a 90/10 confidence level. The accuracy of the measuring equipment as per manufacturer's specification is ±0.02%[66]

[65] Document is available. The accuracy in the specifications of the equipment is mentioned in nm of wavelength. Therefore, the accuracy used is estimated from a wavelength accuracy of ±1 nm and the lowest value of wavelength range (for Model DR/890) of 420 nm.

[66] Document is available

QA/QC procedures to be applied:	The measurement equipment shall be calibrated once in two years[67]. The same equipment as for tapioca procuring shall be used for monitoring the amount of sludge transported to soil application site.
Any comment:	The data will be stored for the crediting period + 2 years.

Data / Parameter:	$Q_{biogas,gas\ engine,y}$
Data unit:	Nm^3 in year *y*
Description:	Quantity of biogas combusted in gas engine
Source of data to be used:	Measured using biogas flow meter. Data recorded manually from log sheets shall be used for estimation of the emission reductions
Value of data applied for the purpose of calculating expected emission reductions in section B.5	3,128,553 – ex-ante estimate
Description of measurement methods and procedures to be applied:	The operator in charge takes the readings directly from the meter and records into the log sheets. The data from log sheet is transferred to excel sheet. Also the flow meter is integrated with Supervisory Control And Data Acquisition system (SCADA). The accuracy of the measuring equipment as per manufacturer's specification is ±1% of reading[68].
QA/QC procedures to be applied:	The gas flow meter is calibrated at least once every three years in line with the manufacturer recommendation[69] and the latest EB guidelines for small-scale project. http://cdm.unfccc.int/Reference/Guidclarif/ssc/methSSC_guid06.pdf. This calibration is usually undertaken in off-season to ensure data accuracy and sufficiency in operation days.
Any comment:	The data will be stored for the crediting period + 2 years. The employed biogas flow meter measures flow, pressure and temperature and displays or outputs the normalised flow of biogas (in Nm^3), hence there is no need for separate monitoring of pressure and temperature of the biogas.

Data / Parameter:	$Q_{biogas,boiler,y}$
Data unit:	Nm^3 in year *y*
Description:	Quantity of biogas combusted in thermal boiler
Source of data to be used:	Measured using biogas flow meter. Data recorded manually from log sheets shall be used for estimation of the emission reductions.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	3,441,408 – for ex-ante estimate

[67] Document is available

[68] https://portal.endress.com/wa001/dla/50000092467/000/02/TI069DEN_0610.pdf

[69] Document is available.

Description of measurement methods and procedures to be applied:	The operator in charge takes the readings directly from the meter and recorded into the log sheets. The data from log sheet is transferred to excel sheet. Also the flow meter is integrated with Supervisory Control And Data Acquisition system (SCADA). The accuracy of the measuring equipment as per manufacturer's specification is ±1% of reading[70].
QA/QC procedures to be applied:	The gas flow meter is calibrated at least once every three years in line with the manufacturer recommendation[71] and the latest EB guidelines for small-scale project. http://cdm.unfccc.int/Reference/Guidclarif/ssc/methSSC_guid06.pdf. This calibration is usually undertaken in off-season to ensure data accuracy and sufficiency in operation days.
Any comment:	The data will be stored for the crediting period + 2 years. The employed biogas flow meter measures flow, pressure and temperature and displays or outputs the normalised flow of biogas (in Nm^3), hence there is no need for separate monitoring of pressure and temperature of the biogas.

Data / Parameter:	$Q_{biogas, flared, y}$
Data unit:	Nm^3 in year *y*
Description:	Total quantity of biogas flared
Source of data to be used:	Measured using biogas flow meter. Data recorded manually from log sheets shall be used for estimation of the emission reductions
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:	According to the measurement of total quantity of biogas flared ($Q_{biogas, flared, y}$), the operator in charge takes the readings directly from the meter and records into the log sheets. The data from log sheet is transferred to excel sheet. The biogas flow meter installed is integrated with Supervisory Control And Data Acquisition system (SCADA) to enable automated logging of hourly gas flow readings for $FV_{RG,h}$. If the automatic system is not available, the manual log sheets shall be used to record the hourly flow rate of biogas sent to flare system. The accuracy of the measuring equipment as per manufacturer's specification is ±1% of reading[72].
QA/QC procedures to be applied:	The gas flow meter is calibrated at least once every three years in line with the manufacturer's recommendation[73] and the latest EB guidelines

[70] https://portal.endress.com/wa001/dla/50000092467/000/02/TI069DEN_0610.pdf

[71] Document is available.

[72] https://portal.endress.com/wa001/dla/50000092467/000/02/TI069DEN_0610.pdf

[73] Document is available.

	for small-scale project. http://cdm.unfccc.int/Reference/Guidclarif/ssc/methSSC_guid06.pdf. This calibration is usually undertaken in off season to ensure data accuracy and sufficiency in operation days.
Any comment:	Please note that the same flow meter is used for measurement of $Q_{biogas, flared, y}$ and $FV_{RG,h}$. The data will be stored for the crediting period + 2 years. The employed biogas flow meter measures flow, pressure and temperature and displays or outputs the normalised flow of biogas (in Nm3), hence there is no need for separate monitoring of pressure and temperature of the biogas.

Data / Parameter:	$EG_{BL,y}$
Data unit:	MWh
Description:	The quantity of net electricity exported to the grid by the project activity during the year *y*
Source of data to be used:	Measured using electricity meter owned government institution (PEA meter). Data recorded manually from monthly report shall be used for estimation of the emission reductions.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	8,432 MWh– for ex-ante estimation of emission reductions.
Description of measurement methods and procedures to be applied:	Actual meter readings shall be used for ex-post monitoring; Monthly monitoring of the power meter is done. This can be verified from the reports issued by PEA (provincial electricity authority). The accuracy of the measuring equipment as per manufacturer's specification is ±0.2%.
QA/QC procedures to be applied:	A national level authority maintains the meter and monthly invoices shall be used to get the amount of power supplied to grid. The meter shall be calibrated once a year as per the authority's requirement[74].
Any comment:	The data will be stored for the crediting period + 2 years.

Data / Parameter:	$EC_{PJ,j,y}$
Data unit:	MWh
Description:	Quantity of grid electricity consumed by the project activity during the year y
Source of data to be used:	Monthly report - measured using electricity meter owned government institution (PEA meter). Data recorded manually from monthly report shall be used for estimation of the emission reductions.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	2,509 – ex-ante estimate

[74] Document is available.

Description of measurement methods and procedures to be applied:	Actual meter readings shall be used for ex-post monitoring; The meter supplies the grid power to all the equipment in wastewater treatment plant and in power generation unit. This can be verified from the reports issued by PEA (provincial electricity authority). The accuracy of the measuring equipment as per manufacturer's specification is ±0.2%.
QA/QC procedures to be applied:	A national level authority maintains the meter and monthly invoices shall be used to get the amount of power used. The meter shall be calibrated once a year as per the authority's requirement[75].
Any comment:	The data will be stored for the crediting period + 2 years.

Data / Parameter:	**$EG_{thermal}$**
Data unit:	TJ
Description:	The net quantity of steam/heat supplied by the project activity during the year y
Source of data to be used:	Calculated based on T_{in}, T_{out} and $Q_{oil,y}$
Value of data applied for the purpose of calculating expected emission reductions in section B.5	80 TJ – ex-ante estimated based on biogas consumption
Description of measurement methods and procedures to be applied:	Calculated
QA/QC procedures to be applied:	NA
Any comment:	The data will be stored for the crediting period + 2 years.

Data / Parameter:	T_{out}
Data unit:	Deg C
Description:	Temperature of thermic fluid leaving the boiler for starch drying.
Source of data to be used:	Starch plant's operation record - measured using temperature gauge Data recorded manually from starch plant's operation record shall be used for estimation of the emission reductions.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	-
Description of measurement methods and procedures to be applied:	Temperature gauge shall be used to monitor the temperature of the thermic fluid. The accuracy of the measuring equipment as per manufacturer's specification is ±0.05%[76].
QA/QC procedures to be applied:	The temperature gauge shall be calibrated at least once every year.
Any comment:	The data will be stored for the crediting period + 2 years.

[75] Document is available.

[76] Document is available.

Data / Parameter:	T_{in}
Data unit:	Deg C
Description:	Temperature of thermic fluid entering the boiler for starch drying.
Source of data to be used:	Starch plant's operation record - measured using temperature gauge Data recorded manually from starch plant's operation record shall be used for estimation of the emission reductions.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	-
Description of measurement methods and procedures to be applied:	Temperature gauge shall be used to monitor the temperature of fluid going back into boiler. The accuracy of the measuring equipment as per manufacturer's specification is ±0.05%[77].
QA/QC procedures to be applied:	The temperature gauge shall be calibrated at least once every year.
Any comment:	The data will be stored for the crediting period + 2 years.

Data / Parameter:	$Q_{oil, y}$
Data unit:	m^3
Description:	Quantity of the thermic fluid from boiler to the process plant.
Source of data to be used:	Starch plant's operation record - measured using flow meter for thermic fluid oil. Data recorded manually from starch plant's operation record shall be used for estimation of the emission reductions
Value of data applied for the purpose of calculating expected emission reductions in section B.5	-
Description of measurement methods and procedures to be applied:	The parameter will be measured continuously using flow meter. The data will be recorded hourly and aggregated daily. The accuracy of the measuring equipment as per manufacturer's specification shall be included after the installation of the equipment.
QA/QC procedures to be applied:	The flow meter shall be subject to regular calibration as per manufacturer's recommendation.
Any comment:	The data will be stored for the crediting period + 2 years.

Data / Parameter:	$FV_{RG,h}$
Data unit:	Nm^3/h
Description:	Volumetric flow rate of the residual gas on dry basis at normal conditions in the hour *h*
Source of data to be used:	Measured using biogas flow meter The automated logging shall be used for estimation of the emission reductions. In case there is no availability of automated logging, data recorded manually from log sheets shall be used instead.
Value of data applied for the	0 – for ex-ante estimation

[77] Document is available.

purpose of calculating expected emission reductions in section B.5	
Description of measurement methods and procedures to be applied:	This parameter is the same as $Q_{biogas, flared, y}$, therefore further details of measurement procedures shall be referred to as per description provided for $Q_{biogas, flared, y}$.
QA/QC procedures to be applied:	The gas flow meter is calibrated in line with the manufacturer's recommendation[78] and the latest EB guidelines for small-scale project. http://cdm.unfccc.int/Reference/Guidclarif/ssc/methSSC_guid06.pdf. This calibration is usually undertaken in off season to ensure data accuracy and sufficiency in operation days.
Any comment:	Please note that the same flow meter is used for measurement of $Q_{biogas, flared, y}$ and $FV_{RG,h}$. The data will be stored for the crediting period + 2 years.

Data / Parameter:	$fv_{CH4,RG,h}$ / $w_{CH4,y}$
Data unit:	-(fraction)
Description:	Volumetric fraction of component *methane* in the residual gas in the hour h
Source of data to be used:	Measured using a continuous gas analyser. This analyser shall be used for measurement of $fv_{CH4,RG,h}$ and $w_{CH4,y}$, which represent the same parameter with different denominations as per flaring tool and AMS.III.H. The automated logging shall be used for estimation of the emission reductions. In case there is no availability of automated logging, data recorded manually from log sheets shall be used instead.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	65% - for ex-ante estimation.
Description of measurement methods and procedures to be applied:	The parameter is measured by using the continuous gas analyser integrated with Supervisory Control And Data Acquisition system (SCADA). In case the continuous gas analyser is not available (or functioning), a portable gas analyser shall be used to monitor the methane content. The data shall be recorded into log sheets. The measurement using portable gas analyser will ensure 90/10 confidence/precision level. The accuracy of the measuring equipment as per manufacturer's specification is ±1%.
QA/QC procedures to be applied:	The gas analyser will be periodically calibrated at least once a year.
Any comment:	The data will be stored for the crediting period + 2 years.

Parameter:	T_{flare}
Unit:	°C
Description:	Temperature in the exhaust gas of the flare
Source of data:	Measured used thermocouple type N

[78] Document is available.

Value of data:	-
Brief description of measurement methods and procedures to be applied:	The flame temperature will be continuously measured using a Thermocouple integrated with Supervisory Control And Data Acquisition system (SCADA). This enables automated logging of temperature readings. The accuracy of the measuring equipment as per manufacturer's specification.
QA/QC procedures to be applied (if any):	Thermocouple will be subjected to calibration at least once a year.
Any comment:	The data will be stored for the crediting period + 2 years.

Data / Parameter:	$\eta_{flare-h}$
Data unit:	%
Description:	Flare efficiency
Source of data used:	Default value - Tool to determine project emissions from flaring gases containing methane
Value applied:	90% - Default value for ex-ante estimation
Brief description of measurement methods and procedures to be applied:	Default flare efficiency for enclosed flare is used as per step 6 "determination of the hourly flare efficiency" of the flaring tool: • 0% if the temperature in the exhaust gas of the flare (T_{flare}) is below 500°C for more than 20 minutes during the hour h. • 50%, if the temperature in the exhaust gas of the flare (T_{flare}) is above 500 °C for more than 40 minutes during the hour h, but the manufacturer's specifications on proper operation of the flare are not met at any point in time during the hour h. • 90%, if the temperature in the exhaust gas of the flare (T_{flare}) is above 500 °C for more than 40 minutes during the hour h and the manufacturer's specifications on proper operation of the flare are met continuously during the hour h. Other flare specific parameters, which might be required to monitor whether the flare operates within the specified range of operating conditions shall be monitored according to the manufacturer's specifications.
QA/QC procedures to be applied (if any):	Maintenance of the flare system shall be conducted periodically as per supplier's specifications to ensure optimal operation.
Any comment:	According to the manufacturer specifications of the flare there are no additional monitoring parameters required to monitor whether the flare operates within the specified range of operating conditions.

Data / Parameter:	$FC_{k,y}$
Data unit:	m^3/year
Description:	Quantity of fossil fuel type k combusted in the thermal oil boiler, where type k is heavy fuel oil
Source of data to be used:	Starch plant's operation record - measured using flow meter Data recorded manually from starch plant's operation record shall be used for estimation of the emission reductions.

Value of data applied for the purpose of calculating expected emission reductions in section B.5	0 – (fuel oil) for ex-ante estimation
Description of measurement methods and procedures to be applied:	The amount of fuel used in the boiler will be monitored using a flow meter. The records will be recorded when fossil fuel is used in the project activity. Default density value as given in section B.6.2 will be used to convert m^3 in to tonne. The accuracy of the measuring equipment as per manufacturer's specification is ±1%[79].
QA/QC procedures to be applied:	The measured value during monitoring period can be crosschecked with the purchase records. The flow meter will be calibrated as per manufacturer's specification or at least once a year.
Any comment:	The data will be stored for the crediting period + 2 years.

B.7.2 Description of the monitoring plan:

1. Monitoring Management

The required monitoring equipment is installed in consultation with the equipment supplier under supervision of the relevant department. Flow meters are regularly calibrated either using a master calibrator or from a third party.

The monitoring system is based on meter readings recorded directly at the meter location and regular records of data measured in the laboratory at the project site.

The log sheets are prepared as follows:

- The plant manager checks the data on regular basis, recording the readings on log sheets. The readings are then inserted in an excel file.
- Since the totalizer readings are reported in log sheets; any doubtful readings can be crosschecked against the running total of the meter. This ensures a high level of accuracy.

The plant is operated by trained operators who also collect data under the supervision of the Plant Manager who is responsible for overall monitoring requirements and shall assign the responsibilities for different tasks.

2. Quality Assurance and Quality Control

The head of the biogas plant will monitor the overall biogas plant's performance, ensuring proper and timely calibration (in accordance with the manufacturer specifications) of systems, data acquisition and storage. Either erroneous data or uncertainties found in measurement of the monitoring devices for the biogas plant (i.e. flow rate, methane analyzer, etc.) are included in the quality assurance and quality control procedures for individual monitoring parameters as per Section B.7.1.

3. Data Storage and Filing

[79] http://www.zimsen.dk/_upload/5_1162165299_vzo15.pdf

The daily manual log sheets are stored at the plant site, and data is transferred to excel sheet on regular basis. Regular back up is ensured for the stored data. The monitoring records shall be archived for a period of crediting period + 2 years.

4. Emergency preparedness

The project activity is not expected to result in any emergency that can result in substantial emissions.

However, leakages, if any, in the piping or digester shall come to the attention of the plant operator either instantly on the control screen, or at the time of data logging. The team shall take necessary action to stop any such leakage etc. and put plant operation back on track.

Unexpected emergency situations might affect the completeness or accuracy of monitored data. Apart from general provisions described under point 3 above and point 5 below, the operator shall also take measures to avoid data loss and inaccuracies under such circumstances. Following an emergency situation, the staff responsible for operation and monitoring of the plant shall be made aware of any event from the previous day or previous shift and plan to promptly rectify the situation. In case of problems with any equipment or machines, immediate action shall be taken to restore regular operation of such affected devices.

5. Uncertainty in data

Some uncertainties may result due to malfunction of meters, calibration issues and wrong data collection (gaps in manual log sheets, human errors by plant operators). The operator is expected to put best efforts to prevent such errors, however regular internal audits shall rectify any such uncertainty in the monitored data.

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

Date of completion of baseline study and monitoring methodology: 30/06/2011

Name of the responsible person(s)/ entity(ies)
Patrick Bürgi
South Pole Carbon Asset Management Ltd.
Technoparkstrasse 1
CH-8005 Zurich
Switzerland

SECTION C. Duration of the project activity / crediting period

C.1 Duration of the project activity:

C.1.1. Starting date of the project activity:

17/05/2008 – Contract with technology provider for the biogas system

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

15 years 00 months

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

The project chooses to use a renewable crediting period.

C.2.1. Renewable crediting period

The length of each crediting period will be 7 years and may be renewed at most twice.

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

01/06/2012 or the date of CDM registration whichever is later.

C.2.1.2. Length of the first crediting period:

7 years 00 months

C.2.2. Fixed crediting period:

C.2.2.1. Starting date:

Not applicable.

C.2.2.2. Length:

Not applicable.

SECTION D. Environmental impacts

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

The proposed Project is not required to undertake an Environmental Impact Assessment according to the Thailand regulations (http://www.onep.go.th/eia/). Initial Environmental Evaluation (IEE) shall be done as part of the requirement of the Thai DNA[80]. The IEE report must be approved in relation to Thai sustainable development criteria for CDM. This process ensures that a project with a negative impact to the environment is considered in parallel with GHG reductions of the project.

[80] Outline of CDM project approval process. Thailand Greenhouse Gas Management Organization (Public Organization). Source: http://www.tgo.or.th/english/index.php?option=com_content&task=view&id=60&Itemid=52

The preventive and mitigation measures to the environmental impact shall be prepared. The IEE report will also recommend monitoring measures of pollutants other than the greenhouse gases covered under the Kyoto Protocol (CO, NO_2, PM, etc). All the recommendations from the IEE report will be adopted by the project developer.

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:

No relevant negative environmental effects are expected from the implementation of the project activity.

SECTION E. Stakeholders' comments

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

Procedure followed to invite stakeholder comments

Public hearing for local stakeholders:

Invitation procedure
The Local Stakeholder Consultation has been conducted by Eiam Rung-Ruang Renewable Co.,Ltd with assistance from South Pole Carbon Asset Management Limited (representative of Swiss Carbon Assets Ltd., Switzerland based company responsible for CDM project development) and Papop Co.,Ltd, technology provider for the wastewater treatment system.

Stakeholder groups were identified and informed through oral and written means about the meeting. The invitation letter was sent by fax to participants located far from the project site, in person to participants without access to a fax and there was also an announcement of the meeting posted at the community hall for people who had not received an invitation letter. This invitation process was done almost two weeks before the meeting date.

The persons or organizations invited were as follows:
Local people impacted by the project or official representatives

- Villager in Moo 1
- Villager in Moo 2
- Villager in Moo 5
- Villager in Moo 6
- Villager in Moo 9
- Subdistrict headman of Ban Mai
- Village headman Moo 1 of Nonghuarat
- Village headman Moo 1 of Ban Mai
- Assistant Village headman Moo 1
- Assistant Village headman Moo 9
- Community leader
- Village Fund
- Village Health Volunteer

Local policy makers and representatives of local authorities

- Ban Mai Subdistrict Administrative Organization (Ban Mai SAO)
- North Eastern Tapioca Trade Association (NETTA)
- Nakhon Ratchasima Provincial Public Health Office
- Nakhon Ratchasima Provincial Agriculture Extension Office
- Nakhon Ratchasima Provincial Administrative Office
- Nakhon Ratchasima Provincial Industrial Office
- Nakhon Ratchasima Provincial Office of Natural Resources and Environment

Designated National Authority

- Thailand Greenhouse Gas Management Organization-TGO

Local non-governmental organisations working on topics relevant to the project

- Greenleaf Foundation
- Energy of Environment Foundation
- The Energy Conservation Foundation of Thailand
- Thailand Environment Institute
- WWF Greater Mekong Programme, Thailand Country Office
- Greenpeace Southeast Asia (Thailand Office)

The local Gold Standard expert who is located closet to the project location

- South East Asia Regional Manager

Relevant international NGOs supporting GS, with a representation in your region and ALL GS supporter NGOs located in the host country of the project

- HELIO International
- Mercy Corps
- REEEP
- WWF International
- Appropriate Technology Association (ATA)
- Dhammanart Foundation
- Renewable Energy Institute of Thailand, REIT

Place and date of the meeting

The local stakeholder consultation was held at the meeting room of Eiam Rungruang Industry Co.,Ltd, 129 Nonghuarat Sub District, Nongbunmak District, Nakhornratsima province, 30410, Thailand on June 8, 2011.

Meeting Participants

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

1. Local people impacted by the project or official representatives
2. Local policy makers and representatives of local authorities
3. The local Gold Standard expert who is located closet to the project location

Language
The documentation and meeting were in Thai which is the local language.

Meetings procedure

- Registration (30 min)
- Opening (10 min)
- Introduction of the Eiam Rung-Ruang Renewable Co.,Ltd (30 min)
- Introduction of the wastewater treatment system and biogas utilization (30 min)
- Description of CDM and environmental impacts (30 min)
- Questions and Answers session and completing questionnaire (40 min)
- Closing (10 min)

Meeting documents and protocols
On completion of the various components of the meeting, the following documents were collected and attested by the information of the stakeholders that were present at the time:

1. Presence list with name, address and occupation.
2. Sustainable Development Questionnaire.

These documents are available as hardcopies.

E.2. Summary of the comments received:

The overall response to the Project, from all invited stakeholders, was encouraging and positive. There were two representatives who are a Chief Executive of the Subdistrict Administrative Organization and a skilled teacher provided comments related to the environmental impact of odour from the implementation of the Project and the employment. Both comments were clarified during the meeting. The greatest asset for the project will be positive effect on the environment. Stakeholders acknowledge that the improvement of wastewater treatment technology will reduce odours released to the surrounding area. This Project is viewed as a positive environmental plan that is important for local water resources and the community's quality of life.

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 water and reduced odours.
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 Project.
4. The Project is well designed and not producing additional pollution.
5. The Project will create new jobs at the plant.

In all, no adverse reaction/comments/clarifications have been received during the Initial Stakeholder Consultation process. The participants of the meetings have not raised any significant concerns related to potential impacts of the Project.

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 were not raised.

It is evident from the stakeholder consultation process, that the Project is perceived as a positive example for the tapioca starch factories in Thailand, and that it contributes to sustainable development in the region.

Annex 1

CONTACT INFORMATION ON PARTICIPANTS IN THE PROJECT ACTIVITY

Organization:	Eiam Rung-Rueng Renewable Co.,Ltd
Street/P.O.Box:	129 Moo 1 Nonghuarat
Building:	
City:	Nakhonratsima
State/Region:	
Postfix/ZIP:	
Country:	Thailand
Telephone:	+66 44 490 232
FAX:	+66 44 490 223
E-Mail:	ngorbi@msn.com
URL:	
Represented by:	
Title:	Mr.
Salutation:	
Last Name:	Satthakun
Middle Name:	
First Name:	Prasong
Department:	Managing Director
Mobile:	
Direct FAX:	
Direct tel:	
Personal E-Mail:	

Organization:	Swiss Carbon Assets Ltd.
Street/P.O.Box:	Technoparkstrasse 1
Building:	
City:	Zurich
State/Region:	
Postfix/ZIP:	8005
Country:	Switzerland
Telephone:	+41 44 633 7870
FAX:	+41 44 633 1423
E-Mail:	
URL:	http://www.southpolecarbon.com/
Represented by:	Patrick Burgi
Title:	Director
Salutation:	Mr.
Last Name:	Burgi
Middle Name:	
First Name:	Patrick
Department:	
Mobile:	
Direct FAX:	
Direct tel:	
Personal E-Mail:	p.buergi@southpolecarbon.com

Annex 2

INFORMATION REGARDING PUBLIC FUNDING

No public funds have been utilized in the project activity.

Annex 3

BASELINE INFORMATION

Grid emission factory
The emission factor of the Thai national grid has been taken from the data made available by the TGO (Thailand DNA)[81] on 29th June 2011. The data was available at the time of first submission of the PDD to the DOE for validation. The TGO refers to version 02 of the "Tool to calculate the emission factor for an electricity system" but the current version of the tool is 2.2.1. The value obtained by using the current version of the tool is also the same as given in the table below.

CDM project type	Emission Factor (tCO_2/MWh)		
	$EF_{grid,OM}$	$EF_{grid,BM}$	$EF_{grid,CM}$
General project	0.6147	0.5477	0.5812
Wind and solar power generation project	0.6147	0.5477	0.5980

COD campaign for the baseline wastewater system:

Sampling date	CODin (mg/l)	CODout (mg/l)	% CODremoval
1/11/2010	16,740.00	304.00	98.18%
2/11/2010	15,782.00	298.00	98.11%
3/11/2010	16,670.00	301.00	98.19%
4/11/2010	17,546.00	315.00	98.20%
5/11/2010	17,530.00	342.00	98.05%
6/11/2010	17,265.00	367.00	97.87%
7/11/2010	16,804.00	402.00	97.61%
8/11/2010	14,844.00	408.00	97.25%
9/11/2010	18,570.00	287.00	98.45%
10/11/2010	17,653.00	246.00	98.61%
Average	**16940.40**	**327.00**	**98.05%**
Uncertainity factor			0.89
CODremoved_BL			**87.27%**

The above measurement was conducted by Papop Co. Ltd. The samples were taken in 250 ml plastic bottle with Sulfuric acid as preservative.

[81] http://www.tgo.or.th/index.php?option=com_content&view=article&id=122:thailand-grid-emission-2009-report&catid=62:tgo-research&Itemid=29

Historical production data for the starch factory

Month	Starch Production (ton)
Nov - 09	1,591
Dec - 09	4,884
Jan - 10	5,397
Feb - 10	7,078
Mar - 10	6,987
Apr - 10	3,133
May - 10	3,447
Jun - 10	0
Jul - 10	0
Aug - 10	0
Sep - 10	0
Oct - 10	3,903
Nov - 10	4,809
Dec - 10	7,863
Jan - 11	6,346
Feb - 11	7,458
Mar - 11	8,232
Apr - 11	4,839
Total	**69,491**

- - - - -

Annex 4

MONITORING INFORMATION

Detailed monitoring plant and information is provided in section B.7.1 and B.7.2.

- - - - -