Project design document form for CDM project activities

(Version 06.0)

Complete this form in accordance with the Attachment "Instructions for filling out the project design document form for CDM project activities" at the end of this form.

PROJECT DESIGN DOCUMENT (PDD)
Title of the project activity: Papop Biogas and Renewable Energy Project in Thailand
Version number of the PDD: 01
Completion date of the PDD: 29/11/2016
Project participant(s): Papop Renewable Company Limited Swiss Carbon Value Limited
Host Party: Thailand
Sectoral scope and selected methodology(ies), and where applicable, selected standardized baseline(s): Sectoral scope: 13 ACM0014: Mitigation of greenhouse gas emissions from treatment of industrial wastewater – Version 06
Estimated amount of annual average GHG emission reductions: 113,835 tCO2e/year

SECTION A. Description of project activity

A.1. Purpose and general description of project activity

The proposed Papop Biogas Project ("the proposed project activity") involves the installation of a new Upflow Anaerobic Sludge Blanket ("UASB") for wastewater treatment and biogas recovery at the Thai San Miguel Liquor ("TSML") distillery ("TSML distillery") located in Amphor Tha Muang, Kanchanaburi Province, Thailand. The proposed project activity is being implemented by the Papop Renewable Company Limited ("Papop") as a builder, operator, transfer scheme, which will be handed over to TSML after a period of 9 years.

The TSML distillery produces alcohol spirits and as a part of the production process generates large amounts of wastewater, which has high organic matter content. Currently, wastewater is treated in an anaerobic lagoon and the anaerobic conditions lead to the production of biogas that is released directly to the atmosphere. The biogas produced contains methane, which when released to the atmosphere is a direct source of greenhouse gas ("GHG") emissions. The TSML distillery currently operates two fossil fuel boilers for heat production. The combustion of fuel oil results in the production of carbon dioxide, which is also a direct source of GHG emissions.

The purpose of the proposed project activity is to use the biogas generated by the UASB for heat generation in the TSML boilers and for electricity generation in a newly installed engine. The electricity generated will be exported to the Thai national electricity grid. The proposed project activity will result in emission reductions from the avoidance of methane emissions from the anaerobic open lagoon, the avoidance of carbon dioxide emissions from the combustion of fuel oil in the TSML boiler and from the displacement of grid sourced electricity which includes fossil fuel based electricity generation. The estimated emission reductions are 113,835 tonnes of CO_2e per year.

Contribution of the proposed project activity to sustainable development
The proposed project activity will deliver sustainable development benefits and has been assessed in line with criteria for CDM projects by the Thai Designated National Authority (DNA)[1].

1. National Resources and Environmental Dimension

- The project activity reduces GHG emissions through the avoidance of methane emissions from the existing open lagoon;
- The project activity reduces GHG emissions through the avoidance of carbon dioxide emission from the combustion of fuel oil in the TSML boiler
- The project activity reduces air pollutant emissions such as oxides of nitrogen, oxides of sulphur, carbon monoxide and particulates, through the reduction in the combustion of fossil fuels.
- The project activity reduces the carbon intensity of the Thai national grid by reducing the emission of GHGs on a per MWh basis across the entire system;
- The project activity reduces the consumption of non-renewable natural resources (through replacing fossil fuel sourced grid electricity).

2. Social Dimension

During construction, the proposed project activity is expected to employ around 120 temporary workers. The proposed project activity is expected to employ at least 9 people for operating the biogas plant. The workforce will be trained to operate the UASB plant, resulting in an improvement in the skills and technical knowledge of plant operators.

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[1] http://www.tgo.or.th/english/index.php?option=com_content&view=article&id=24:sustainable-development-criteria&catid=27:approval-process&Itemid=45

3. Development/Transfer of Technology

The proposed project activity requires the use of both imported and Thai technology, which provides an opportunity to promote and disseminate the successful application and integration of technologies for replication across Thailand.

4. Economic Dimension

- The project activity leads to the utilization of renewable energy and contributes thereby to energy security and savings in expenditure on imported fuel.
- The project activity increases the employment opportunities for the local people by setting up an industrial unit in the area. This will directly promote other income generation sources like local suppliers, manufacturers, small shop owners etc.
- The project activity contributed to the employment of local people both in the skilled and semi-skilled category during the construction phase.

In light of the information above, the project activity strongly contributes to sustainable development. The proposed project activity is implemented purely on a voluntary basis. There is no regulation that requires implementing such a project.

A.2. Location of project activity

A.2.1. Host Party

Thailand

A.2.2. Region/State/Province etc.

Kanchanaburi Province

A.2.3. City/Town/Community etc.

Wangkhanai Subdistrict, Thamuang District

A.2.4. Physical/Geographical location

The proposed project activity is located within the TSML distillery at 60/9, Moo 1, Wangkhanai, Subdistrict, Thamuang District, Kanchanaburi Province, Thailand.

The geographical coordinates are 13°56’32.13" N latitude and 99°40’06.83" E longitude.

Figure 1: The location map of Kanchanaburi Province

Figure 2: Map showing the location of Project activity in Thamuang District

A.3. Technologies and/or measures

The technologies and measures to be employed and/or implemented by the project activity:
The project activity is implemented closed to the TSML factory in order to treat the wastewater generated by the distillery production process. The distillery factory has an installed capacity of about 75,000 Liter of liquor per day. The proposed project activity involves the installation of a UASB digester in between the exiting sump pit and anaerobic lagoons. The exact location is provided in section A.2.4.

Anaerobic treatment system
The UASB consists of concrete reinforced lagoons, which are covered with a biogas storage dome made from PVC sheeting. The UASB is a methanogenic digester, which uses an anaerobic process whilst forming a blanket of granular sludge, which is suspended in the tank. The wastewater will be entered to the UASB digester at the base of the system and will flow upwards through the blanket where it is degraded by anaerobic microorganisms contained in the sludge. With an average inlet COD of 179,937[2] mg/l and a COD removal efficiency of around 95%[3], the production of biogas is expected at 49,277 m3 per day (with the methane percentage being around 55%). The treated wastewater leaves the UASB digester at the top of the lagoon, and will flow into the exiting anaerobic lagoon (storage Pond 9), before being discharged to the existing evaporation ponds.

The biogas is produced as a by-product of the wastewater treatment in the UASB digester and captured in the biogas storage dome. The project activity utilizes the biogas for thermal and power

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[2] One-year historical data of TSML distillery factory

[3] Technology provider

generation purposes. The biogas will be passed through a biogas dryer before being combusted for thermal generation in the existing TSML distillery boilers. The thermal oil boiler is designed with a capacity of 16 TPH.

The remaining biogas will be used for electricity generation in two gas engines. The capacity of each engine is 952kWe. The biogas will be first treated to reduce the sulphur content by the H_2S cleaning system (Bio-Scrubber) with biogas capacity of 23,000m3/day. In the case of emergencies or surplus, biogas will be flared by enclosed flaring system having a capacity of 1,000 Nm3/hour at 30 mBar. The electricity generated by gas engines will be exported to Thai national grid under the Very Small Power Producer (VSPP) Scheme.

Figure 4 illustrates the proposed project activity of wastewater treatment and biogas utilization process. The project activity is expected to have a lifetime of 15 years, which is confirmed by the technology supplier.

Technology, measure and know-how transfer
The UASB system is supplied by Papop Co,Ltd., a local technology provider. The gas engine is manufactured by a Spanish manufacturer (Guascor). The bio-scrubber and the enclosed flare are manufactured by Thai companies. The bio-Scrubber is developed by Papop Renewable Company Limited. The enclosed flare is manufactured by BKE Combustion Control Limited. It presents that the project activity is leading to a significant transfer of technology from developed countries to Thailand. Furthermore, all the suppliers will provide necessary training for the operation and maintenance of the equipment in the project activity, which will further enhance the skill set of the local employees.

The technology existing prior to the implementation of the project activity:
The scenario existing prior to the project activity is identified as the baseline scenario later in section B.4 of the PDD. In the absence of project activity, the wastewater generated by the distillery process have been treated in the anaerobic open lagoon (pond no.1 and 2). The figure 3 shows the diagram of baseline boundary. The wastewater has a high organic loading with COD of 175,794 mg/l that is based on one-year historical data. The wastewater remained in the anaerobic lagoon for 117 days approximately, before being discharged to the evaporation ponds. The methane in biogas was emitted to the atmosphere. Prior to the implementation of project activity, the TSML distillery factory operated two boilers for thermal generation. The fossil fuel was consumed in the steam boiler system[4]. The electricity supplied to the national grid is largely based on fossil fuel based power plants[5].

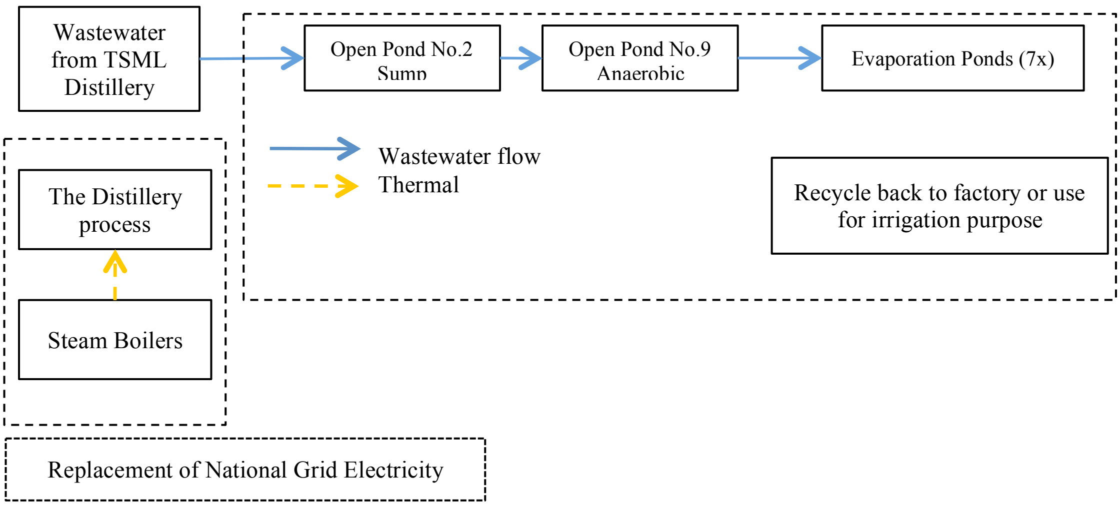

Figure 3: Baseline boundary

[4] Historical data of HFO consumption in the boiler system of TSML factory.
[5] http://prinfo.egat.co.th/report/annual_report/annual2009/annual2009eng/pdf/annual2009en_p86.pdf

A.4. Parties and project participants

Party involved (host) indicates host Party	Private and/or public entity(ies) project participants (as applicable)	Indicate if the Party involved wishes to be considered as project participant (Yes/No)
Thailand (host)	Papop Renewable Company Limited (Private entity)	No
Switzerland	Swiss Carbon Value Limited (Private entity)	No

A.5. Public funding of project activity

No public funding from Annex I countries has been sought for this project.

SECTION B. Application of selected approved baseline and monitoring methodology and standardized baseline

B.1. Reference of methodology and standardized baseline

The following methodology is applicable to the project activity:
ACM0014 “Treatment of wastewater”, version 06.0.0

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

- “Tool for the demonstration and assessment of additionality”, version 07;
- “Tool to calculate the emission factor for an electricity system”, version 03;
- ”Project and leakage emissions from anaerobic digesters”, version 01;
- “Tool to determine the baseline efficiency of thermal or electric energy generation systems”, version 01;
- “Tool to calculate project or leakage CO2 emissions from fossil fuel combustion”, version 02.

B.2. Applicability of methodology and standardized baseline

ACM0014 is applicable to the project activity that aims to reduce the methane emission from industrial wastewater treatment. The biogas captured is utilised for thermal and power generation purpose. The project activity is applicable to scenario 1 of ACM0014 whereas:

In the baseline scenario the effluents from the distillery factory is sent to the existing open lagoon system that have clearly anaerobic condition. The solid materials are not separated before directing the wastewater to the open lagoons. As part of the project activity, the anaerobic digester (UASB) is installed. There are no solid materials separated before directing wastewater to the UASB system. The biogas extracted from the anaerobic digester (UASB) is flared and used to generate heat and electricity. The sludge generated by the UASB will be used for land application under clearly aerobic conditions. The situation before and after the start of implementation of the project activity are presented as the diagrams of figure 3 and 4 respectively. The project activity fulfills the applicability criteria of methodology as shown in Table 1.

Table 1: Applicability Criteria

Type	Applicability criteria	Project status
For scenarios 1 and 2	(a) The average depth of the open lagoons or sludge pits in the baseline scenario is at least 1m.	In the baseline scenario, the wastewater from the distillery factory is treated in the open lagoons with depth greater than 2 meter[6] and without aeration. Therefore, the lagoons which was operated in the absence of the project activity satisfies the condition for anaerobic lagoons as mentioned in the methodology.
	(b) The residence time of the organic matter in the open lagoon or sludge pit system should be at least 30 days.	The residence time of the organic matter in the existing anaerobic lagoon is approximately 177 days in the baseline scenario. Therefore, the project satisfies the applicability of methodology.
	(c) Inclusion of solid materials in the project activity is only applicable where: (i) Such solid materials are generated by the industrial facility producing the wastewater; and (ii) The solid materials would be generated both in the project and in the baseline scenario;	The solid materials are not generated as a part of regular operation of the project activity. In case, the sludge is generated, it will be used for land application under aerobic condition.
	(d) The sludge produced during the implementation of the project activity is not stored onsite before land application to avoid any possible methane emissions from anaerobic degradation.	The sludge generated by the project activity is applied on the land application under clearly aerobic condition. It will not be stored onsite before being used. This is applicable to the methodology.

B.3. Project boundary

According to ACM0014, the spatial extent of the project boundary includes: (as shown in figure 4)

- The sump pit, anaerobic lagoons and evaporation ponds where wastewater is treated in both the project and baseline scenario;
- The land application where any sludge generated from the project activity is included in the project boundary;
- The Thai national grid, which supplies electricity for wastewater treatment and from which electricity is displaced by the electricity generated by the proposed project activity;
- The TSML boilers from which fuel oil is displaced by biogas captured by the project activity;
- The UASB digester, the biogas engines and the emergency flare installed under the proposed project activity

[6] Based on the as-built drawing no TS-WP-03

Table 2: Emission sources included and excluded from the project boundary

	Source	GHGs	Included?	Justification/Explanation
Baseline	Wastewater treatment processes	CH_4	Yes	Main source of emissions in the baseline from anaerobic open lagoons.
		N_2O	No	Excluded for simplification.
		CO_2	No	CO_2 emissions from the decomposition of organic waste are not accounted for.
	Electricity consumption / generation	CO_2	Yes	Electricity consumed for the operation of the wastewater treatment system in the baseline scenario (pumping wastewater to the open lagoons) is supplied from the grid. Electricity is generated with biogas from anaerobic digester under the proposed project activity and will displace electricity generation from the grid.
		CH_4	No	Excluded for simplification
		N_2O	No	Excluded for simplification
	Thermal energy generation	CO_2	Yes	The on-site thermal energy generation of distillery factory is displaced by the project activity. Thermal energy is generated by using biogas fuel from project activity.
		CH_4	No	Excluded for simplification
		N_2O	No	Excluded for simplification
Project Activity	Wastewater treatment processes or sludge treatment process	CH_4	Yes	This is a main source of emission. The wastewater treatment under the project will lead to the following emissions: (i) Methane emissions from the lagoons (ii) Physical leakage of methane from the digester system (iii) Methane emissions from flaring.
		CO_2	No	CO_2 emissions from the decomposition of organic waste are not accounted for
		N_2O	No	In case the sludge is generated by the project activity. The sludge will be applied on land under clearly aerobic condition. This is excluded for simplification. The emission source is assumed to be very small.
	On-site electricity use	CO_2	Yes	Electricity consumed for the operation of the project activity (UASB system and open lagoons) will be supplied from the grid.
		CH_4	No	Excluded for simplification
		N_2O	No	Excluded for simplification
	On-site fossil fuel consumption	CO_2	No	Excluded for simplification. The project activity does not use fossil fuels.
		CH_4	No	Excluded for simplification
		N_2O	No	Excluded for simplification

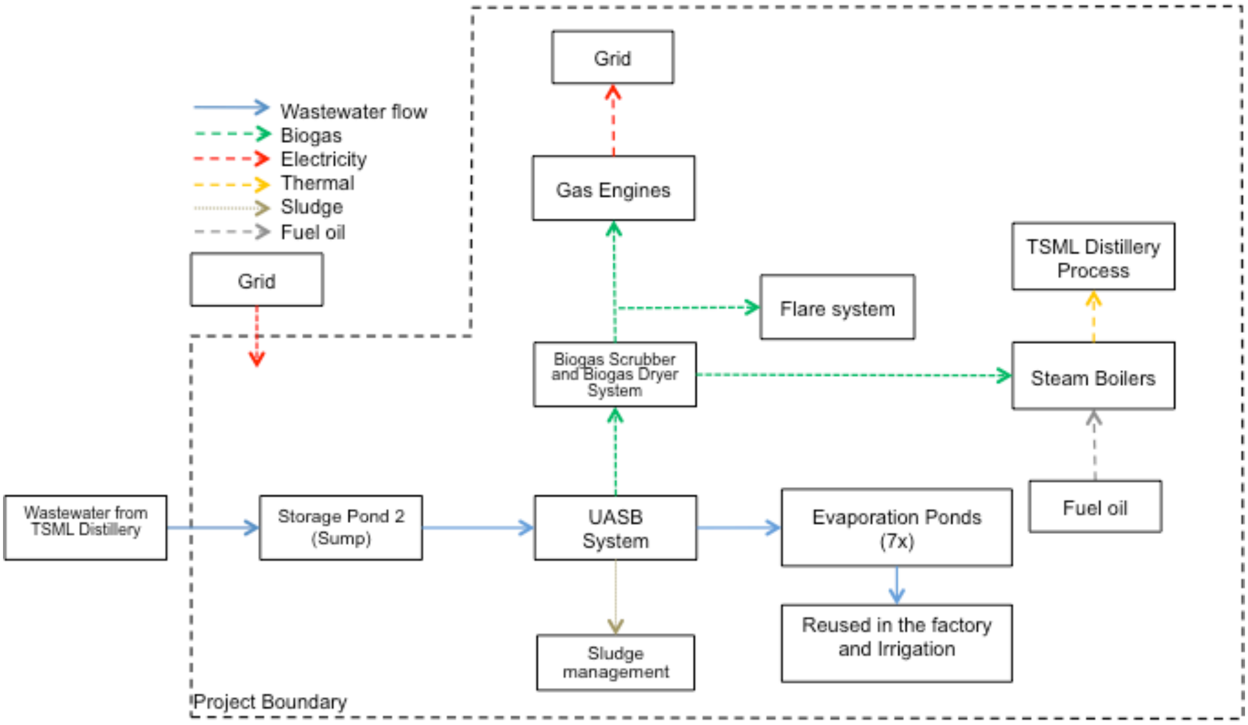

Figure 4: Project Boundary

B.4. Establishment and description of baseline scenario

ACM0014 (version 06.0.0) outlines the procedure for the identification of the most plausible baseline scenario through the application of the following steps:

Step 1: Identification of alternative scenarios

The project activity is applicable to scenario 1 of the project activity. The plausible alternative scenarios for the treatment of wastewater (W) for this project include:

- W1: The use of open lagoons for the treatment of the wastewater;
- W2: Direct release of wastewater to a nearby water body;
- W3: Aerobic wastewater treatment facilities (e.g. activated sludge or filter bed type treatment);
- W4: Anaerobic digester with methane recovery and flaring, including infiltration to the soil;
- W5: Anaerobic digester with methane recovery and utilization for electricity or heat generation;
- W6: Wastewater is directed to land application without dewatering;
- W7: Wastewater is dewatered and directed to land application/used as fuel in energy applications.
- W8: Wastewater is not treated.

The project activity is not applicable to scenario 2, the plausible alternative scenarios for the treatment of sludge (S1-S6) are not considered.

As the project activity involves the generation of electricity using biogas from UASB system, plausible alternative scenarios fro the generation of electricity have been determined. These include the following:

- E1: Power generation using fossil fuels in a captive power plant;
- E2: Electricity generation in the grid;
- E3: Electricity generation using renewable sources.

As the project activity involves heat generation with biogas from a new anaerobic digester, plausible alternative scenarios for the generation of heat should been determined. These include the following:

- H1: Co-generation of heat using fossil fuels in a captive cogeneration power plant;
- H2: Heat generation using fossil fuels in a boiler;
- H3: Heat generation using renewable sources.

In the baseline scenario, there is no sludge treatment in the baseline and project activity. In case the sludge is removed from UASB system, it will be applied on land under aerobic conditions. The sludge shall not be stored at the project site before land application.

The project activity does not involve generation of any solid materials, which need to be treated or disposed. Thereby, the plausible alternative scenarios for the treatment of solid materials (SM1-SM4) are not considered.

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

<u>*For wastewater treatment alternatives:*</u>
As per ACM0014, sub-step 1b from the “Tool for the demonstration of assessment of additionality” (version 07.0.0) is applied to eliminate alternatives that are not in compliance with all applicable legal and regulatory requirements.

Regulations in Thailand prohibit the direct discharge of untreated wastewater into water bodies such a rivers and lakes, primarily through the Factory Act B.E.2535 (1992). Therefore, alternative W2 is not incompliance with local laws and regulations and is not further considered.

According to the Notification of Ministry of Science, Technology and Environment issue no. 3, B.E.2539[7] regarding the effluent standard of the industrial/industrial estate wastewater states, “the effluent refers to the discharged wastewater from the industrial activities to the public water bodies or the environment. The quality of the effluent must be complied with the standards as stated in this notification”. There are many control parameters i.e. BOD (max.60 mg/L), COD (max.120 mg/L), SS (max.50 mg/L), etc., which is much lower than the untreated wastewater quality from the project i.e. COD is approx. 16,500 mg/L.

Therefore; alternative W2 “Direct release of wastewater to a nearby water body”, alternative W6 “Wastewater is directed to land application without dewatering”, alternative W7 “Wastewater is dewatered and directed to land application/used as fuel in energy applications” and alternative 8 “Wastewater is not treated”, do not comply with this standard and thus are eliminated from the alternative scenarios.

The remaining alternatives include W1 “The usage of open lagoons for the treatment of the wastewater”; W3 “Aerobic wastewater treatment facilities (e.g., activated sludge or filter bed type treatment)”; W4 “Anaerobic digester with methane recovery and flaring” and W5 “Anaerobic digester with methane recovery and utilization for electricity and heat generation”; are in compliance with applicable laws and regulations.

<u>*For electricity generation alternatives:*</u>
All the three alternatives (E1 to E3) are complying with applicable laws and regulations.

<u>*For heat generation alternatives:*</u>
All the tree alternatives (H1 to H3) are complying with applicable laws and regulations.

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[7] 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)

Therefore, the remaining combinations of alternatives to be considered in the next steps are the combinations of wastewater treatment alternatives with all three alternatives of electricity generation and thermal generation:

Wastewater treatment alternatives:	**Electricity generation alternatives:**	**Heat generation alternatives:**
W1: The use of open lagoons for the treatment of the wastewater; W3: Aerobic wastewater treatment facilities (e.g. activated sludge or filter bed type treatment); W4: Anaerobic digester with methane recovery and flaring; W5: Anaerobic digester with methane recovery and utilization for electricity or heat generation.	E1: Power generation using fossil fuels in a captive power plant; E2: Electricity generation in the grid; E3: Electricity generation using renewable sources.	H1: Co-generation of heat using fossil fuels in a captive cogeneration power plant; H2: Heat generation using fossil fuels in a boiler; H3: Heat generation using renewable sources.

Step 3: Eliminate alternative that face prohibitive barriers:

As required by ACM0014, step 3 (Barrier Analysis) from the "Tool for the demonstration and assessment of additionality (version 07.0.0) is applied to eliminate alternatives that face prohibitive barriers. The following barriers are considered in the analysis:

a) Investment barriers
b) Technological barriers such as complex operation
c) Barriers due to prevailing practice
d) Other barriers – non-availability of fuel, grid electricity etc.

For wastewater treatment alternatives:

Investment Barriers:

W1: The use of open lagoons for the treatment of the wastewater;

Anaerobic open lagoons (W1) require the least investment in technology, apart from excavating the ponds and installing pipes and pumps. The practice is low cost in terms of capital investment, operation and maintenance cost[8]. Consequently, the majority of wastewater treatment systems in Thailand are open lagoons. The system involves lower maintenance and operation cost. This alternative does not face any of the above-identified barriers and hence it cannot be eliminated.

W3: Aerobic wastewater treatment facilities (e.g., activated sludge or filter bed type treatment);

Aerobic systems (W3) require a high investment to purchase machinery such as aerators, sludge handling systems, mixing devices, etc. The aerobic systems are power intensive and require high investment in terms of operation and maintenance. Thailand Pollution Control Department and the Environmental Engineering Association of Thailand published the 'Guideline and criteria for design the wastewater treatment system and water improvement system for Thailand, 2003' and mentioned that there are 3 most suitable treatment technologies in Thailand, which are stabilization pond (open lagoons), aerated lagoon and activated sludge system. The stabilization pond is the lowest-cost system while the aerated lagoon and activated sludge require higher cost for investment, operating and maintenance. Therefore, W3 can be excluded.

[8] Thailand Pollution Control Department, Part 1: Guideline and criteria for design the wastewater treatment system and water improvement system, 2003 page 69 on site: www.pcd.go.th/count/waterdl.cfm?FileName=1_CoP_All.pdf.

W4: Anaerobic digester with methane recovery and flaring;
This scenario provides no incentive for the owner of the industrial facility to install a new system, which requires investment on anaerobic digesters and flaring equipment. This option is economically less attractive than W5 as the biogas is flared out instead of being utilized as fuel for power generation. The use of methane as fuel would substitute the fossil fuel usage to an extent and represents some financial returns, whereas flaring the methane gives no financial benefit. Thus being less attractive, it is excluded from the plausible alternative scenarios.

W5: Anaerobic digester with methane recovery and utilization for electricity or heat generation;
Alternative W5 also involves substantial capital investment but also has economic returns for biogas usage for energy generation and thus, cannot be eliminated.

In addition, the available literature also presents the industry situation in Thailand. It analyses the kind of barriers, which already exists to the implementation of different kind of project technologies. The relevant implementation barriers that must be overcome to establish sustainable energy technologies in Thailand are shown in **Table 4**. The table is referred to here to establish that implementation of sustainable energy technologies in Thailand, there are some relevant barriers i.e. lack of knowledge to operate and manage new technologies and limited availability of spare parts and maintenance expertise. Thus being non-profitability and facing with many technical barriers, it is excluded from the plausible alternative scenarios.

Table 4: The relevant implementation barriers to established sustainable energy technologies in Thailand

Implementation barriers	High ranked technologies				
	Biomass generator	Biogas generator	Energy efficiency	CHP	Steam boiler upgrading
1. Limited present affordability	✓	✓	✓	✓	✓
2. Existing domestic legal/institution framework	✓	✓			
3. Availability of cheaper but less sustainable alternative technologies	✓	✓		✓	
4. Investment climate, financial misuse/limited transparency, lack of investment	✓	✓	✓		✓
5. Lack of knowledge to operate and manage new technologies	✓	✓	✓	✓	✓
6. Limited availability of spare parts and maintenance expertise	✓	✓	✓	✓	✓
7. Negative impact on community social structures	✓	✓			
8. Lack of effective publicity for investors and the public	✓	✓	✓		
9. Lack of energy subsidies	✓	✓	✓	✓	✓

Source: "Potential of sustainable energy technologies under CDM in Thailand: Opportunities and barriers"[9]

Conclusion for wastewater treatment alternatives:
Alternatives scenarios W3 and W4 are prevented by at least one barrier as mentioned above. Therefore, the plausible alternatives that remain for further discussion are W1 and W5, which is the current practice and project scenario without CDM respectively.

[9] S. Adhikari, N. Mithulananthan, A. Dutta, A. J. Mathias, 2008. Potential of sustainable energy technologies under CDM in Thailand: Opportunities and barriers, cited at http://itee.uq.edu.au/~uqnmithu/sarina.pdf

For electricity generation alternatives:

Technological barriers

E1: Power generation using fossil fuels in a captive power plant

Alternative E1, operating captive power plant requires high skilled labor to set up and operate the technology that then lead to high investment and O&M costs. There are also other technical problems i.e. lack of fossil fuels (Nam Pong power plant, Khon Khaen province), environmental pollution (Mae Mo power plant, Lam phang province)[10]. Thus, alternative E1 faces with technological barriers.

E2: Electricity generation in grid

Alternative E2 is a common practice for industrial facilities that have a demand for electricity. No specific technologies as well as skills are required. Hence, no significant barriers may prohibit the implementation of this option.

E3: Electricity generation using renewable sources

Alternative E3, electricity generation using renewable sources, could be a possibility but faces considerable financial barrier as explained in the following section. .

Prevailing Practice Barrier

E1: Power generation using fossil fuels in a captive power plant

Alternative E1: Power generation using fossil fuels for low capacities requires high investment and is not more viable as compared to grid electricity. As per the existing situation at the project site, the grid electricity is used for the other manufacturing units and no captive power unit is implemented.

E2: Electricity generation in grid

Alternative E2: Electricity generation in the grid, this scenario does not require additional investment and annual O&M costs and currently is a common practice for industrial facilities that have a demand for electricity.

According to **Figure 5**,[11] it represents that alternative E2, electricity generated by the national grid is 87% (IPPs and EGAT) of electricity production while, electricity generated by the captive power plant used fossil fuels (E1) and renewable energies (E3) is only 11% (SPPs). Therefore; alternative E2 is the prevailing practice.

[10] www.eppo.go.th/power/powerplant/3-powerreserve.html
[11] http://www.sea-user.org/download_pubdoc.php?doc=3366

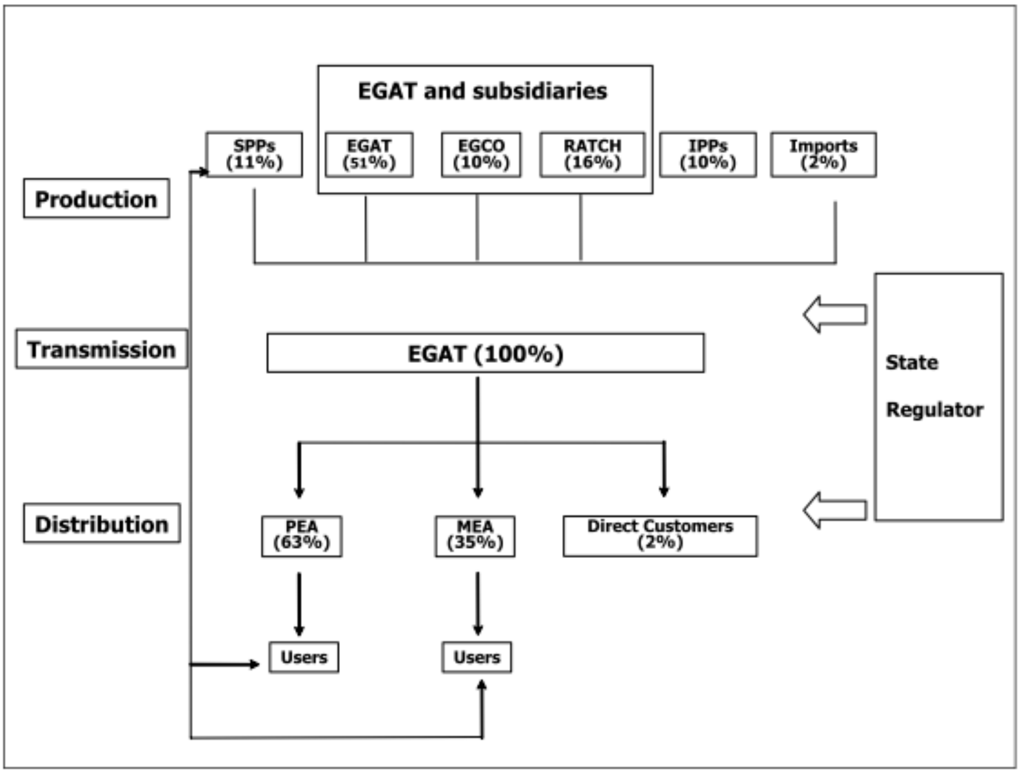


Figure 5: Thailand's electricity supply industry

E3: Electricity generation using renewable sources
Alternative E3: Electricity generation using renewable sources incur additional and substantial investment cost together with annual O&M cost. It therefore faces a significant investment barrier. The details of financial analysis and common practice analysis are elaborated in the later sections.

Conclusion for electricity generation
Alternative: E1 and E3 face significant barriers in terms of investment and technology. Alternative E2 has the advantage of being the prevailing practice and does not require additional investment and therefore does not face significant barriers. There is only one alternative remains that "can be considered the baseline" as stated in the methodology.

For heat generation alternatives:
Technical Barriers
H1: Co-generation of heat using fossil fuels in a captive power plant;
The TSML distillery currently combusts fuel oil for heat generation in two exiting boilers. The heat that is generated is sufficient to meet the full demand of the TSML distillery. The removal of the exiting boiler and replacement with a cogeneration system would require modifications to the TSML distillery control systems and additional training of the operators. In addition, the introduction of new equipment, and operating requirements, would introduce additional risk to the stability and reliability of the heat supply at the TSML distillery. As the distillery relies on heat for operation, this additional risk is not warranted without substantial gains such as a financial return, or increases in efficiency. Therefore, this alternative can be eliminated.

H2: Heat generation using fossil fuels in a boiler
TSML factory currently combusts fuel oil for heat generation in two existing boilers. The heat that is generated is sufficient to meet the full demand of the distillery process. In addition, the existing boiler system has been reliably operating since the factory started the production process. The operators are experienced in operating the system. Therefore, no technical barrier is faced to the continuation of the existing situation.

H3: Heat generation using renewable resources:
The use of renewable energy sources to generate heat faces the same challenges as described under alternative E3 in relation to renewable electricity generation. The project activity does not require any heat. The heat demand of TSML distillery is about 16 ton/hour of low-grade heat for requirement in the alcohol distillery. This low demand would not justify the high up-front investment cost to install and operate a renewable based system.

The only option that could be considered is a biomass boiler to generate the steam. Since this factory operates alcohol distillery process, biomass is not produced within the facility and must be sourced from outside. The major limitations of biomass utilization in Thailand include difficulty in the assessment of resources, inconsistent production, inappropriate properties such as low bulk density and high moisture content, problems of collection, transportation and storage and availability and reliability concerns[12]. Some of these barriers can be overcome by establishing long term supply contracts, but these are very difficult to secure[13]. The installation of biomass technology is an additional investment cost which is not required by Thai law and is not required to meet the heat requirement. This alternative can be eliminated.

Conclusion for heat generation
The alternative H1 and H3 face the technical barriers. Therefore, alternative H2 is the only alternative that is not prevented due to the technical barrier and is not eliminated.

Overall conclusion for the plausible scenarios
The analysis of each alternative above shows that the only combinations which are realistic and plausible baseline scenario for the project is the combination of W1 “The use of open lagoons for the treatment of the wastewater”, E2 “Electricity generation in the grid” and H2 “Heat generation using fossil fuels in a boiler” while W5 “Anaerobic digester with methane recovery and utilization for electricity” is the project activity without CDM.

Step 4: Compare economic attractiveness of remaining alternatives
According to version 06 of ACM0014, this step is necessary when more than one combination or alternative for the project activity remains at Step 3. For the proposed project activity, only one alternative remains in Step 3 and thus this step can be neglected.

The scenarios analysis demonstrate that the baseline scenario corresponds to Scenario 1 described in Table 3 and scenarios W1 for the treatment of wastewater, E2 for the generation of electricity and H2 for the heat generation are most likely, therefore ACM0014 is applicable for the proposed project activity.

[12] Overview of Biomass Utilization in Thailand, Seksan Papong.
[13] Biomass based power generation and cogeneration within small rural industries of Thailand, Plekta Rayan

B.5. Demonstration of additionality

The project activity, as explained in earlier sections, reduces Greenhouse Gas (GHG) emissions by capturing the methane that would have escaped into the environment from anaerobic reduction of organic matter in open lagoons and also by using the captured methane to replace the use of fossil fuel in heat boiler and to generate power replacing grid electricity. The benefits from carbon credits revenue are integral part in the viability of the project. The following outlines a few key milestones in the project's life cycle and discussion on additionality.

ACM0014 (Version 6) requires that the additionality of the project be demonstrated and assessed using the latest version of the "Tool for the demonstration and assessment of additionality" (Version 7). The tool defines a step-wise approach as follows:

1. Identification of alternatives to the project activity consistent with mandatory laws and regulations;
2. Investment analysis to determine that the proposed project activity is not the most economically or financially attractive;
3. Barriers analysis; and
4. Common practice analysis.

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

Sub-step 1: Define alternatives to the project activity:

Realistic and credible alternative scenarios that deliver similar outputs and services to the proposed project activity were identified in Section B4 as per the "procedure for the identification of the most plausible baseline scenario" described in ACM0014 (Version 6).

Sub-step 1: Consistency with mandatory laws and regulation:

As determined in section B4, all alternative scenarios are in compliance with applicable legal and regulatory requirements except for the direct release of wastewater into nearby water bodies (W2), which is eliminated from further analysis.

Step 2: Investment analysis

Sub-step 2a: Determine appropriate analysis method:

The "Tool for the demonstration and assessment of additionality" (Version 7) provides three options for performing the investment analysis:

- Option I: simple cost analysis;
- Option II: investment comparison analysis; or
- Option III: benchmark analysis.

As the proposed project activity will receive revenue from the sale of electricity, in addition to the carbon credits revenue, simple cost analysis (Option I) is not applicable.
The project proponent has chosen to apply the benchmark analysis (Option III).

Sub-step 2b: Option III Apply benchmark analysis:
The financial indicator chosen for the purpose of the benchmark analysis is the proposed project activity's pre-tax project internal rate of return (IRR). The selected benchmark is the Weighted Average Cost of Capital (WACC), calculated as at 22 August 2008, the date that the project owner made the investment decision to proceed with the project by signing a build operate transfer contract to supply the equipment required.

Benchmark analysis

Financial indicator calculation
The financial indicator chosen for the project activity is the pre-tax project IRR. The period of assessment is taken as 15 years in line with the expected operational lifetime of the equipments in the project activity. Depreciation and other non-cash items are not included in the analysis. The loan repayment and interest is not included in the calculation of project IRR. The following table summarizes the main points about investment analysis:

Parameter	Value	Reference to "Guideline on the assessment of investment analysis"
Period of assessment	15 years (technical lifetime)	Guidance 3 – The period of assessment should not be limited to proposed crediting period
Taxation	Excluded	Guidance 5
Depreciation	Excluded	Guidance 5 – The project IRR does not include taxes and is compared to a pre-tax benchmark and therefore depreciation is excluded.
Loan repayment and interest	Excluded	Guidance 9 – The loan repayment and interest are excluded to avoid double counting in the investment analysis. Furthermore, a pre-tax benchmark is applied.

Input values used in the investment analysis were valid at the time of investment decision taken by the project participant. Most of the input values are taken from the proposals supplied by the technology provider to the project participant. The spreadsheet version of investment analysis has been submitted to the DOE.

The input values are detailed in the tables below:

Description	Value (THB)	References
Civil work	33,434,000	*Technology provider*
Machinery and Equipment part	115,375,132	
Electricity generation	49,470,800	
Biogas treatment system	62,872	
Plant utilities and office equipment	5,629,000	
Contigency@7%	14,278,084	
Total investment cost	218,250,718	

Operation and maintenance cost:

Description	THB/year	References
O&M of biogas and other systems	27,369,737	*Technology provider*
O&M of gas engine	7,213,067	
Admin	4,038,600	
Total	**THB 37,012,805**	

The total amount of electricity exported to Thai national grid is estimated to be 11,206 MWh. The electricity tariff assumed is taken from the publicly available data from EPPO VSPP Scheme at the time of decision-making. The average wholesale tariff is taken as 1.6414 THB/kWh, average whole sale Ft is taken as 0.6748 THB/kWh. The project activity will also be selling biogas[14] to the adjoining TSML factory. As per ex-ante estimates, 6,989,348 Nm^3 of biogas at a price of 6.98 THB/Nm3 will be sold to the TSLM factory. Based on the input values outlined above, the pre-tax project IRR has been calculated as 12.27%.

Selection of appropriate benchmark
As per guidance given in paragraph 12 of the **"Guideline on the assessment of investment analysis"** –

[14] Biogas purchase agreement

> *"Local commercial lending rates or weighted average costs of capital (WACC) are appropriate benchmarks for a project IRR"*

The weighted average cost of capital (WACC) has been selected as the appropriate benchmark for the project activity. Paragraph 13 of the guidance further states that –

> *"In the cases of projects which could be developed by an entity other than the project participant the benchmark should be based on parameters that are standard in the market."*

As this is not the first time that such project is being developed and the technology required for the project is available in the market, it would be reasonable to assume that such project could be developed by any entity other than the project participant. Therefore, estimation of WACC is based on parameters that are standard in the market.

Calculation of benchmark (WACC)
The project participant applies the following WACC equation to estimate the required return on capital
as a benchmark:

$$WACC = \frac{E}{V} \cdot R_E + \frac{D}{V} \cdot R_D$$

Where:

WACC	Weighted average costs of capital
E	Amount of equity in the project
D	Amount of debt in the project
R_E	Cost of equity
R_D	Cost of debt
V	Value of total investment

Cost of equity - R_E
The cost of equity has been determined based on the Capital Asset Pricing Model (CAPM). The CAPM is a method of valuing any investment by relating risk and expected returns. The model can be written to calculate cost of equity as follows:

$$R_E = R_f + \beta \cdot \left(R_m - R_f\right)$$

Where:

R_E	Return on equity
R_f	Risk free rate such as interest arising from government bonds
β	Beta is the sensitivity of the returns of the asset to the returns of the market
R_m	Market returns

Risk free rate (R_f) has been taken from Thai government bond[15]. The market return (R_m) has been calculated on the basis of SET50. SET50 index is calculated from the prices of 50 selected SET stocks by the Stock Exchange of Thailand[16]. Beta has been calculated for the Resource industry group which includes the energy and utilities companies. The detailed calculations have been submitted in the spreadsheet to the DOE. The cost of equity has been calculated as 33.76%.

Cost of debt - R_D

[15] http://www.thaibma.or.th/yieldcurve/YieldTTM.aspx
[16] http://www.set.or.th/en/index.html

The cost of debt is the interest rate for a long-term loan at the time of investment decision. The cost of debt is taken from the Bank of Thailand[17] publicly available data for commercial banks. It is taken as 7.56%.

As per guidance given in paragraph 18 of the "Guideline on the assessment of investment analysis", if the benchmark is based on the parameters that are standard in the market, then the typical debt/equity finance structure observed in the sector of the country should be used. In line with the same equity has been taken as 49.02% and debt has been taken as 50.98%.

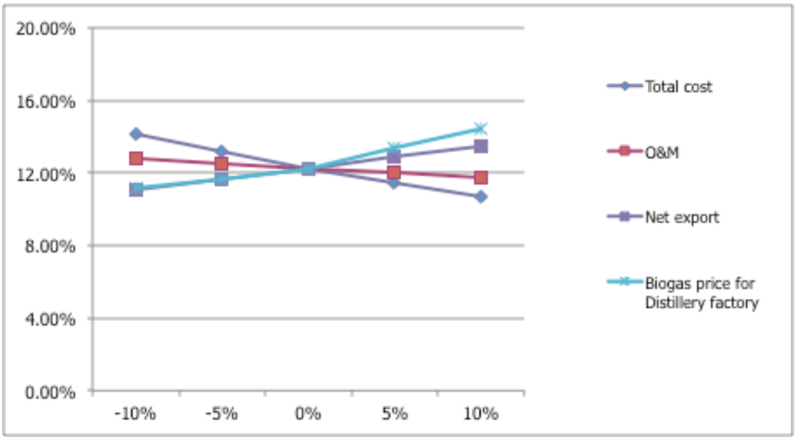
Based on the above data, the WACC has been calculated as 20.41%.

The project IRR has been calculated as 12.27%, which is lower than the benchmark of 20.41%.

Sensitivity analysis
A sensitivity analysis is performed to determine in which scenario the project activity would pass the benchmark. The following table outlines the parameters on which sensitivity analysis has been performed and the results. The parameters have been subjected to a variation of +/- 10% to determine the effect on the project IRR.

%Variation	-10%	-5%	0%	5%	10%
Total cost	14.10%	13.15%	12.27%	11.46%	10.70%
O&M	12.82%	12.55%	12.27%	11.99%	11.72%
Net export	11.06%	11.67%	12.27%	12.86%	13.44%
Biogas price for distillery factory	11.13%	11.64%	12.27%	13.38%	14.46%

The following figure plots the above data:



It is therefore clear from above that variation in the critical parameters gives a maximum project IRR of 12.27%, which is still below the benchmark.

Based on the above discussion, it can be concluded that the assumptions used in the investment analysis are suitable and the project activity does not generate sufficient returns to be considered financially viable.

Step 3: Barrier Analysis

Please refer to Section B4.

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

Step 4: Common practice analysis

The purpose of the common practice analysis as defined by the Tool for the demonstration of additionality (Version 7) is as a credibility check on the investment or barrier analysis. The project activity applies measures that are listed in the definition section of the tool. Therefore, the sub-step 4a: The proposed CDM project activity applies measure that are listed in the definition section is considered. In addition, the latest of the " Guidelines on common practice[18]" available on the UNFCCC website shall be applied.

The common practice analysis is conducted based on data that reflects the situation in Thailand around the time of investment decision for this particular project activity (August 2008). The exiting common practices are identified and discussed through the following stepwise approach:

Step 1: Calculation applicable capacity or output range as +/- 50% of the total design capacity or output of the proposed project activity.

Since the proposed project activity entails a UASB system for wastewater treatment and biogas recovery at the TSML distillery factory, the common practice analysis will limit its scope only to this field of industry. TSML produce alcoholic beverage through a distillation process. This processes is similar to the production of bio-ethanol. Therefore, the bio-ethanol and distillery industry have been considered.

The distillery capacity of TSML factory is 75,000 Litter per day. The wastewater generation rate is 1,250 m3/day with COD of 90,000 mg/l. The design capacity of the project plant is compared to other similar projects.

In considering with +/-50% output range, the wastewater treatment plants that receive the wastewater generated by distillery processing should have the flow capacity range of 625 m3/day to 1,875 m3/day and the COD range of 45,000 mg/l to 135,000 mg/l. Thereby, the flow rate in the wastewater treatment system is an apt indicator for comparing the output capacity of the project plant with other similar projects. The list of the projects considered for common practice analysis, inherently covers the biogas usage aspect for comparative analysis.

Step 2: Identify similar projects (both CDM and non-CDM) with fulfil all of the following conditions:

a) The projects are located in the applicable geographical area;
b) The projects apply the same measure as the proposed project activity;
c) The projects use the same energy source/fuel and feedstock as the proposed project activity, if a technology switch measure is implemented by the proposed project activity;
d) The plants in which the projects are implemented produce goods or service

Currently, there are 39 distillery factories in Thailand that based on the published data from Thailand Department of Industrial Work (DIW)[19]. Their feedstock is molasses. The available data on DIW website only shows the registered factories which have the same production license as the TSML distillery plant. Prior the time of project start[20], there were only 16 existing registered plants with capacity of wastewater flow rate into the treatment system as shown in Table 3.

Table 3 of List of existing the distillery factory in Thailand

No.	Project Company	Location	Wastewater flow rate	Wastewater treatment system
			(m3/day)	

[18] Version 02.0, EB69, Annex-8
[19] http://www.diw.go.th/hawk/content.php?mode=data1search
[20] The study report of considering issuance of distillery producing license in Thailand

1	Sura Bangyikhan Co., Ltd.	Patumthani	900	Anaerobic ponds
2	Athimart Co., Ltd.	Buriram	653	Anaerobic ponds
3	Thep Arunothai Co, Ltd	Nhongkai	776	Biogas system
4	Tanapakdee Co., Ltd.	Chiangmai	515	Biogas system
5	Nateechai Co., Ltd.	Suratchthani	771	Anaerobic ponds
6	Simaturakit Co., Ltd.	Nakornsawan	575	Anaerobic ponds
7	Lakchaikasura Co., Ltd.	Ratchaburi	591	Biogas system
8	Monkolsamai Co., Ltd.	Utraradit	581	Biogas system
9	Fuangfooanant Co., Ltd.	Prachineburi	751	Anaerobic ponds
10	S.S. Karnsura Co., Ltd.	Ubonratchthani	680	Biogas system with carbon revenue
11	Kankwan Co., Ltd.	Khonkan	604	Biogas system
12	United Winery and Distillery Co., Ltd.	Nakhonpatom	435	Anaerobic ponds
13	Sang Som Co., Ltd.	Nakhonpatom	384	Anaerobic ponds
14	Sang Som Co., Ltd.	Karnchanaburi	580	Anaerobic ponds
15	Redbull Distillery (1988) Co., Ltd.	Samutsakorn	559	Biogas system
16	Karnchansingkorn Co., Ltd	Karnchanburi	513	Biogas system

Among these 16 plants, 6 plants are operating within the capacity range of the propose project activity as mentioned above. One factory considers carbon credit revenue with the implementation of biogas system, which is similarly to project activity. Therefore; N_{all} = 5.

Step 3: Within the projects identified in Step 2, identify those that are neither registered CDM project activities, project activities submitted for registration, nor project activities undergoing validation. Note their number N_{all}.

As mentioned in step2, therefore; N_{all} = 5.

Step 4: Within similar projects identified in Step 3, identify those that apply technologies that are different to the technology applied in the proposed project activity. Note their number N_{diff}.

Four distillery factories have different wastewater treatment technology. Thus, N_{diff} = 4.

Step 5: Calculate factor F=1-Ndiff/Nall representing the share of similar projects (penetration rate of the measure/technology) using a measure/technology similar to the measure/technology used in the proposed project activity that deliver the same output or capacity as the proposed project activity.

Calculation factor – F :
N_{all} = 5, N_{diff} =4
F = 0.2

The result of factor F calculation is not greater than 0.2. Also, the calculation of $N_{all} – N_{diff}$ is 1 which less than 3. In conclusion, the proposed project activity is not a common practice within a sector in the applicable geographical area. The proposed project activity is additional.

Additionality Conclusion:
As shown above, the proposed project activity cannot be considered financially attractive and is not prevailing practice.

The additional revenue from the sale of carbon credits increases the IRR of the proposed project activity to 12.27%, which was instrumental in the decision to commence with development of the proposed project activity and increases the financial attractiveness of the proposed project activity to the point that it is comparable with expected returns from the energy sector in Thailand. Papop only decided to proceed with the development of the proposed project after taking into account this additional CDM revenue stream.

B.6. Emission reductions

B.6.1. Explanation of methodological choices

The proposed project activity involves the installation of a new anaerobic digester for the treatment of wastewater. This corresponds to scenario 1 of ACM0014 and therefore all data and terms used in the calculation of the baseline and project activity emissions relate to scenario 1.

Baseline Emissions
Baseline emissions are calculated using the following formula:

$$BE_y = BE_{CH4,y} + BE_{EL,y} + BE_{HG,y} \quad (1)$$

Where:

BE_y	=	Baseline emissions in year *y* (tCO_2e/yr)
$BE_{CH4,y}$	=	Methane emissions from anaerobic treatment of the wastewater in open lagoons (Scenario 1) in the absence of the project activity in year *y* (tCO_2e/yr)
$BE_{EL,y}$	=	CO_2 emissions associated with electricity generation that is displaced by the project activity in year *y* (tCO_2/yr)
$BE_{HG,y}$	=	CO_2 emissions associated with fossil fuel combustion for heating equipment that is displaced by the project in year *y* (tCO_2/yr)

Baseline emissions are calculated in three steps, as follows:
Step 1: Calculation of baseline emissions from anaerobic treatment of the wastewater;
Step 2: Calculation of baseline emissions from generation and consumption of electricity;
Step 3: Calculation of baseline emissions from heat generation.

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

The methodology proposes to use the minimum value between the methane produced after the implementation of the project activity and methane conversion factor method for the estimation of methane emissions from open lagoons in case of the wastewater lagoons.

$$BE_{CH4,} = \min \{Q_{CH4,y} ; BE_{CH4,MCF,y}\} \quad (2)$$

Methane produced

Projects proponent shall use Step 1" Determination of the quantity of methane produced in the digester ($Q_{CH4,y}$)"of the latest version of the tool "Project and leakage emissions from anaerobic digesters" to determine the amount of methane produced after the implementation of the project activity ($Q_{CH4,y}$).

As per step 1 of the tool: determination of the quantity of methane produced in the digester ($Q_{CH4,y}$), the option 1 (Procedure using monitoring data) shall be used due to the proposed project activity is the large scale. According to option 1, $Q_{CH4,y}$ shall be measured using the "Tool to determine the mass flow of greenhouse gas in a gaseous stream". When applying the tool, the following applies:

- The gaseous stream to which the tool is applied is the biogas collected from the digester;
- CH_4 is the greenhouse gas *i* for which the mass flow should be determined; and
- The flow of the gaseous stream should be measured on an hourly basis or a smaller time interval; and then accumulated for the year *y*. Please note that units need to be converted to tons, when applying the results in this tool.

As per the guidance given in the "Tool to determine the mass flow of a green house gas in a gaseous stream", Step 1 determines the mass flow of methane ($F_{CH4,RG,m}$) as kg unit in the gaseous stream in the minute "m".

$F_{CH4,RGm}$, which is measured as the mass flow during minute *m*, shall then be used to determine the mass of methane in kilograms generated by anaerobic digester in minute *m* ($F_{CH4,RG,m}$). $F_{CH4,RG,m}$ shall be determined on a dry basis. Therefore, the measurement option A as per the table 1 of the tool is selected in order to determine the volume flow and the volumetric fraction of the gaseous stream on the dry basis. The temperature of the gaseous stream is less than 60ºC at the flow measuring point. Therefore as per Option A (b), the gaseous stream is considered dry.

$F_{CH4,m}$ is determined as following equation;

$$F_{CH4,RG,m} = V_{m,db} * v_{CH4,m,db} * \rho_{CH4,m} \quad (3)$$

Where:

$F_{CH4,RG,m}$	Mass flow of greenhouse gas CH_4 in the gaseous stream in the minute m (kg)
$V_{m,db}$	Volumetric flow of the gaseous stream in minute m on dry basis (Nm3)
$v_{CH4,m,db}$	Volumetric fraction of the greenhouse gas CH_4 in the gaseous stream in minute m on dry basis (%).
$\rho_{CH4,m}$	Density of greenhouse gas CH_4 in the gaseous stream in minute m (0.716 kg/m3) at reference conditions

As mentioned above, the mass flow of greenhouse gas CH_4 ($F_{CH4,RG,m}$) in the gaseous stream in the minute *m* (kg) will be converted in ton CH_4/year unit of the quantity of methane produced in the digester ($Q_{CH4,y}$).

<u>Methane conversion factor</u>

The baseline methane emissions from anaerobic treatment of the wastewater in open lagoons (Scenario 1) is estimated based on the chemical oxygen demand (COD) of the wastewater that would enter the lagoon in the absence of the project activity ($COD_{BL,y}$), the maximum methane producing capacity (B_o) and a methane conversion factor ($MCF_{BL,y}$) which expresses the proportion of the wastewater that would decay to methane, as follows:

$$BE_{CH4,MCF,y} = GWP_{CH4} * MCF_{BL,y} * B_o * COD_{BL,y} \quad (4)$$

Where:

$BE_{CH4,MCF,y}$	=	Methane emissions from anaerobic treatment of the wastewater in open lagoons (Scenario 1) in the absence of the project activity in year *y* (tCO_2e/yr)
GWP_{CH4}	=	Global Warming Potential of methane valid for the commitment period (tCO_2e/tCH_4)
B_o	=	Maximum methane producing capacity, expressing the maximum amount of CH_4 that can be produced from a given quantity of chemical oxygen demand (tCH_4/tCOD)
$MCF_{BL,y}$	=	Average baseline methane conversion factor (fraction) in year *y*, representing the fraction of ($COD_{PJ,y}$ x B_o) that would be degraded to CH_4 in the absence of the project activity
$COD_{BL,y}$	=	Quantity of chemical oxygen demand that would be treated in open lagoons (Scenario 1) in the absence of the project activity in year *y* (tCOD/yr)

Determination of $COD_{BL,y}$

The baseline chemical oxygen demand ($COD_{BL,y}$) is equal to the chemical oxygen demand that is treated under the project activity ($COD_{PJ,y}$), unless there would have been effluent from the lagoons (Scenario 1) in the baseline, in this case the COD_{PJ} should be adjusted by an adjustment factor which relates the COD supplied to the lagoon with the COD in the effluent.

$$COD_{BL,y} = \rho * \left(1 - \frac{COD_{out,x}}{COD_{in,x}}\right) * COD_{PJ,y} \quad (5)$$

Where:

$COD_{BL,y}$	=	Quantity of chemical oxygen demand that would be treated in open lagoons (Scenario 1) in the absence of the project activity in year *y* (t COD/yr)
$COD_{PJ,y}$	=	Quantity of chemical oxygen demand that is treated in the anaerobic digester or under clearly aerobic conditions in the project activity in year *y* (t COD/yr)
$COD_{out,x}$	=	COD of the effluent in the period *x* (t COD)
$COD_{in,x}$	=	COD directed to the open lagoons (Scenario 1) in the period *x* (t COD)
x	=	Representative historical reference period
ρ	=	Discount factor for historical information

The value of $COD_{out,x}$ and $COD_{in,x}$ are referred to the one-year historical records of the COD inflow and COD effluent from the open lagoon. The COD measurements were conducted prior the implementation of project activity. The measurement had been done under normal operation condition of the distillery production and the ambient condition of the site (temperature etc.). The representative historical reference period (x) is the one-year data record; please see detail in Appendix 4.

$COD_{PJ,y}$ is determined as follows:

$$COD_{PJ,y} = \sum_{m=1}^{12} F_{PJ,dig,m} * COD_{dig,m} \quad (6)$$

Where:

$COD_{PJ,y}$	=	Quantity of chemical oxygen demand that is treated in the anaerobic digester in the project activity in year *y* (t COD/yr)
$F_{PJ,dig,m}$	=	Quantity of wastewater that is treated in the anaerobic digester in the project activity in month *m* (m^3/month)
$COD_{dig,}m$	=	Chemical oxygen demand in the wastewater that is treated in the anaerobic digester in the project activity in month *m* (t COD / m^3)
m	=	Months of year *y* of the crediting period

Determination of $MCF_{BL,y}$

The quantity of methane generated from COD disposed to the open lagoon (Scenario 1) depends mainly on the temperature and the depth of the lagoon. Accordingly, the methane conversion factor is calculated based on a factor f_d, expressing the influence of the depth of the lagoon on methane generation, and a factor $f_{T,y}$ expressing the influence of the temperature on the methane

generation. In addition, a conservativeness factor of 0.89 is applied to account for the considerable uncertainty associated with this approach. $MCF_{BL,y}$ is calculated as follows:

$$MCF_{BL,y} = f_d * f_{T,y} * 0.89 \quad (7)$$

Where:

$MCF_{BL,y}$	=	Average baseline methane conversion factor (fraction) in year *y*, representing the fraction of ($COD_{PJ,y}$ x B_o) that would be degraded to CH_4 in the absence of the project activity
f_d	=	Factor expressing the influence of the depth of the lagoon on methane generation
$f_{T,y}$	=	Factor expressing the influence of the temperature on the methane generation in year *y*
0.89	=	Conservativeness factor

Determination of fd

f_d represents the influence of the average depth of the lagoons on methane generation.

$$f_d = \begin{cases} 0 \ ; if\ D < 1m \\ 0.5\ ; if\ 1m \le D < 2m \\ 0.7; if\ D \ge 2m \end{cases}$$

Where:

f_d	=	Factor expressing the influence of the depth of the lagoons on methane generation
D	=	Average depth of the lagoons (m)

The value of f_d is determined from the average depth of the anaerobic open lagoon. In the baseline scenario, a value of 0.7 has been applied, which is the default value of lagoons with the average depth of greater than 5m[21].

Determination of $f_{T,y}$

An increase in temperature in the lagoon has several benefits to generate more methane, including an increasing solubility of the organic compounds, enhanced biological and chemical reaction rates. The factor $f_{T,y}$ is calculated using a monthly stock change model which aims at assessing how much COD degrades in each month.

For each month *m*, the quantity of wastewater directed to the lagoon, the quantity of organic compounds that decay and the quantity of any effluent water from the lagoon is balanced, giving the quantity of COD that is available for degradation in the next month: the amount of organic matter available for degradation to methane ($COD_{available,m}$) is assumed to be equal to the amount of organic matter directed to the open lagoon, less any effluent, plus the COD that may have remained in the lagoon from previous months, as follows:

$$COD_{available,m} = COD_{BL,m} + (1-f_{T,m-1}) * COD_{available,m-1} \quad (8)$$

[21] Drawing no TS-WP-03, Section 1-1, Pond 9

Where:

$COD_{available,m}$	=	Quantity of chemical oxygen demand available for degradation in the open lagoon in month *m* (t COD/month)
$COD_{BL,m}$	=	Quantity of chemical oxygen demand that would be treated in open lagoons (Scenario 1) in the absence of the project activity in month *m* (t COD/month)
$f_{T,m-1}$	=	Factor expressing the influence of the temperature on the methane generation in previous month (*m-1*)
m	=	Months of year *y* of the crediting period
T	=	Temperature of the lagoon in the month (deg K)
$COD_{avialable,\ m-1}$	=	Quantity of chemical oxygen demand that may have remained in the lagoon from previous month m-1 (tCOD/month)

$$COD_{BL,m} = \left(1 - \frac{COD_{out,x}}{COD_{in,x}}\right) * \ COD_{PJ,m} \tag{9}$$

Where:

$COD_{out,x}$	=	COD of the effluent in the period *x* (t COD)
$COD_{in,x}$	=	COD directed to the open lagoons (Scenario 1) in the period *x* (t COD)
$COD_{PJ,m}$	=	Quantity of chemical oxygen demand that is treated in the anaerobic digester or in the project activity in month *m* (t COD/month)
x	=	Representative historical reference period

and

$$COD_{PJ,m} = F_{PJ,dig,m} * COD_{dig,m} \tag{10}$$

Where:

$COD_{PJ,m}$	=	Quantity of chemical oxygen demand that is treated in the anaerobic digester or in the project activity in month *m* (t COD/month)
$F_{PJ,dig,m}$	=	Quantity of wastewater that is treated in the anaerobic digester or under clearly aerobic conditions in the project activity in month *m* (m^3/month)
$COD_{dig,m}$	=	Chemical oxygen demand in the wastewater that is treated in the anaerobic digester in the project activity in month *m* (t COD/m^3)

In case of emptying the lagoon, the accumulation of organic matter restarts with the next inflow and the COD available from the previous month should be set to zero. The monthly factor to account for the influence of the temperature on methane generation is calculated based on the following “van’t Hoff – Arrhenius” approach:

$$f_{T,m} = \begin{cases} 0 & \text{if } T_{2,m} < 278K \\ e^{\left(\frac{E*(T_{2,m}-T_1)}{R*T_1*T_{2,m}}\right)} & \text{if } 278K \leq T_{2,m} \leq 302.5K \\ 0.95 & \text{if } T_{2,m} > 302.5K \end{cases} \tag{11}$$

Where:

$f_{T,m}$	=	Factor expressing the influence of the temperature on the methane generation in month *m*

E	=	Activation energy constant (15,175 cal/mol)
$T_{2,m}$	=	Average temperature at the project site in month *m* (K)
T_1	=	303.16 K (273.16 K + 30 K)
R	=	Ideal gas constant (1.987 cal/K mol)
m	=	Months of year *y* of the crediting period

The annual value $f_{T,y}$ is calculated as follows:

$$f_{T,y} = \frac{\sum_{m=1}^{12} f_{T,m} * COD_{available,m}}{\sum_{m=1}^{12} COD_{BL,m}} \qquad (12)$$

Where:

$f_{T,y}$	=	Factor expressing the influence of the temperature on the methane generation in year *y*
$f_{T,m}$	=	Factor expressing the influence of the temperature on the methane generation in month *m*
$COD_{available,m}$	=	Quantity of chemical oxygen demand available for degradation in the open lagoon in month *m* (t COD/month)
$COD_{BL,m}$	=	Quantity of chemical oxygen demand that would be treated in open lagoons (Scenario 1) in the absence of the project activity in month *m* (t COD/month)
m	=	Months of year *y* of the crediting period

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

In this step, baseline emissions from the following sources are estimated:

- Baseline emissions from consumption of electricity associated with the treatment of wastewater (Scenario 1)
- Baseline emissions from the generation of electricity in the grid (E2) in the absence of the electricity generation with biogas.

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

$$BE_{EL,y} = (EC_{BL} * EF_{BL,EL,y}) + (EG_{PJ,y} * EF_{PJ,EL,y}) \qquad (13)$$

Where:

$BE_{EL,y}$	=	CO_2 emissions associated with electricity generation that is displaced by the project activity and/or electricity consumption in the absence of the project activity in year *y* (tCO_2/yr)
EC_{BL}	=	Annual quantity of electricity that would be consumed in the absence of the project activity for the treatment of the wastewater (Scenario 1) (MWh/yr) and which is displaced by electricity produced from the project activity

$EF_{BL,EL,y}$ = Baseline emission factor for electricity consumed in the baseline in the absence of the project activity in year *y* (tCO_2/MWh)

$EG_{PJ,y}$ = Net quantity of electricity generated in year *y* with biogas from the new anaerobic biodigester (MWh/yr)

$EF_{PJ,EL,y}$ = Baseline emission factor for electricity generated by the project activity in year *y* (tCO_2/MWh)

Determination of $EF_{BL,EL,y}$

The baseline scenario for displacement of electricity generated with biogas from the anaerobic digester is E2: Electricity generation in the grid. Therefore, the grid emission factor is calculated using the latest version of the "Tool to calculate the emission factor for an electricity system". The source of data is referred to Thai DNA and other publicly available sources in Thailand. The choice of data has been detailed in Appendix 4.

$$EF_{BLL,EL,y} = EF_{CO2,grid,y} \quad (14)$$

Where:

$EF_{CO2,grid,y}$ = Thailand National Grid emission factor (tCO2e/Mwh)

Determination of $EF_{PJ,EL,y}$

$EF_{PJ,EL,y}$ is calculated using the latest version of the "Tool to calculate the emission factor for an electricity system". The source of data is referred to Thai DNA and other publicly available sources in Thailand. The choice of data has been detailed in Appendix 4.

$$EF_{PJ,EL,y} = EF_{CO2e,grid,y} \quad (15)$$

Where:

$EF_{CO2,grid,y}$ = Thailand National Grid emission factor (tCO2e/Mwh)

Step 3: Baseline emissions from the generation of heat

The biogas captured from the new anaerobic digester is utilized in the project scenario for heat generation. In the absent of the proposed project activity, the heat would have been generated by using fossil fuels. The baseline scenario of the project activity is H2, therefore, fossil fuels from the generation of heat in boilers are displaced and baseline emissions are calculated as follows:

$$BE_{HG,y} = \frac{HG_{PJ,y} * EF_{CO2,FF,boiler}}{\eta_{BL,boiler}} \quad (16)$$

Where:

$BE_{HG,y}$ = CO_2 emissions associated with fossil fuel combustion for heating equipment that is displaced by the project in year *y* (tCO_2/yr)

$HG_{PJ,y}$ = Net quantity of heat generated in year *y* with biogas from the new anaerobic digester (GJ)

$EF_{CO2,FF,boiler}$ = CO_2 emission factor of the fossil fuel type used in the boiler for heat generation in the absence of the project activity (tCO_2/GJ)

$\eta_{BL,boiler}$ = Efficiency of the boiler that would be used for heat generation in the absence of

the project activity

Determination of $EF_{CO2,FF,boiler}$

This is the existing project. The project participant chooses the fossil fuel with the lowest emission factor that was used in the facility that generates the wastewater for heating purposes before the implementation of the project activity the year prior the implementation of the project activity.

Determination of $\eta_{BL,boiler}$

In order to determine the efficiency of the boiler ($\eta_{BL,boiler}$), the latest version of the "Tool to determine the baseline efficiency of thermal or electric energy generation systems" will be applied.

The biogas captured by the project will be supplied to the steam boiler whose specification is multiple fuel consumption. Thus, the option F is selected to establish the efficiency of the boiler as per the tool. A default value for the applicable technology is referred to the table 1 of the tool. The steam boiler system of the TSML distillery has been installed since November 2007. Its individual age is less than 10 years. So, it is considered as a new oil fire boiler. Thus the default efficiency of 90% is applied in corresponding to the tool.

Project emissions

The project involves the installation of anaerobic digester for the treatment of the wastewater. The wastewater treated will be sent to the open lagoons. It is not expected that the project activity will generate significant amount of sludge. The excess sludge may be used for starting up other systems equipped with biogas recovery or for soil application under aerobic conditions.

Emissions attributed to the project activity under scenario 1 include the following:

(a) In the case of project activities that introduce an anaerobic digester for the treatment of wastewater, solid materials or sludge. Use the latest approved version of the tool "Project and leakage emissions from anaerobic digesters" to calculate project emissions;

(b) In the case of project activities that introduce a treatment of sludge or land application of wastewater. Estimate methane and nitrous oxide emissions from land application of sludge following step (i) below;

Configuration (a)

As per ACM0014, emissions attributed to the project activity under scenario 1, the introduction of an anaerobic digester for the treatment of the wastewater. In order to calculate project and leakage emissions, the latest approved version of the tool "Project and leakage emissions from anaerobic digesters" is applied.

According to section II of the tool: project emission procedure, the project emissions associated with the anaerobic digester ($PE_{AD,y}$) are determined as follows:

$$PE_{AD,y} = PE_{EC,y} + PE_{FC,y} + PE_{CH4,y} + PE_{flare,y} \quad (17)$$

Where:

$PE_{AD,y}$ = Project emissions associated with the anaerobic digester in year *y* (tCO2e)

$PE_{EC,y}$ = Project emissions from electricity consumption associated with the anaerobic digester in year *y* (tCO2e)

$PE_{FC,y}$ = Project emissions from fossil fuel consumption associated with the anaerobic digester in year *y* (tCO2e)

$PE_{CH4,y}$ = Project emissions of methane from the anaerobic digester in year *y* (tCO2e)

$PE_{flare,y}$ = Project emissions from flaring of biogas in year *y* (tCO2e)

These parameters are determined through the steps outlined below.

Step 1: Determination of the quantity of methane produced in the digester ($Q_{CH4,y}$)

As per the tool of “Project and leakage emissions from anaerobic digesters”, the project is large scale. The option 1 – procedure using monitored data is applied in order to determine $Q_{CH4,y}$.

$Q_{CH4,y}$ shall be measured using the “Tool to determine the mass flow of a greenhouse gas in a gaseous stream”. When the applying the too, the following applies:

- The gaseous stream to which the tool is applied is the biogas collected from the digester;
- CH_4 is the greenhouse gas *i* for which the mass flow should be determined; and
- The flow of the gaseous stream should be measured on an hourly basis or a smaller time interval; and then accumulated for the year *y*. Please note that units need to be converted to tons, when applying the results in this tool.

This determination is similar to the methane-produced approach in the baseline determination as mentioned previously. Therefore, the quantity of methane produced in digester ($Q_{CH4,y}$) is referred to the determination of the mass flow of methane ($F_{CH4,RG,m}$) as kg unit in the residue gaseous stream in the minute “m”.

$F_{CH4,m}$ is determined as following equation;

$$F_{CH4,RG,m} = V_{m,db} * v_{CH4,m,db} * \rho_{CH4,m} \quad (18)$$

Where:

$F_{CH4,RG,m}$ = Mass flow of greenhouse gas CH_4 in the gaseous stream in the minute m (kg)

$V_{m,db}$ = Volumetric flow of the residual gaseous stream in minute m on dry basis (Nm3)

$v_{CH4,m,db}$ = Volumetric fraction of the greenhouse gas CH_4 in the gaseous stream in minute m on dry basis (%).

$\rho_{CH4,m}$ = Density of greenhouse gas CH_4 in the gaseous stream in minute m (0.716 kg/m3) at reference conditions

As mentioned above, the mass flow of greenhouse gas CH_4 ($F_{CH4,RG,m}$) in the residual gaseous stream in the minute *m* (kg) will be converted in ton CH_4/year unit of the quantity of methane produced in the digester ($Q_{CH4,y}$).

Step 2: Determination of project emissions from electricity consumption ($PE_{EC,y}$)

The proposed project activity consumes electricity for the operation of the wastewater treatment system. Electricity used in the proposed project activity will be sourced from the biogas generator and will therefore not result in additional emissions. Based on this assumption;

$PE_{EC,y}$ = 0 tCO2e/year

However, in the event the biogas engine is not functioning, electricity will be sourced from the Thai national grid. The electricity consumption will be monitored and the “tool to calculated baseline,

project and/or leakage emissions from electricity consumption" will be used to calculate project emissions from electricity consumption. This approach is complied with option 1 of the tool "Project and leakage emissions from anaerobic digesters".

Option 1: Procedure using monitored data

PE_{EC} shall be calculated using the "Tool to calculated baseline, project and/or leakage emission from electricity consumption", where the project emission source *j* referred in the tool is the total electricity consumption associated with the anaerobic digestion facility. As per the tool, the *Scenario A: Electricity consumption from the grid* 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:

$$PE_{EC,y} = \sum EC_{PJ,j,y} \times EF_{EL,j,y} \times (1+TDL_{j,y}) \quad (19)$$

Where:

$PE_{power,y}$	=	Project emissions from electricity consumption in year y (tCO_2)
$EC_{PJ,j,y}$	=	Quantity of 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. A default value of 20% shall be assumed as conservative assumption as per applied tool.
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, version 02.2.1" ($EF_{EL,j,y} = EF_{CO2,grid,y}$). The grid emission factor details are further explained in Appendix 4.

Determination of average technical transmission and distribution losses
$TDL_{j,y}$ will be taken from the recent data available within the host country.

Step 3: Determination of project emissions from fossil fuel consumption ($PE_{FC,y}$)

Where the anaerobic digester facility uses fossil fuels, project participants shall calculate $PE_{FC,y}$ using the "Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion". The project emission source *j* referred to in the tool is fossil fuel consumption associated with the anaerobic digestion facility (not including fossil fuels consumed for transportation of feed material and digestate or any other on-site transportation).

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 period. The determination of the CO_2 emission coefficient ($COEF_{i,j}$) is referred to option B based on net calorific value and CO2 Emission factor of the fuel type *i*. Therefore, CO2 emissions from fossil fuel consumption in the boiler are calculated as:

$PE_{FC,y} = FC_{i,y} \times NCV_{i,y} \times EF_{CO2,i,y}$ (20)

Where:

$F_{Ci,y}$	=	Quantity of fossil fuel type i combusted in the boiler during the year y (mass or volume unit/yr);
$NCV_{i,y}$	=	Net calorific value of fossil fuel type i, GJ/mass or volume unit)
$EF_{CO2,i,y}$	=	CO2 emission factor of fuel type i in the year y (tCO2/GJ)
i	=	The fuel type combusted in process *j* during the year *y*

Step 4: Determination of project emissions of methane from the anaerobic digester ($PE_{CH4,y}$)

Project emission of methane from the anaerobic digester include emissions during maintenance of the digester, physical leaks through the roof and side walls, and release through safety valves due to excess pressure in the digester. These emissions are calculated using a default emission factor ($EF_{CH4,default}$), as follows:

$PE_{CH4,y} = Q_{CH4,y} \times EF_{CH4,default} \times GWP_{CH4}$ (21)

Where:

$PE_{CH4,y}$	= Project emissions of methane from anaerobic digester in year *y* (tCO2e)
$Q_{CH4,y}$	= Quantity of methane produced in the anaerobic digester in year *y* (tCH4)
$EF_{CH4,defaut}$	= Default emission factor for the fraction of CH4 produced that leaks from the anaerobic digester (fraction)
GWP_{CH4}	= Global warming potential of CH4 (tCO2/tCH4)

The project activity installs the UASB digester system for wastewater treatment from distillery factory. Therefore, $EF_{CH4,default}$ is determined as 0.05.

Step 5: Determination of project emissions from flaring of biogas ($PE_{flare,y}$)

In the case of unscheduled events; such as the engine failure or malfunction, result in biogas being unable to be sent to the gas engines, or if there is an excess of biogas, the enclosed flaring system will be used for such emergency case.

The project activity includes flaring of biogas, then project emissions from flaring of biogas ($PE_{flare,y}$) shall be estimated using the "Tool to determine project emissions from flaring gases containing methane". The following applies:

- The tool provides default factors for the flare efficiency, which can be used for large scale project as described below;

The calculation procedures provided the determination of the project emissions from flaring the residual gas ($PE_{flare,y}$) based on the flare efficiency ($\eta_{flare,m}$) and the mass flow of methane to flare ($F_{CH4,RG,m}$). The project emissions calculation procedure is given in the following steps:

Step1 - Determination of the methane mass flow rate in the residual gas

This step determines the mass flow of methane ($F_{CH4,RG,m}$) as kg unit in the residue gaseous stream in the minute "m" as per the guidance given in the "Tool to determine the mass flow of a green house gas in a gaseous stream".

$F_{CH4,RGm}$, which is measured as the mass flow during minute *m*, shall then be used to determine the mass of methane in kilograms fed to the flare in minute *m* ($F_{CH4,RG,m}$). $F_{CH4,RG,m}$ shall be determined on a dry basis. Therefore, the measurement option A as per the table 1 of the tool is selected in

order to determine the volume flow and the volumetric fraction of the residue gaseous stream on the dry basis. The temperature of the gaseous stream is less than 60 deg C at the flow measurement point. Therefore as per Option A (b), the gaseous stream is considered dry.

$F_{CH4,m}$ is determined as following equation;

$$F_{CH4,RG,m} = V_{m,db} * v_{CH4,m,db} * \rho_{CH4,m} \quad (22)$$

Where:

$F_{CH4,RG,m}$	=	Mass flow of greenhouse gas CH4 in the residual gaseous stream in the minute m
$V_{m,db}$	=	Volumetric flow of the residual gaseous stream in minute m on dry basis (Nm3)
$v_{CH4,m,db}$	=	Volumetric fraction of the greenhouse gas CH4 in the gaseous stream in minute m on dry basis (%).
$\rho_{CH4,m}$	=	Density of greenhouse gas CH4 in the gaseous stream in minute m (0.716 kg/m3) at reference conditions

Density of methane ($\rho_{CH4,m}$) is determined at the normal condition in line with below equation. The measurement of biogas flow will be conducted in normalized unit (Nm^3).

$$\rho_{i,t} = \frac{P_t \times MM_i}{R_u \times T_t}$$

Where:

$\rho_{CH4,m}$	=	Density of greenhouse gas (CH4) in the gaseous stream in minute m
P_t	=	Absolute pressure of the gaseous stream in time interval t (Pa)
MM_{CH4}	=	Molecular mass of CH4 (kg/kmol)
R_u	=	Universal ideal gases constant ($Pa.m^3/kmol.K$)
T_i	=	Temperature of the gaseous stream in time interval t (K)

STEP 2 Determination of flare efficiency

The enclosed flare will be used in the project activity. As per the tool of project emission from flaring, the project participant chooses the option A: apply a default value for flare efficiency. The flare efficiency for the minute *m* ($\eta_{flare,m}$) is 90% when the following two conditions are met to demonstrate that the flare is operating:

(1) The temperature of the flare ($T_{EG,m}$) and the flow rate of the residual gas to the flare ($F_{RG,m}$) is within the manufacturer's specification for the flare ($SPEC_{flare}$) in minute *m*: and
(2) The flame is detected in minute *m* ($Flare_m$)

Otherwise $\eta_{flare,m}$ is 0%.

STEP 3 Calculation of project emissions from flaring

Project emissions from flaring are calculated as the sum of emissions for each minute *m* in year *y*, based on the methane mass flow in the residue gas ($F_{CH4,RG,m}$) and the flare efficiency ($\eta_{flare,m}$), as follow:

(23)

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

Where:

$PE_{flare,y}$	=	Project emissions from flaring of the residual gas in year *y* (tCO_2e)
GWP_{CH4}	=	Global warming potential of methane valid for the commitment period (tCO_2e/tCH_4)
$F_{CH4,RG,m}$	=	Mass flow of methane in the residue gas in the minute *m* (kg)
$\eta_{flare,m}$	=	Flare efficiency in minute *m*

Configuration (b)

It is not expected that the project activity will generate significant amount of sludge. The excess sludge may be used for starting up other systems equipped with biogas recovery or for soil application under aerobic conditions. To be conservative, the project emissions from the land application of sludge will be applied as per following step (i)

(i) Project emissions from land application of sludge

This emission source is only applicable if under the project activity sludge is applied on lands. For conservativeness, an MCF of 0.05 is to be used to estimate possible methane emissions from the land application treatment process to account for any possible anaerobic pockets. These emissions are to be estimated from the following equations:

$$PE_{sludge,LA,y} = COD_{sludge,\ LA,y} * B_o * MCF_{sludge,LA} * GWP_{CH4} + N_{sludge,LA,y} * EF_{N2O,\ LA,\ sludge} * GWP_{N2O} \quad (24)$$

with

$$COD_{sludge,LA,y} = \sum_{m=1}^{12} S_{LA,m} * W_{sludge,COD,LA,m} \quad (25)$$

and

$$N_{sludge,LA,y} = \sum_{m=1}^{12} S_{LA,m} * W_{N,sludge,m} \quad (26)$$

Where:

$PE_{sludge,LA,y}$	=	Project emissions from land application of sludge in year *y* (tCO_2e/yr)
$COD_{sludge,\ LA,y}$	=	Chemical oxygen demand (COD) of the sludge applied to land after the dewatering process in year *y* (tCOD/yr)
B_o	=	Maximum methane producing capacity, expressing the maximum amount of CH_4 that can be produced from a given quantity of chemical oxygen demand ($tCH_4/tCOD$)
$MCF_{sludge,LA}$	=	Methane conversion factor for the application of sludge to lands
GWP_{CH4}	=	Global Warming Potential of methane valid for the applicable commitment period (tCO_2e/tCH_4)
$W_{sludge,COD,m}$	=	Average chemical oxygen demand in the sludge applied to land after the dewatering process in month *m* (t COD/t sludge)

$S_{LA,m}$ = Amount of sludge applied to land in month *m* (t sludge/month)
$N_{Sludge,LA,y}$ = Amount of nitrogen in the sludge applied to land in year *y* (t N/yr)
$W_{N,sludge,m}$ = Mass fraction of nitrogen in the sludge applied to land in month *m* (t N/t sludge)
$EF_{N2O, LA, sludge}$ = N_2O emission factor for nitrogen from sludge applied to land (t N_2O/t N)
GWP_{N2O} = Global Warming Potential of nitrous dioxide (tCO_2e/tN_2O)

Leakage emissions

The project activity introduces an anaerobic digester for the treatment of wastewater. As per ACM0014, the latest approved version of the tool "Project and leakage emissions from anaerobic digesters" is applied to calculate leakage emissions as following equation.

$$LE_y = LE_{AD} = LE_{storage} + LE_{comp,y} \quad (27)$$

Where:
LE_{AD} = Leakage emissions associated with the anaerobic digester in year y (tCO_2e/yr)
$LE_{storage}$ = Leakage emissions associated with storage of digestate in year y (tCO_2e/yr)
$LE_{comp,y}$ = Leakage emissions associated with composting digestate in year y (tCO_2e/yr)

As per the tool, the leakage emissions associated with the anaerobic digester ($LE_{AD,y}$) depend on how the digestate is managed. In the project, the wastewater treated at the outlet of digester will be supplied to evaporation ponds. This effluent treated is considered as the digestate. Therefore, the leakage emission is only determined the leakage emission associated with storage of digestate ($LE_{storage}$). The option 2 of procedure using a default value recommended in the tool is chosen as following equation;

$$LE_{AD} = LE_{storage} = F_{ww,CH4,default} \times Q_{CH4,y} \times GWP_{CH4} \quad (28)$$

Where:
LE_{AD} = Leakage emissions associated with the anaerobic digester in year y (tCO_2e/yr)
$LE_{storage}$ = Leakage emissions associated with storage of digestate in year y (tCO_2e/yr)
$F_{ww,CH4,default}$ = Default factor representing the remaining methane production capacity of liquid digestate (fraction)
$Q_{CH4,y}$ = Quantity of methane produced in the digester in year y (tCH_4)
GWP_{CH4} = Leakage emissions associated with composting digestate in year y (tCO_2e/yr)

Emission reductions

Emission reductions for any given year of the crediting period are obtained by subtracting project emissions from baseline emissions:

$$ER_y = BE_y – PE_y - LE_y \quad (29)$$

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

B.6.2. Data and parameters fixed ex ante

Data / Parameter	$COD_{out, x}$ $COD_{in, x}$
Unit	tonCOD/year
Description	COD of the effluent in the period x COD directed to the open lagoons in the period x
Source of data	Specifications of the baseline anaerobic lagoon are defined according to version 06.0.0 of ACM0014.
Value(s) applied	$COD_{in, x}$ = 65,923 $COD_{out, x}$ = 8,367
Choice of data or Measurement methods and procedures	For existing plants: These parameters are referred to one year of historical data of open lagoons.
Purpose of data	Used for determination of $COD_{BL,y}$
Additional comment	-

Data / Parameter	x
Unit	Time
Description	Representative historical reference period
Source of data	For existing plants: The one-year historical data is available.
Value(s) applied	The one-year period
Choice of data or Measurement methods and procedures	For existing plants: The one-year historical data is available. The period is referred to COD historical data.
Purpose of data	Used for determination of $COD_{BL,y}$
Additional comment	-

Data / Parameter	ρ
Unit	-
Description	Discount factor for historical information
Source of data	Default value as per ACM0014.
Value(s) applied	1
Choice of data or Measurement methods and procedures	For existing plants: If one year of historical data is available ρ=1; If a measurement campaign of at least 10 days is available ρ=0.89.
Purpose of data	Used for determination of $COD_{BL,y}$
Additional comment	

Data / Parameter	B_o
Unit	$tCH_4/tCOD$
Description	Maximum methane producing capacity, expressing the maximum amount of CH_4 that can be produced from a given quantity of chemical oxygen demand (COD)
Source of data	2006 IPCC Guidelines
Value(s) applied	0.25
Choice of data or Measurement methods and procedures	As per ACM0015, no measurement procedures. The default IPCC value for B_o is 0.25 kg CH_4/kg COD.
Purpose of data	Used for determination of $BE_{CH4,MCF,y}$
Additional comment	-

Data / Parameter	D
Unit	m
Description	Average depth of the lagoons
Source of data	Based on as-built drawing
Value(s) applied	>5m.
Choice of data or Measurement methods and procedures	Determine the average depths of the whole lagoon under normal operating conditions
Purpose of data	Used for the identification of the most plausible baseline scenario of the project activity.
Additional comment	-

Data / Parameter	$EF_{CO2,FF,boiler}$
Unit	tCO_2/GJ
Description	CO_2 emission factor of the fossil fuel type used in the boiler for heat generation in the absence of the project activity
Source of data	2006 IPCC value
Value(s) applied	0.0774
Choice of data or Measurement methods and procedures	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, valume2-chapter1). Local values are not available
Purpose of data	Calculation of baseline emissions
Additional comment	-

Data / Parameter	$\eta_{BL,boiler}$
Unit	%
Description	Efficiency of the boiler that would be used for heat generation in the absence of the project activity
Source of data	Default value from Table 1 of "Tool to determine the baseline efficiency of thermal or electric energy generation systems".
Value(s) applied	90%
Choice of data or Measurement methods and procedures	The existing steam boiler system has been installed since November 2007. The existing boilers age is lower than 10 years. Theses boilers are considered as a new oil fired boiler. The default efficiency of 90% is selected as per Table 1: default baseline efficiency for different technologies of "Tool to determine the baseline efficiency of thermal or electric energy generation systems", version 01, EB48.
Purpose of data	Calculation of baseline emissions
Additional comment	-

Data / Parameter	GWP_{CH4}
Unit	-
Description	Global warming potential of methane gas
Source of data	AMS.III.H
Value(s) applied	21
Choice of data or Measurement methods and procedures	IPCC default value
Purpose of data	(i) Calculation of baseline emissions (ii) Calculation of project emissions
Additional comment	-

Data / Parameter	f_d
Unit	-
Description	Factor expressing the influence of the depth of the lagoon on methane generation
Source of data	Apply the following values for the corresponding average depth of the open lagoon: $f_d = \begin{cases} 0 \ ; if\ D < 1m \\ 0.5 \ ; if\ 1m \ \leq D < 2m \\ 0.7; if\ D \geq 2m \end{cases}$
Value(s) applied	0.7
Choice of data or Measurement methods and procedures	Since the minimum depth of the existing open lagoons is more than 2 m. A factor of 0.7 is applied as per the ACM0014
Purpose of data	Calculation of baseline emissions
Additional comment	-

Data / Parameter	$FL_{biogas,\ digester,y}$
Unit	m3 biogas leaked/m3
Description	Fraction of biogas that leaks from the digester
Source of data	IPCC (2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 5, Chapter 4)
Value(s) applied	0.05
Choice of data or Measurement methods and procedures	Default value stated in ACM0014 (version 6) is applied.
Purpose of data	Calculation of project emissions
Additional comment	-

Data / Parameter	$EF_{N2O,LA,sludge}$
Unit	t N_2O/t N
Description	Emission factor of nitrogen from sludge applied to land to be assumed
Source of data	Stehfest, E. and Bouwman, A.F. N_2O and NO emission from agricultural fields and soils under natural vegetation: summarizing available measurement data and modelling of global annual emissions. Nutr. Cycl. 29 Agroecosyst., in press. The average emission factor used is 0.01 kg N_2O-N / kg N (= 0.016 kg N_2O / kg N).
Value(s) applied	0.016
Choice of data or Measurement methods and procedures	No measurement procedures. Value to be applied: 0.016
Purpose of data	Calculation of project emission
Additional comment	Applicable if sludge is applied on lands under the project activity

Data / Parameter	$MCF_{sludge,LA}$
Unit	-
Description	Methane conversion factor for sludge used for land application
Source of data	ACM0014, version 6.0.0
Value(s) applied	0.05
Choice of data or Measurement methods and procedures	No measurement procedures. Value to be applied 0.05
Purpose of data	Calculation of project emission
Additional comment	Used to calculate project emission of sludge from land application

Data / Parameter	GWP_{N2O}
Unit	tCO_2e/tN_2O
Description	Global warming potential for N_2O
Source of data	IPCC
Value(s) applied	296
Choice of data or Measurement methods and procedures	Default to be applied: 296 for the first commitment period
Purpose of data	Calculation of project emission
Additional comment	The parameter shall be updated according to any future COP/MOP decisions

Data / Parameter	$SPEC_{flare}$
Unit	Temperature - ºC Flow rate or heat flux – kg/h or m3/h
Description	Manufacturer's flare specifications for temperature and flow rate
Source of data	Flare manufacturer as per option A in "Methodological tool of project emissions from flaring"
Value(s) applied	N/A
Choice of data or Measurement methods and procedures	The flare specifications set by the manufacturer for the correct operation of the flare: (a) Minimum and maximum inlet flow rate as 500 and 750 Nm3/hour respectively (b) Minimum and maximum operating temperature as 800 deg C and 1000 dec C respectively.
Purpose of data	Calculation of project emission
Additional comment	Only applicable in case of enclosed flare. Maintenance schedule is not required if option A is selected to determine flare efficiency of an enclosed flare.

Data / Parameter	$EF_{CO2,grid,y}$
Unit	tCO_2/MWh
Description	CO_2 emission factor for grid power
Source of data	Thai DNA and other publicly available sources in Thailand (please refer to Appendix 4)
Value(s) applied	0.5897 – Fixed ex-ante
Choice of data or Measurement methods and procedures	The emission factor is calculated according to the "Tool to calculate the emission factor for an electricity system" (version 02.2.1). The choice of data has been detailed in Annex-4.
Purpose of data	(i) Calculation of baseline emissions (ii) Calculation of project emissions
Additional comment	-

Data / Parameter	$F_{ww,CH4,default}$
Unit	Fraction
Description	Default factor representing the remaining CH_4 production capacity of liquid digestate
Source of data	Reference papers (see references below) and current industry practice
Value(s) applied	0.15
Choice of data or Measurement methods and procedures	The project involves with the installation of UASB type digester. The choice of data is based on the tool of project and leakage emissions from anaerobic digesters.
Purpose of data	The calculation of project emission
Additional comment	-

Data / Parameter	LHV_{CH4}
Unit	MJ/kg
Description	Low heating value
Source of data	IPCC value
Value(s) applied	50.4
Choice of data or Measurement methods and procedures	
Purpose of data	The calculation of baseline emission
Additional comment	-

Data / Parameter	$EF_{CH4,default}$
Unit	t CH4 leaked / t CH4 produced
Description	Default emission factor for the fraction of CH4 produced that leaks from the anaerobic digester
Source of data	Project and leakage emissions from anaerobic digesters (version 01.0.0) IPCC (2006), Flesch et al. (2011) and Kurup (2003)
Value(s) applied	Use the default value corresponding to the type of digester used in the project activity. The digester type shall be identified by manufacturer information. If this is not possible, then the factor 0.1 shall be applied (upper range of the IPCC values). • 0.028: Digesters with steel or lined concrete or fiberglass digesters and a gas holding system (egg shaped digesters) and monolithic construction; • **0.05:** UASB type digesters, floating gas holders with no external water seal; (This value is applied as the IC reactor is a type of UASB type digester) • 0.10: Digesters with unlined concrete/ferrocement/brick masonry arched type gas holding section; monolithic fixed dome digesters, covered anaerobic lagoon.
Choice of data or Measurement methods and procedures	-
Purpose of data	Calculation of project emissions
Additional comment	-

Data / Parameter	Ru
Unit	Pa.m^3/kmol.K
Description	Universal ideal gases constant
Source of data	Tool to determine the mass flow of a greenhouse gas in a gaseous stream (version 2.0.0)
Value(s) applied	8,314
Choice of data or Measurement methods and procedures	-
Purpose of data	Calculation of baseline/project emissions
Additional comment	-

Data / Parameter	MMi
Unit	kg/kmol
Description	Molecular mass of greenhouse gas i (CH4)
Source of data	Tool to determine the mass flow of a greenhouse gas in a gaseous stream (version 2.0.0)
Value(s) applied	16.04
Choice of data or Measurement methods and procedures	-
Purpose of data	Calculation of baseline and project emissions
Additional comment	-

Data / Parameter	P_n
Unit	Pa
Description	Total pressure at normal conditions
Source of data	Tool to determine the mass flow of a greenhouse gas in a gaseous stream (version 2.0.0)
Value(s) applied	101,325 Pa
Choice of data or Measurement methods and procedures	-
Purpose of data	Calculation of baseline/project emissions
Additional comment	-

Data / Parameter	**T_n**
Unit	K
Description	temperature at normal conditions
Source of data	Tool to determine the mass flow of a greenhouse gas in a gaseous stream (version 2.0.0)
Value(s) applied	273.15 K
Choice of data or Measurement methods and procedures	-
Purpose of data	Calculation of baseline/project emissions
Additional comment	-

Data / Parameter	**T_1**
Unit	K
Description	Temperature
Source of data	ACM0014
Value(s) applied	303.16 K (273.16 K + 30 K)
Choice of data or Measurement methods and procedures	-
Purpose of data	Calculation of baseline emissions
Additional comment	-

B.6.3. Ex ante calculation of emission reductions

Emission reductions are calculated as the difference between baseline emissions and project emissions in line with the provisions in ACM0014. In order to determine baseline emissions, the following data, variables, and parameters will be used for ex-ante calculations:

Baseline emissions: $BE_y = BE_{CH4,y} + BE_{EL,y} + BE_{HG,y}$ **(1)**			
Step 1: Calculation of baseline emissions from anaerobic treatment of the wastewater $BE_{CH4,MCF,y} = GWP_{CH4} * MCF_{BL,y} * B_o * COD_{BL,y}$ (4)			
Parameter	**Description**	**Value**	**Source**
$COD_{in,x}$	COD directed into open lagoon (tCOD/yr)	*65,923*	1-year historical data
$COD_{out,x}$	COD of the effluent (tCOD/yr)	*8,367*	1-year historical data
ρ	Discount factor for historical information	*1*	As per ACM0014
$F_{PJ,dig,m}$	Quantity of wastewater that is treated in the anaerobic digester in the project activity in month *m* (m³/month)	*31,250*	Designed
$COD_{PJ,y}$	Quantity of chemical oxygen demand that is treated in the anaerobic digester or under clearly aerobic conditions in the project activity	*62,627*	Calculated as per (6), section B.6.1

	in year *y* (t COD/yr)		
$COD_{BL,y}$	Quantity of chemical oxygen demand that would be treated in open lagoons (Scenario 1) in the absence of the project activity in year *y* (tCOD/yr)	*54,678*	Calculated as per (5), section B.6.1
GWP_{CH4}	Global Warming Potential of methane valid for the commitment period (tCO_2e/tCH_4)	*21*	As per ACM0014
B_o	Maximum methane producing capacity, expressing the maximum amount of CH_4 that can be produced from a given quantity of chemical oxygen demand (tCH_4/tCOD)	*0.25*	As per ACM0014
f_d	Factor expressing the influence of the depth of the lagoon on methane generation	*0.5*	As per ACM0014
$T_{2,m}$	Average temperature at the project site in month m (K)	Month / Temp.(K): Jan 290 Feb 293 Mar 295 Apr 298 May 298 Jun 297 Jul 296 Aug 296 Sep 296 Oct 295 Nov 293 Dec 290	Average temp. at the site in a month. Reference: http://www.kanchanaburi-info.com/en/weather.html
E	Activation energy constant (cal/mol)	*15,175*	As per ACM0014
T_1	Temperature (K)	*303.16*	As per ACM0014
R	Ideal gas constant (cal/K mol)	*1.987*	As per ACM0014
$f_{T,m}$	Factor expressing the influence of the temperature on the methane generation in month *m*	-	Calculated as per (11), section B 6.1
$COD_{PJ,m}$	Quantity of chemical oxygen demand that is treated in the anaerobic digester in the project activity in month *m* (tCOD/month)	*5,219 (300 operating days/12months)*	Calculated as per (10), section B 6.1
$COD_{BL,m}$	Quantity of chemical oxygen demand that would be treated in open lagoons in the absence of the project activity in month *m* (tCOD/month)	*4,557 (300 operating days/12months)*	Calculated as per (9), section B 6.1
$COD_{available,m}$	Quantity of chemical oxygen demand available for degradation in the open lagoon in month *m* (tCOD/month)	-	Calculated as per (8), section B 6.1
$COD_{dig,m}$	Chemical oxygen demand in the wastewater that is treated in the anaerobic digester in the project activity in month *m* (t COD/m³)	*0.1670*	Based on % efficiency of anaerobic digester
$f_{T,y}$	Factor expressing the influence of the temperature on the methane generation in year *y*	*0.88*	Calculated as per (12), section B 6.1
$MCF_{BL,y}$	Average baseline methane conversion factor (fraction) in year *y*, representing the fraction of ($COD_{PJ,y}$ x Bo) that would be degraded to CH_4 in the absence of the project activity	*0.55*	Calculated as per (7), section B 6.1
$BE_{CH4,y}$	Methane emissions from anaerobic treatment	*157,774*	Calculated as

	of the wastewater in open lagoons (scenario 1) in the absence of the project activity in year *y* (tCO_2e/yr)		per (4), section B 6.1

Step 2: Calculation of baseline emissions generation and/or consumption of electricity

$$BE_{EL,y} = (EC_{BL,y} \times EF_{BL,EL,y}) + (EG_{PJ,y} \times EF_{PJ,EL,y}) \quad (13)$$

Parameter	Description	Value	Source
$EC_{BL,y}$	Annual quantity of electricity that would be consumed in the absence of the project activity for the treatment of the wastewater (Scenario 1) (MWh/yr)	*Neglected as very small amount*	-
$EG_{PJ,y}$	Net quantity of electricity generated in year *y* with biogas from the new anaerobic biodigester (MWh/yr)	*10,801*	Calculated
$EF_{grid,y}$	Baseline emission factor for electricity generated and/or consumed in the absence of the project activity in year *y* (tCO_2/MWh)	*0.5897*	Thai DNA default values
$BE_{EL,y}$	CO_2 emissions associated with electricity generation that is displaced by the project activity and/or electricity consumption in the absence of the project activity in year *y* (tCO_2/yr)	*6,370*	Calculated as per (13)

Note: The emission coefficient is calculated as 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'. The $EF_{BL,EL,y}$ applied in this calculation is calculated based on the mentioned tool and announced by the Thai DNA. The electricity required for the baseline system is calculated based on the design. The biogas will be fed to two sets of 0.952MW generator. The electricity will be supplied to the national grid. Thus the net electricity exported will be calculated as total electricity generated minus self-consumption of biogas system. The details of project electricity consumption are as follows:

1) Total electricity generation
= **approx. 12,489 MWh/year**

2) The amount of electricity used in biogas system (from the required electricity of the equipment)
= **approx. 1,282 MWh/year**

Thus, electricity substitutes grid
= **approx. 11,206 Mwh/year**

Step 3: Calculation of baseline emissions from the generation of heat

$$BE_{HG,y} = \frac{HG_{PJ,y} * EF_{CO2,FF,boiler}}{\eta_{BL,boiler}} \quad \textbf{(16)}$$

Parameter	Description	Value	Source
$HG_{PJ,y}$	Net quantity of heat generated in year *y* with biogas from the new anaerobic digester (GJ)	*138,721*	Calculated based on historical data.
$EF_{CO2,FF,boiler}$	CO_2 emission factor of the fossil fuel type used in the boiler for heat generation in the absence of the project activity (tCO_2/GJ)	*0.0774*	IPCC value
$\eta_{BL,boiler}$	Efficiency of the boiler that would be used for heat generation in the absence of the project activity	*90%*	As per Tool
$BE_{HG,y}$	CO_2 emissions associated with fossil fuel combustion for heating equipment that is displaced by the project in year *y* (tCO_2/yr)	*9,663*	Calculated as per (13)

Project activity emissions: $PE_{AD,y} = PE_{EC,y} + PE_{FC,y} + PE_{CH4,y} + PE_{flare,y}$ **(17)**			
In line with ACM0014, the following emission sources are attributed to the project activity: ***Step 1: Determination of the quantity of methane produced in the digester ($Q_{CH4,y}$)*** $F_{CH4,RG,m} = V_{m,db} * v_{CH4,m,db} * \rho_{CH4,m}$ (18)			
Parameters	**Description**	**Value**	**Sources**
$V_{m,db}$	Volumetric flow of the residual gaseous stream in in year on dry basis (Nm3)	*14,783,100 (Based on 300 operating days)*	Technology provider
$v_{CH4,m,db}$	Volumetric fraction of the greenhouse gas CH_4 in the gaseous stream in minute m on dry basis (%).	*55%*	Technology provider
$\rho_{CH4,m}$	Density of greenhouse gas CH_4 in the gaseous stream in minute m (0.716 kg/m3) at reference conditions	*0.716*	As per ACM0014
$Q_{CH4,y}$	Mass flow of greenhouse gas CH_4 in the gaseous stream in year (kg)	*5,821,585*	Calculated as per section 6.1
Step 2: Determination of project emissions from electricity consumption ($PE_{EC,y}$) The project activity will be utilized electricity generated by the on-site biogas power plant thus; there will be zero emission from project electricity consumption. In case electricity is imported from the national grid, the actual amount of consumption will be monitored during the crediting period and the emission will be calculated based on detail in section B 6.1. $PE_{EC,y} = EC_{PJ,y} \times EF_{EL,y} \times (1+TDL_y)$ (19)			
Parameters	**Description**	**Value**	**Sources**
$EC_{PJ,y}$	Quantity of electricity consumed by the project electricity consumption in year *y* (MWh/yr)	*0*	Electricity generated by the project will be used to power equipment of the project. If grid electricity is used, this will be monitored and calculated.
EF_{ELy}	Emission factor for electricity generation in year *y* (tCO_2/MWh) equal to $EF_{grid, CM,y}$	*0.5897*	Announced by Thai DNA, calculated based on the 'Tool to calculate the emission factor for an electricity system' V.02.2.1
TDL_y	Average technical transmission and distribution loses for providing electricity in year *y*	*6.3%*	Annual report published by DEDE.
$PE_{EC,y}$	Project emission from electricity consumption in year *y* (tCO_2/yr)	*0*	Calculated as per section 6.1
Step 3: Determination of project emissions from fossil fuel consumption ($PE_{FC,y}$) $PE_{FC,y} = FC_{i,y} \times NCV_{i,y} \times EF_{CO2,i,y}$ (20)			
Parameters	**Description**	**Value**	**Sources**

$FC_{i,y}$	Quantity of fossil fuel type i combusted in the boiler during the year y (mass or volume unit/yr)	*0*	Assumed value.
$NCV_{i,y}$	Net calorific value of fossil fuel type i, GJ/mass or volume unit)	*0.0323*	HFO supplier
$EF_{CO2,i,y}$	CO_2 emission factor of fuel type i in the year y (tCO_2/GJ)	*0.0774*	As per ACM0014
$PE_{FC,y}$	Project emissions from fossil fuel consumption associated with the anaerobic digester in year *y* (tCO2e	*0*	Calculated as per section 6.1

Step 4: Determination of project emissions of methane from the anaerobic digester ($PE_{CH4,y}$)

$$PE_{CH4,y} = Q_{CH4,y} \times EF_{CH4,default} \times GWP_{CH4} \quad (21)$$

Parameters	Description	Value	Sources
$Q_{CH4,y}$	Quantity of methane produced in the anaerobic digester in year *y* (tCH4)	*5,822*	Calculated as per Eq. (17) in section 6.1
$EF_{CH4,defaut}$	Default emission factor for the fraction of CH4 produced that leaks from the anaerobic digester (fraction)	*0.05*	As per ACM0014
GWP_{CH4}	Global warming potential of CH4 (tCO2/tCH4)	*21*	As per ACM0014
$PE_{CH4,y}$	Project emissions of methane from anaerobic digester in year *y* (tCO2e)	*6,112*	Calculated as per Eq. (20) in section 6.1

Step 5: Determination of project emissions from flaring of biogas ($PE_{flare,y}$)

None of gas is expected to be flared. The actual gas to flare will be monitored during verification period;

$$PF_{flare,y} = \sum_{h=1}^{8760} TM_{RG,h} * (1 - \eta_{flare-h}) * GWP_{CH4}/1000 \quad (23)$$

Parameters	Description	Value	Sources
$FV_{RG,h}$	Volumetric flow rate of the residual gas in dry basis at normal conditions in hour h (Nm^3/h)	*0*	Calculated
$fv_{ch4,RG,h}$	Volumetric fraction of methane in the residual gas on dry basis in hour h	*55%*	Technology provider
$\rho_{CH4,h}$	Density of methane at normal conditions (kg/Nm^3)	*0.716*	As per Flaring tool
$TM_{RG,h}$	Mass flow rate of methane in the residual gas in the hour h (kg/h)	-	Calculated as per Step 5, section B 6.1
GWP_{CH4}	Global warming potential of methane (tCO_2e/tCH_4)	*21*	As per ACM0014
η_{flare}	Flare efficiency in hour h	*90%*	As per Flaring tool
$PE_{flare,y}$	Project emissions from physical leakage of methane from flaring (tCO_2e/yr)	*0*	Calculated as per Eq (23) in section B 6.1

Configuration (b)

It is not expected that the project activity will generate significant amount of sludge. The excess sludge may be used for starting up other systems equipped with biogas recovery or for soil application under aerobic conditions. The project emission of $PE_{sludge,LA,y}$ is assumed as zero for ex-ante calculation.

Leakage emission:			
$LE_{storage} = F_{ww,CH4,default} \times Q_{CH4,y} \times GWP_{CH4}$ (28)			
Parameter	**Description**	**Value**	**Source**
$F_{ww,CH4,default}$	Default factor representing the remaining methane production capacity of liquid digestate (fraction)	*0.1*	As per tool
$Q_{CH4,y}$	Quantity of methane produced in the digester in year y (tCH_4)	*5,822*	Calculated as per Eq. (17) in section 6.1
GWP_{CH4}	Leakage emissions associated with composting digestate in year y (tCO_2e/yr)	*21*	IPCC value

Emissions reductions:			
$ER_y=BE_y – PE_y - LE_y$ (28)			
Parameter	**Description**	**Value**	**Source**
BE_y	Baseline emission in year *y* (tCO_2e/yr)	138,286	Calculated as per (1)
PE_y	Project emission in year *y* (tCO_2e/yr)	*6,113*	Calculated as per (16)
LE_y	Leakage emissions in year *y* ($tCO_2e/year$)	*18,338*	As per section B 6.1
ER_y	Emission reduction in year *y* (tCO_2e/yr)	*113,835*	Calculated as per (26)

B.6.4. Summary of ex ante estimates of emission reductions

Year	Baseline emissions (t CO_2e)	Project emissions (t CO_2e)	Leakage (t CO_2e)	Emission reductions (t CO_2e)
2015	138,286	6,113	18,338	113,835
2016	138,286	6,113	18,338	113,835
2017	138,286	6,113	18,338	113,835
2018	138,286	6,113	18,338	113,835
2019	138,286	6,113	18,338	113,835
2020	138,286	6,113	18,338	113,835
2021	138,286	6,113	18,338	113,835
Total	986,022	42,789	128,366	796,847
Total number of crediting years	**796,847**			
Annual average over the crediting period	138,286	6,113	18,338	113,835

B.7. Monitoring plan

B.7.1. Data and parameters to be monitored

Data / Parameter	$F_{PJ,dig,m}$
Unit	m^3/month
Description	Quantity of wastewater that is treated in the anaerobic digester or under clearly aerobic conditions in the project activity in month *m*
Source of data	Measured
Value(s) applied	31,250
Measurement methods and procedures	Flow meter will be installed at the inlet to the UASB digester tanks for measurement of the influent wastewater into the tanks. The flow of wastewater will be monitored continuously and measurements will be recorded in the SCADA system. The measurements will be aggregated to give monthly values and reported quarterly.
Monitoring frequency	Continuous
QA/QC procedures	The flow meter will undergo maintenance / calibration in accordance with the manufacturer's specifications. Data will be archived electronically and kept until 2 years after the last issuance of credits. Meters will be installed to enable easy inspection at least half-yearly and are not to be installed where they will or may be submerged.
Purpose of data	(i) Calculation of baseline emission (ii) Calculation of project emission
Additional comment	For the purpose of ex ante estimation of emission reductions monthly wastewater flow was estimated based on 1,250 m^3/day for 300 operating days per year. This is based on typical operating conditions.

Data / Parameter	$COD_{,dig,m}$
Unit	T COD/m^3
Description	Chemical oxygen demand in the wastewater that is treated in the anaerobic digester in the project activity in month *m*
Source of data	Measurements
Value(s) applied	0.1670 – based on one-year historical data as given in Appendix 4
Measurement methods and procedures	The COD of the wastewater entering the UASB digester will be monitored daily by Papop's in-house lab. Average values will be calculated and reported quarterly.
Monitoring frequency	Daily
QA/QC procedures	Sampling and analysis will be carried out by plant technicians adhering to internationally recognized procedures. Data will be archived electronically and kept on site until 2 years after the last issuance of carbon credits.
Purpose of data	Sampling and analysis will be carried out by plant technicians adhering to internationally recognized procedures. Data will be archived electronically and kept on site until 2 years after the last issuance of car credits.
Additional comment	-

Data / Parameter	$T_{2,m}$
Unit	K
Description	Average temperature at the project site in month *m*
Source of data	Refer to national or regional weather statistics
Value(s) applied	-
Measurement methods and procedures	Refer to national or regional weather statistics
Monitoring frequency	Continuously, aggregated in monthly average values
QA/QC procedures	-
Purpose of data	Calculation of baseline emission
Additional comment	Applicable for the methane conversion factor method

Data / Parameter	$EG_{PJ,y}$
Unit	MWh/year
Description	Net quantity of electricity generated in year *y* with biogas from the new anaerobic.
Source of data	Measurements
Value(s) applied	10,801
Measurement methods and procedures	Metered continuously by electricity meters with data reported quarterly. Net quantity of electricity generated is the difference between electricity produced by the project and that consumed by the project equipment.
Monitoring frequency	Monitored daily and at least monthly recording.
QA/QC procedures	The metering system will consist of a main meter. Meters will be calibrated prior to synchronization and will undergo maintenance/calibration by the PEA. Data will be archived electronically and kept on site until 2 years after the last issuance of carbon credits. In event the meter is not functioning or removed for calibration, average power generation data for the month will be taken from the generation panel at the gas engine.
Purpose of data	Calculation of baseline emission
Additional comment	For the purpose of ex ante estimation of emission reductions the amount of biogas captured from the UASB digester was estimated based on the methane generation potential of the wastewater. The amount of biogas sent to the engine was based on the balance of biogas remaining after TSML's fuel oil requirements were met.

Data / Parameter	$EC_{PJ,j,y}$
Unit	MWh/yr
Description	Net quantity of grid electricity consumed by the project in year y
Source of data	Measurements
Value(s) applied	0
Measurement methods and procedures	Metered continuously by electricity meters with data reported quarterly. The readings will be based on monthly invoices or meter reading reports.
Monitoring frequency	Monitored daily
QA/QC procedures	The metering system will consist of a main meter. The power meter will be calibrated and undergo maintenance / calibration as per supplier's recommendation. Data will be archived electronically or on paper and kept on site until 2 years after the last issuance of carbon credits.
Purpose of data	Calculation of project emission
Additional comment	-

Data / Parameter	$HG_{PJ,y}$
Unit	GJ/year
Description	Net quantity of heat generated in year y by the biogas from proposed project activity combusted in the TSML boilers
Source of data	The value will be calculated based on the amount of biogas combusted in the boiler, the monitored methane content in the biogas, the net calorific value of methane and the rated efficiency of the TSML boiler, given in the boiler data specification sheet, by the suppliers.
Value(s) applied	138,721
Measurement methods and procedures	The value is calculated based on the annual biogas production, the monitored methane content in the biogas, the calorific value of biogas and the expectation that the biogas will displace 100% of the fuel oil used.
Monitoring frequency	Monitored daily
QA/QC procedures	Data will be archived electronically or on paper and kept on site until 2 years after the last issuance of carbon credits.
Purpose of data	Calculation of baseline emission
Additional comment	-

Data / Parameter	$F_{biogas,y}$
Unit	m^3 / yr
Description	Amount of biogas collected in the outlet of the new digester in year y
Source of data	Measured
Value(s) applied	14,783,100
Measurement methods and procedures	A mass flow meter or similar will be installed at the outlet to the UASB digester. The gas flow rate will be monitored continuously and measurements will be recorded quarterly.
Monitoring frequency	Parameter monitored continuously but aggregated annually for calculation
QA/QC procedures	The mass flow meter will be calibrated prior to installation. The meters will undergo maintenance/calibration as per the manufacturer's specifications. Data will be archived electronically or on paper and kept on site until 2 years after the last issuance of carbon credits.
Purpose of data	(i) Calculation of baseline emission (ii) Calculation of project emission
Additional comment	For the purpose of ex ante estimation of emission reductions the amount of biogas captured from the UASB digester was estimated based on the methane generation potential of the wastewater.

Data / Parameter	$w_{CH4,biogas,y}$
Unit	kg CH_4/m^3
Description	Concentration of methane in the biogas in the outlet of the new digester
Source of data	Measured
Value(s) applied	0.3938 kgCH4/m^3 Based on technology provider, methane fraction in produced biogas is 55% multiply with density of methane 0.716 kg/m^3.
Measurement methods and procedures	A continuous gas analyser will record the methane content in the biogas, with the measurements recorded monthly.
Monitoring frequency	Either with continuous analyser or alternatively with periodical measurement at 95% confidence level
QA/QC procedures	The continuous gas analyser will be calibrated prior to installation. The meters will undergo maintenance/calibration as per the manufacturer's specifications. Data will be archived electronically or on paper and kept on site until 2 years after the last issuance of carbon credits.
Purpose of data	(i) Calculation of baseline emission (ii) Calculation of project emission
Additional comment	For the purpose of ex ante estimation of emission reductions the concentration of methane in the biogas is estimated based on the expected concentration of 55% methane based on the design specifications of the UASB digester and an assumed standard density of methane of 0.716 kg/m^3.

Data / Parameter	$V_{RG,m}$
Unit	Nm^3
Description	Volumetric flow of the residual gas on dry basis at normal conditions in the minute m
Source of data	Measured by project developer using a flow meter
Value(s) applied	-
Measurement methods and procedures	The parameter is measured continuously on dry basis. The values will be averaged every minute. It will be ensured that same basis (dry or wet) is considered for this measurement and the measurement of volumetric fraction of methane when the temperature of residual gas exceeds 60 Deg C.
Monitoring frequency	Continuous
QA/QC procedures	The flow meter will be calibrated as per manufacturer's specifications but at least once every three years.
Purpose of data	Calculation of project emissions from flaring
Additional comment	The data will be stored for the crediting period + 2 years.

Data / Parameter	$T_{flare,m}$
Unit	°C
Description	Temperature in the exhaust gas of the enclosed flare in minute m
Source of data	Temperature sensor
Value(s) applied	-
Measurement methods and procedures	The flame temperature will be measured once per minute using a Thermocouple. The data will be recorded in the SCADA system but if this data is not available during a monitoring period, the flare efficiency will be assumed to be zero.
Monitoring frequency	Once per minute
QA/QC procedures	Thermocouple will be subject to calibration or replacement as per manufacturer's specification.
Purpose of data	Calculation of project emissions from flaring
Additional comment	The data will be stored for the crediting period + 2 years.

Data / Parameter	$v_{CH4,RG,m}$,
Unit	- (fraction)
Description	Volumetric fraction of component *methane* in the residual gas on a dry basis in minute m
Source of data	Measured by project developer using a continuous gas analyser
Value(s) applied	55% - for ex-ante estimation.
Measurement methods and procedures	The methane percentage shall be measured using continuous gas analyser. The value will be averaged on a minute basis. It will be ensured that same basis (dry or wet) is considered for this measurement and the measurement of volumetric flow when the temperature of residual gas exceeds 60 Deg. In case continuous analyser is not available, periodical measurements at a 90/10 confidence level should be made.
Monitoring frequency	Continuous during the operation of flaring
QA/QC procedures	The gas analyser will be periodically calibrated according to manufacturer's specifications/recommendation or at least once every three years. A zero check and a typical value check will be performed by comparison with a standard certified gas.
Purpose of data	Calculation of project emissions from flaring
Additional comment	The data will be stored for the crediting period + 2 years.

Data / Parameter	$Flame_m$
Unit	Flame on or Flame off
Description	Flame detection of flare in the minute m
Source of data	Project proponent
Value(s) applied	-
Measurement methods and procedures	Measured using a fixed installation optical flame detector.
Monitoring frequency	Once per minute.
QA/QC procedures	Equipment shall be maintained and calibrated in accordance with manufacturer’s recommendations.
Purpose of data	Calculation of project emissions from flaring
Additional comment	The data will be stored for the crediting period + 2 years.

Data / Parameter	$FC_{k,y}$
Unit	m^3/year
Description	Quantity of fossil fuel type k combusted in the thermal oil boiler
Source of data	Measured using flow meters
Value(s) applied	0 – (fuel oil) for ex-ante estimation
Measurement methods and procedures	The amount of fuel used in the boiler will be monitored continuously using a flow meter. The records will be kept as and 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.
Monitoring frequency	Continuous
QA/QC procedures	The measured value can be cross-checked with the purchase records. The flow meter will be calibrated as per manufacturer's specification or at least once every three years.
Purpose of data	Calculation of project emissions
Additional comment	The data will be stored for the crediting period + 2 years.

Data / Parameter	$EF_{CO2,k,y}$
Unit	tCO_2/TJ
Description	CO_2 emission factor of fossil fuel type k combusted in the boiler
Source of data	National value (if available) or most recent IPCC values
Value(s) applied	-
Measurement methods and procedures	As per the " Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion", the following order will be followed: (i) Values provided by fuel supplier in invoices (ii) Regional or national default values (iii) IPCC default values at the upper limit of the uncertainty at a 95% confidence interval as provided in Table 1.4 of Chapter 1 of vol 2 of the 2006 IPCC
Monitoring frequency	-
QA/QC procedures	Any future revision of the IPCC Guidelines will be taken into account
Purpose of data	Calculation of project emissions
Additional comment	The data will be stored for the crediting period + 2 years.

Data / Parameter	$NCV_{k,y}$
Unit	GJ/tonne
Description	Net calorific value of fossil fuel type k combusted in the boiler
Source of data	National value (if available) or most recent IPCC values
Value(s) applied	-
Measurement methods and procedures	As per the " Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion", the following order will be followed: (i) Values provided by fuel supplier in invoices (ii) Regional or national default values (iii) IPCC default values at the upper limit of the uncertainty at a 95% confidence interval as provided in Table 1.2 of Chapter 1 of vol 2 of the 2006 IPCC
Monitoring frequency	-
QA/QC procedures	Any future revision of the IPCC Guidelines will be taken into account
Purpose of data	Calculation of project emissions
Additional comment	The data will be stored for the crediting period + 2 years.

Data / Parameter	$TDL_{j,y}$
Unit	%
Description	Average technical transmission and distribution losses for providing electricity to the project activity (electricity import)
Source of data	Annual report published by DEDE and Ministry of Energy, Thailand
Value(s) applied	6.3% (based on most recent report published – Electric Power In Thailand – 2011)
Measurement methods and procedures	As per the guidance given in the "Tool to calculate baseline, project and/or leakage emissions from electricity consumption", most recent data available within the host country will be used during monitoring and verification.
Monitoring frequency	Annually
QA/QC procedures	Not applicable.
Purpose of data	Calculation of project emissions
Additional comment	The data will be stored for the crediting period + 2 years.

Data / Parameter	$S_{LA,m}$
Unit	t/month
Description	Amount of sludge applied to land in month *m*
Source of data	Measured
Value(s) applied	0 – initial assumption
Measurement methods and procedures	The project proponent does not envisage the generation of any sludge during the crediting period, however in case sludge is generated and removed from the digester; records will be kept on its quantity and disposal method and end use of final sludge. Frequency of measurement cannot be specified ex-ante. The total quantity of sludge will be measured on a wet basis. 100% of sludge will be monitored through continuous or batch measurements. The volume and density or direct weighing may be used to determine the sludge amount on wet basis. The moisture content will be monitored through representative sampling to ensure 90/10 confidence level.
Monitoring frequency	The frequency cannot be set ex-ante. The amount of sludge removal out of the system will be measured during the crediting period.
QA/QC procedures	The measurement equipment shall be calibrated based on manufacturer's specification but at least once every three years.
Purpose of data	Calculation of project emission
Additional comment	The data will be stored for the crediting period + 2 years.

B.7.2. Sampling plan

Not applicable.

B.7.3. Other elements of monitoring plan

The purpose of the monitoring plan is to ensure that the required data is accurately monitored and recorded to enable the calculation of the emission reductions achieved by the proposed project activity.

1. Monitoring Management

The required monitoring equipment will be installed and monitoring procedures will be followed as mentioned in section B.7.1. The data will be recorded on a continuous basis or as indicated in section B.7.1 and fed into the logbooks and the SCADA system. The data will be kept in both soft and hard copy format and proper data backups will be maintained. The calibration of monitoring equipment will be done on regular intervals as per manufacturer's specification or at least once every year. However, calibration of energy meters for the measurement of export/import is under the responsibility of PEA.

All biogas plant staff will be trained by Technology Provider Company prior to full commissioning of biogas plant. The training records can be checked during future verifications. The figure below outlines the structure of operation and management of the project activity.

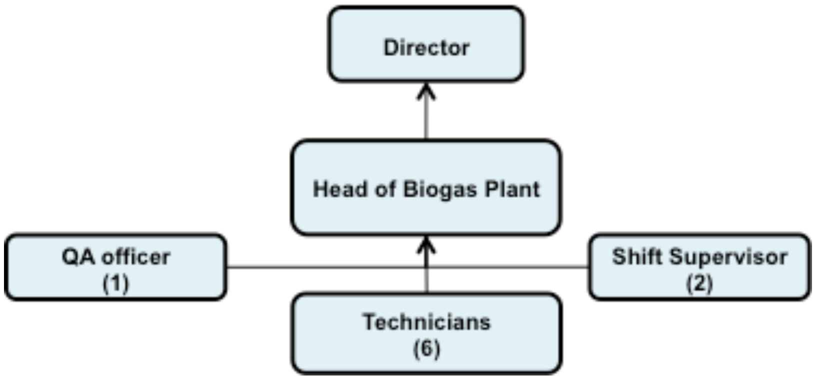


Figure of Organization chart

The overall responsibility regarding the proper operation, maintenance and CDM monitoring lies with the Managing Director who will be supported by the technicians who will undertake the actual measurements. Further the staff will follow monitoring procedures and GHG emission reduction standard requirement.

2. Quality Assurance and Quality Control
The team mentioned above will ensure proper and timely calibration (in accordance with the manufacturer specifications) of systems, data acquisition and storage. The head of biogas plant will also undertake regular follow-ups to make sure the data measured is consistent.

3. Data Storage and Filing
All monitoring data will be stored in the logbooks and in electronic format. The monitoring records shall be archived for a period of the crediting period plus 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. The project activity has many provisions to guarantee safety and some of these include pressure controller, gas analyser, automatic blowout, flame arrestor and switches. The operation manual for the project activity includes procedures on safety, which will make sure that the operators are fully aware of emergency procedures.

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 technician 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 application of methodology and standardized baseline and contact information of responsible persons/ entities

27/05/2015
Mr. Renat Heuberger
Managing Partner, Swiss Carbon Value Limited.

SECTION C. Duration and crediting period

C.1. Duration of project activity

C.1.1. Start date of project activity

25/06/2009, first payment for starting construction of project activity.

C.1.2. Expected operational lifetime of project activity

15 years 0 month

C.2. Crediting period of project activity

C.2.1. Type of crediting period

Renewable

C.2.2. Start date of crediting period

01/01/2016 or the date the DOE had submitted a complete request for registration

C.2.3. Length of crediting period

7 years 0 month

SECTION D. Environmental impacts

D.1. Analysis of environmental impacts

In accordance with the Thai environmental regulations, projects with a power plant capacity below 10MW are not required to carry out an Environmental Impact Assessment (EIA)[22]. However, an Initial Environmental Evaluation (IEE) has been done as part of the requirement of the Thai DNA[23]. The IEE report is considered by the Thai DNA committee meeting in relation to Thai sustainable development criteria for CDM. This process ensures that a project with the impact evaluation to the environment is considered in parallel with GHG reductions of the project.

The completed IEE report can be provided to the Designated Operation Entity (DOE) on request. The IEE report concluded that the project will create no negative impact on the local environment. In the event of a negative impact, mitigation measures need to be implemented. The main conclusions of the IEE report are:

Noise: The evaluation found out that the impact on the local community is negligible. In addition, the evaluation report showed that the noise level generated by project activity is lower than the standard as following;

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[22] Notification of Natural Resources and Environment Ministry, Re: The regulation of types and specifications of projects or business that require an environment impact assessment (EIA) including the principles, procedures, practices and guidelines for making an EIA report, under the "Enhancement and Conservation of Natural Environmental Quality Act of 1992", Part 4, Section 46-51.

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

Parameters	National standard[24]
Lmax	< 115 dB(A)
Leq 24 hr	< 70 dB(A)
Annoyance Noise	< 10 dB(A)

Air quality: The sources of air emission are from the gas generator of the project activity. The main emission due to the operation of the project activity (Total Suspended Particles (TSP), SO_2 and NO_2) is under the air quality standard of national regulation. Where:

Parameters	National standard[25] @24 hr.
TSP	< 330 µg/m^3
SO_2	< 300 µg/m^3
NO_2	< 320 µg/m^3

Effluent quality: Wastewater of the project activity is from the use of employee's daily activity and the wastewater treatment system. The effluent in the last pond will be reused for irrigation purpose. Therefore the impact on water quality due to the project activity is low.

The IEE report also recommended some preventive measures for the construction phase, as a means to manage on-site solid and liquid wastes, reduce noise, and recommend Occupational Health and Safety (OHS) measures. The IEE report also recommended 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. Environmental impact assessment

According to the IEE report, there is no significant environmental impact likely to occur due to the project activity. Moreover, according to the regulation, all significant pollutants other than greenhouse gases will be monitored and controlled.

SECTION E. Local stakeholder consultation

E.1. Solicitation of comments from local stakeholders

A stakeholder consulation meeting for the proposed project activity was held on 10/07/2009 at the meeting room of TSML, Tambon WangKhanai, Tha Muang district, Kanchanaburi Province. The purpose of meeting was as follows:

1. To introduce the greenhouse effect, Kyoto Protocol and the CDM process;
2. To present the proposed project activity to the local stakeholders;
3. To describe the advantages of developing the project under the CDM;
4. To describe the environmental impacts of the proposed project activity and outline mitigation of these impacts; and
5. To allow the stakeholders an opportunity to raise questions, expresses their concerns regarding the project, and to clarify issues if any.

Stakeholders were invited to attend the meeting via letters. Potential local stakeholders were identified through a consideration of those individuals/organisations that may have a general interest in the proposed project activity or live in close proximity to the proposed project activity site. Identified stakeholders included NGOs, academic institutions, and members of the local

[24] Notification of the Ministry of Industry on Specification of Annoyance Noise and Noise Level from the Factory. B.E. 2548 (2005)
[25] Ambient Air Standards. Notification of National Environmental Board No. 24, B.E. 2547 (2004) and No. 33 B.E. (2552) under the Enhancement and Conservation of National Environmental Quality Act B.E.2535 (1992).

community. Representatives from the Local Administrative Organizations and relevant government authorities were also invited to attend the meeting.

Sixty-two (62) participants from local authorities, Tambon Administrative Organization and villagers living nearby the project location participated the meeting. During the meeting, detailed information on the proposed project activity was presented by the project developers. This included a detailed explanation of the technology to be employed and a comparison between the proposed project activity and the existing open lagoon system, an overview of key environmental benefits such as a reduction in odour, greenhouse gas emissions, and surface and groundwater pollution and a detailed presentation on greenhouse gases, the Kyoto Protocol and the CDM. All presentations were made in Thai.

Following the initial presentation, a question and answer session was held to allow stakeholders to raise questions regarding the impacts of the project and to share opinions. Representatives from Papop answered questions regarding the biogas technology, climate change and the development of the project under the CDM.

E.2. Summary of comments received

During the stakeholder consultation meeting, the project developer clarified all raised issues and provided a detailed explanation of technology to be applied. The following responses were provided to the questions asked during the local stakeholder meeting:

1. *Quality of the treated wastewater*:
    a. Wastewater from the TSML distillery does not contain any metal contaminants and there will be no affect on the surrounding areas, including local farmland.
    b. The biogas system may be applied to other projects in the local area, including the city council. However, Papop will only be able to develop projects one at a time.
    c. The project developer will make the results of the wastewater quality analysis available to any interested parties. Wastewater quality analysis will be conducted by an external agency.
    d. The UASB digester is made of reinforced concrete and therefore wastewater will not leach into the groundwater system. Therefore, there will be no contamination of the local groundwater or public water supply.
2. *The operational lifetime of the proposed project activity:*
   The UASB system lifetime is approximately 20 years and an annual maintenance program is planned.
3. *Sludge management:* The UASB will not produce large quantities of sludge. Any sludge that is removed may be used for the purpose of further UASB projects. Sludge will not be disposed of on land or in waterways.

At the conclusion of the local stakeholder meeting the participants indicated they were satisfied that the proposed project activity had positive environmental outcomes and that they would report back positively to villagers.

E.3. Report on consideration of comments received

As no major concerns were raised during the entire 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.

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

SECTION F. Approval and authorization

The letter of approval from following parties to be involved in the project activity is available at the time of submitting the PDD to the validating DOE

Date of approval	Party to be involve in the project activity
08/08/2010	Thailand (horst country)

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Appendix 1. Contact information of project participants and responsible persons/ entities

Project participant and/or responsible person/ entity	☒ Project participant ☐ Responsible person/ entity for application of the selected methodology (ies) and, where applicable, the selected standardized baselines to the project activity
Organization name	Papop Renewable Company Limited
Street/P.O. Box	4/34, Moo 1, Soi Prasurtmanukitch 5, Prasurtmanukitch Rd. Jorakaebua, Ladprao
Building	-
City	Bangkok
State/Region	-
Postcode	
Country	Thailand
Telephone	+66 2 570 5580
Fax	+66 2 570 5581
E-mail	likit@papop.com
Website	www.papop.com
Contact person	-
Title	Mr.
Salutation	Managing Director
Last name	Nimtrakul
Middle name	-
First name	Likit
Department	-
Mobile	-
Direct fax	-
Direct tel.	-
Personal e-mail	likit@papop.com

Project participant and/or responsible person/ entity	☒ Project participant ☒ Responsible person/ entity for application of the selected methodology (ies) and, where applicable, the selected standardized baselines to the project activity
Organization name	Swiss Carbon Value Limited
Street/P.O. Box	-
Building	Technoparkstr. 1
City	Zurich
State/Region	-
Postcode	8005
Country	Switzerland
Telephone	+41 43 501 35 50
Fax	-
E-mail	registration@southpolecarbon.com

Website	-
Contact person	-
Title	Mr.
Salutation	Managing Partner
Last name	Heuberger
Middle name	-
First name	Renat
Department	-
Mobile	-
Direct fax	-
Direct tel.	-
Personal e-mail	-

Appendix 2. Affirmation regarding public funding

No public funding from Annex I countries has been sought for this project.

Appendix 3. Applicability of methodology and standardized baseline

Appendix 4. Further background information on ex ante calculation of emission reductions

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Appendix 5. Further background information on monitoring plan

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Appendix 6. Summary of post registration changes

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