Project design document form for small-scale CDM project activities

(Version 05.0)

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

PROJECT DESIGN DOCUMENT (PDD)	
Title of the project activity	Biogas Project at MH Bio-Ethanol Distillery, Cambodia
Version number of the PDD	11.0
Completion date of the PDD	09/12/2014
Project participant(s)	MH Bio-Energy Co., Ltd
Host Party	Kingdom of Cambodia
Sectoral scope and selected methodology(ies), and where applicable, selected standardized baseline(s)	Sectorial Scope 13 – Methane Recovery in Wastewater Treatment - AMS-III.H. (Version 16.0) and Sectorial Scope 01 – Thermal Energy for User - AMS-I.C. (Version 18.0)
Estimated amount of annual average GHG emission reductions	58,146

SECTION A. Description of project activity

A.1. Purpose and general description of project activity

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MH Bio-Energy Co., LTD, bio-ethanol distillery Cambodia, has taken the initiative for the implementation of the project activity in Duong village, Preak Phnouv Commune, Pornhear Leu District, Phnom Penh Province, Kingdom of Cambodia.

The Project activity involves the installation of an anaerobic digestion system with methane recovery for the treatment organic wastewater generated by an existing ethanol manufacturing plant. The recovered methane will be used for steam generation onsite consumption that will displace fuel oil (RFO) consumed in co-fired boilers. The Project activity therefore results in a reduction of methane that would have otherwise been allowed to dissipate into the atmosphere, at the same time displace the use of fossil fuels (RFO) for steam. Wastewater treatment facility is an integrated part of the distillery of MH Bio-Energy Co., LTD (hereafter referred to as MH). Wastewater is generated 1,200m^3/day dependent on quantity of ethanol production 40,000kl.

<u>Contribution to Sustainable Development</u>

Cambodian DNA (Designated National Authority) presents a document regarding sustainable development criteria for proposed CDM activities[1]. The following shows how the project meets the 4 criteria outlined in the instruction.

Environmental Protection and Improvement

By recovering and utilizing methane, which would have otherwise been emitted to the atmosphere, the project contributes to mitigation of global climate change.

1) Reducing air pollution, odor and also will not result negative environmental impact.
2) Recovered methane displace carbon intensive fossil fuel, other chemical components otherwise would evaporate to the atmosphere are reduced

Social-Enhancement of income and quality of life

1) Improving human capacity and diversity of new job opportunity for the biogas recovery and wastewater treatment sector. It will contribute to enhancement of Cambodian staffs' income and quality of life.

Technology transfer

1) Relevant technologies will be transferred to Cambodian local staff through MH's manpower training schedule.

Economic Benefits

1) Reducing fossil fuel consumption: Since nearly 100% of fossil fuel is imported to Cambodia, the project partially attribute to energy independence and Cambodia's national economy.

A.2. Location of project activity

A.2.1. Host Party

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Kingdom of Cambodia

A.2.2. Region/State/Province etc.

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Pornhear Leu district/ Phnom Penh province

[1] The document is titled Sustainable Development Criteria for Clean Development Mechanism (CDM) Projects and available from the DNA.

A.2.3. City/Town/Community etc.

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Duong village/ Preak Phnouv Commune

A.2.4. Physical/Geographical location

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The plant is located at Duong village, Pornhear Leu district, Phnom Penh. The site is well connected by 5 national roads. It is located at 11° 45’13,01N, 104°49’32,67 E

Location map

A.3. Technologies and/or measures

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Type and Category(ies)

In accordance with Appendix B of the simplified modalities and procedures for small-scale CDM project activities, the proposed Project falls under the following type and categories;

Type III : Other Project Activities
Category H. Methane recovery in Wastewater Treatment
Project: Fugitive methane capture

Type I : Renewable energy projects
Category C. Thermal energy production with or without electricity
Project: Replacement of fossil fuel with captured biogas to generate steam

Technology /measure of the small-scale project activity

Technology of the Project

Methane recovery
The technology to be implemented by the project activity is conventional type of anaerobic digester with circulator. An anaerobic double-digester, 1m thickness top-sealed concrete building, is designed and installed with the wastewater treatment system as well as biogas extraction system. The anaerobic digester reduces the COD concentration of the wastewater from around 40,000 mg/l at the in-let of the digester to around 2,000 mg/l at the out-let of the digester. The technical specifications of the digesters are detailed on the <Table A.4.2-2> below.

The recovered biogas (52%-55% of CH_4 content) from the top-sealed digesters is sent to the gas holder for purification and blown to the co-fired boilers. The project will introduce double digesters, a biogas holder, piping system, measurement devices and blowers to transport the biogas to the co-fired boilers, In addition, project participants planned to introduce the biogas generator to burn the excess of biogas if the boiler fail. During scheduled maintenance period, the remained gas will be used to generate electricity for office use. Therefore, none of biogas excess to dissipated into the atmosphere during the crediting period. Since this gas generator will not be operated continuously, project participant will not claim the CER benefit.

Heat generation
In the project activity, two units of co-fired burners are introduced to existing fire &smoke tube type boilers to produce steam which is used for bio-ethanol process. Most recovered and purified biogas will be utilized for boiler fuel combining with residual fuel oil. Technology parameters are detailed on the <Table A.4.3-1>below.

Main technical parameters for the project activity are shown in <Table A.4.3-1> and <Table A.4.3-2> respectively.

<Table A.4.3-1> Main technical parameters designed of the project activity

Parameters	Unit	Value
Number of days ethanol plant operation	Days /year	330
Wastewater generation amount(Maximum)	m^3 /day	1,200
COD inflow to the Digester	mg /l	40,000
COD out from the Digester	mg / l	2,000
COD in final discharge to the lake	mg /l	100

<Table A.4.3-2> Specifications of Digester and devices installed.

Components	Specification		
Methane recovery system	Digester	Capacity	5,000 m^3 * 2 units
		Detention time	10.4 days
		Removal efficiency (designed)	Over 95%
		Construction	Top sealed concrete building
Heat generation system	Co-fired Boiler	Output	15ton/hour *2 units
		Pressure	10kg/cm^2
		Type	Fire & Smoke tube
		Rated capacity	11.56*2units=23.12$MW_{thermal}$
Sub-equipments	Blower	Capacity	37 kw*4 units(Spare 2unit)
		Pressure	0.5 kg/ cm^2 respectively

	Circulation pump	Capacity	37 kw * 6 units (Spare 2unit)
	Wastewater pump	Capacity	15 kw * 2 units
	Aerator	Capacity	30 kw * 4 units

** Source: Manufacturer's specification

Main technical parameters for baseline scenario are shown in the <Table A.4.3-3>. As per the table, open anaerobic lagoons are designed to meet the applicable wastewater quality standards (under 100mg/L of COD) as per Sub-Decree on Water Pollution Control (NO 27 ANRK BK Phnom penh, April 06, 1999).

<Table A.4.3-3> Main technical parameters of the baseline scenario

Parameters	Unit	Value
Operating days	Days/year	330
COD of wastewater flow into the open anaerobic lagoons	mg /l	40,000
COD of wastewater discharged from the open anaerobic lagoons to the river	mg /l	100
Depth of open anaerobic lagoons	M	5
Design removal efficiency of each open anaerobic lagoon[2]	%	90
Number of open anaerobic lagoons		28

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)
Kingdom of Cambodia	MH Bio-Energy Co., Ltd (Private entity. Project developer.)	No

A.5. Public funding of project activity

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No public funding from parties included in Appendix I is available to the project.

A.6. Debundling for project activity

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As highlighted in Appendix C of the Simplified Modalities and Procedures for Small-Scale CDM project activities, a proposed small-scale project activity shall be deemed to be a debundled component of a large project activity if there is a registered small-scale CDM project activity or an application to register another small-scale CDM project activity:

§ With the same project participants;
§ In the same project category and technology/measure;
§ Registered within the previous 2 years; and
§ Whose project boundary is within 1 km of the project boundary of the proposed small-scale activity at the closest point.

On the basis of the above, the Project cannot be considered a debundled component of a larger project

[2] It must be less than 100mg/L as per the wastewater quality standard of the Cambodia.

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

B.1. Reference of methodology and standardized baseline

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<u>Methane recovery component</u>
Type III.H: Methane Recovery in Wastewater Treatment
Reference: '*Methane recovery in wastewater treatment'* approved small scale CDM baseline methodology III.H./Version 16_Scope 13_EB58.

<u>Heat generation component</u>
Type I.C: Thermal Energy for User
Reference '*Thermal Energy production with or without electricity'* approved small scale CDM baseline methodology
I.C./Version 18_Scope01_EB56.

B.2. Project activity eligibility

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Methane recovery in wastewater treatment
Type III.H: Methane Recovery in Wastewater Treatment
Reference: '*Methane recovery in wastewater treatment'* approved small scale CDM baseline methodology III.H./Version 16_Scope 13_EB58.

No.	Technology/Measure	*In the case of project*	Applicability
1	This methodology comprises measures that recover biogas from biogenic organic matter in wastewater by means of one, or a combination, of the following options: (d) Introduction of biogas recovery and combustion to an anaerobic wastewater treatment system such as anaerobic reactor, lagoon, septic tank or an on site industrial plant	*The project introduced a biogas recovery and combustion to an anaerobic wastewater treatment system.*	Applicable
2	In cases where baseline system is anaerobic lagoon the methodology is applicable: (a) The lagoons are ponds with a depth greater than two meters, without aeration. The value for depth is obtained from engineering design documents, or through direct measurement, or by dividing the surface area by the total volume. If the lagoon filling level varies seasonally, the average of the highest and lowest levels may be taken; (b) Ambient temperature above 15°C, at least during part of the year, on a monthly average basis; (c) The minimum interval between two consecutive sludge removal events shall be 30 days.	*In absence of the project activity, the wastewater would have been treated in open lagoons without aeration.* *The ambient average temperature at Phnom Penh is above 15 ℃.* *The sludge removal period is expected to be more than 1 year.*	Applicability
3	The recovered biogas from the above measures may also be utilized for the following applications instead of combustion/flaring: (a) Thermal or mechanical,2 electrical energy	*The project is covered under paragraph 3 (a). The recovered methane is utilized*	Applicable

	generation directly; (b) Thermal or mechanical, electrical energy generation after bottling of upgraded biogas, in this case additional guidance provided in Annex 1 shall be followed; or (c) Thermal or mechanical, electrical energy generation after upgrading and distribution, in this case additional guidance provided in Annex 1 shall be followed: (i) Upgrading and injection of biogas into a natural gas distribution grid with no significant transmission constraints; (ii) Upgrading and transportation of biogas via a dedicated piped network to a group of end users; or (iii) Upgrading and transportation of biogas (e.g. by trucks) to distribution points for end users. (d) Hydrogen production; (e) Use as fuel in transportation applications after upgrading.	*directly for Thermal energy generation.*	
4	If the recovered biogas is used for project activities covered under paragraph 3(a), that component of the project activity can use a corresponding methodology under Type Ⅰ.	*The approved baseline and monitoring Methodology AMS I.C. is used for the heat generation component of the project activity*	Applicable
5	If the recovered biogas is utilized for production of hydrogen (project activities covered under paragraph 3 (d)), that component of project activity shall use corresponding category AMS-Ⅲ.O.	*The project is not covered under paragraph 3 (d).*	N/A
6	In case of project activities covered under paragraph 3 (b) if bottles with upgraded biogas are sold outside the project boundary the end-use of the biogas shall be ensured via a contract between the bottled biogas vendor and the end-user. No emission reductions may be claimed from the displacement of fuels from the end use of bottled biogas in such situations. If however the end use of the bottled biogas is included in the project boundary and is monitored during the crediting period CO_2 emissions avoided by the displacement of the fuels is eligible under a corresponding Type Ⅰ methodology, e.g., AMS-**I**.C.	*The project is not covered under paragraph 3 (b).*	N/A
7	In case of project activities covered under paragraph 3(c i) emission reductions from the displacement of the use of natural gas is eligible under this methodology, provided the geographical extent of the natural gas distribution grid is within the host country boundaries.	*The project is not covered under paragraph 3 (c i).*	N/A
8	In particular, for the case of 3 (b) and (c) (iii), the physical leakage during storage and transportation of upgraded biogas, as well as the emissions from fossil fuel consumed by vehicles for transporting biogas shall be considered. Relevant procedures in paragraph 11 of Annex 1 of AMS-III.H "Methane recovery in wastewater treatment" shall be followed in this regard.	*The project is not Covered under paragraph 3 (c ii).*	N/A
9	In case of project activities covered under paraagraph3	*The project is not*	N/A

	(b) and (c), this methodology is applicable of upgraded methane content of the biogas is in accordance with relevant national regulations (where these exist) or, in the absence of national regulations, a minimum of 96% (by volume).	*covered under paragraph 3 (b) and (c).*	
10	If the recovered biogas is utilized for the production of hydrogen (project activities covered under paragraph 3 (d)), that component of the project activity shall use the corresponding methodology AMS-III.O .Hydrogen production using methane extracted from biogas..	*The recovered biogas is not utilized for the production of hydrogen.*	N/A
11	If the recovered biogas is used for project activities covered under paragraph 3 (e), that component of the project activity shall use corresponding methodology AMS-III.AQ .Introduction of Bio-CNG in road transportation.	*The recovered biogas is not used for project activities covered under paragraph 3(e)*	N/A
12	New facilities (Green field projects) and project activities involving a change of equipment resulting in a capacity addition of the wastewater or sludge treatment system compared to the designed capacity of the baseline treatment system are only eligible to apply this methodology if they comply with the requirements in the General Guidance for SSC methodologies concerning these topics. In addition the requirements for demonstration of the remaining lifetime of the equipment replaced as described in the general guidance shall be followed.	*The project is New facilities (Greenfield projects).*	Applicable
13	The location of the wastewater treatment plant shall be uniquely defined as well as the source generating the wastewater and described in the PDD.	*The location of the wastewater treatment plant uniquely defined in the PDD.*	Applicable
14	Measures are limited to those that result in aggregate emission reductions of less than or equal to 60kt CO_2 equivalent annually from all TypeⅢ components of the project activity.	*Annual emission reductions achieved by the methane recovery component of the project is estimated to be 47,110tCO_2e, which is less than 60 ktCO_2e.*	Applicable

Thermal energy for user

AMS-I.C (Version 18) is applicable to the heat generation component of the project activity as shown in the following table

NO.	Technology/measure	*In case of the project*	Applicability
1	This category comprises renewable energy technologies that supply users with thermal energy that displaces fossil fuel use. These units include technologies such as solar thermal water heaters and dryers, solar cookers, energy derived from renewable biomass and other technologies that provide thermal energy that displaces fossil fuel.	*The project will generate thermal energy (steam) from biogas captured through wastewater treatment process and displace steam that would have been supplied by a co- fired boilers.*	Applicable
2	Biomass-based cogeneration systems consisting of steam generator(s) and steam turbine(s) are included in this category. For the purpose of this methodology "cogeneration" shall mean the simultaneous generation	*The project activity is not cogeneration system.*	N/A

	of thermal energy and electrical energy in one process. Project activities that produce heat and power in separate element processes do not fit under the definition of cogeneration project.		
3	Biomass-based co-generating systems that produce heat and electricity are included in this category. For the purpose of this methodology "Cogeneration" shall mean the simultaneous generation of thermal energy and electrical and/or mechanical energy in one process. Cogeneration system may supply one of the following: (a) Electricity to a grid; (b) Electricity and/or thermal energy (steam or heat) for on-site consumption or for consumption by other facilities; (c) Combination of (a) and (b).	*The project activity is not cogeneration system.*	N/A
4	The total installed rated thermal energy generation capacity of the project equipment is equal to or less than 45MW thermal (see paragraph 5 for the applicable limits for cogeneration project activities).	*The aggregated installed capacity of the co-fired boilers are equivalent to 23.12MWth(see table B.2).*	Applicable
5	For co-fired systems, the total installed thermal energy generation capacity of the project equipment, when using both fossil and renewable fuel shall not exceed 45MW thermal (see paragraph 5 for the applicable limits for cogeneration project activities).	*Ditto.*	Applicable
6	The following capacity limits apply for biomass cogeneration units: (a) If the project activity includes emission reductions from both the thermal and electrical energy components, the total installed energy generation capacity (thermal and electrical) of the project equipment shall not exceed 45MW thermal. For the purpose of calculating this capacity limit the conversion factor of 1:3 shall be used for converting electrical energy to thermal energy (i.e., for renewable project activities, the maximal limit of 15MW(e) is equivalent to 45MW thermal output of the equipment or the plant); (b) If the emission reductions of the cogeneration project activity are solely on account of thermal energy production (i.e., no emission reductions accrue from electricity component), the total installed thermal energy production capacity of the project equipment of the cogeneration unit shall not exceed 45MW thermal; (c) If the emission reductions of the cogeneration project activity are solely on account of electrical energy production (i.e., no emission reductions accrue from thermal energy component), the total installed electrical energy generation capacity of the project equipment of the cogeneration unit shall not exceed 15MW.	*The project activity is not cogeneration system.*	N/A
7	In case electricity and/or steam/heat produced by the project activity is delivered to another facility or facilities within the project boundary, a contract	*The electricity produced by project activity is not*	N/A

	between the supplier and consumer(s), of the energy will have to be entered into specifying that only the facility generating the energy can claim emission reductions from the energy displaced.	*delivered to another facility or facilities within the project boundary.*	
8	Project activities that seek to retrofit or modify an existing facility for renewable energy generation are included in this category.	*The project activity is new facilities (green field projects).*	N/A
9	The capacity limits specified in the above paragraphs apply to both new facilities and retrofit projects. In the case of project activities that involve the addition of renewable energy units at an existing renewable energy facility, the total capacity of the units added by the project should comply with capacity limits in paragraphs 3 to 5 and should be physically distinct from the existing units.	*The project activity is new facilities (green field projects).*	N/A
10	Charcoal based biomass energy generation project activities are eligible to apply the methodology only if the charcoal is produced from renewable biomass sources provided: (a) Charcoal is produced in kilns equipped with methane recovery and destruction facility; or (b) If charcoal is produced in kilns not equipped with a methane recovery and destruction facility, methane emissions from the production of charcoal shall be considered. These emission shall be calculated as per the procedures defined in the approved methodology AMS-Ⅲ.K. Alternatively, conservative emission factor values from peer reviewed literature or from a registered CDM project activity can be used, provided that it can be demonstrated that the parameters from these are comparable e.g., source of biomass, characteristics of biomass such as moisture, carbon content, type of kiln, operating conditions such as ambient temperature.	*The project activity is not covered charcoal biomass sources.*	N/A
11	If solid biomass fuel (e.g. briquette) is used, it shall be demonstrated that it has been produced using solely renewable biomass and all project or leakage emissions associated with its production shall be taken into account in emissions reduction calculation.	*The project activity is not solid biomass.*	N/A

Total installed capacity is 23.12 $MW_{thermal}$ this is below the threshold of 45 $MW_{thermal}$. The installed capacity can be found in <Table B. 2>.

<Table B.2> Total installed thermal energy production capacity of the total installed capacity

Energy generation units	Name/type	Installed capacity($MW_{thermal}$)
Boiler 1(15 ton/hr,10kg/㎠)	Fire & Smoke Tube	11.56
Boiler 2(15 ton/hr.10kg/㎠)	Fire & Smoke Tube	11.56
Total		23.12

B.3. Project boundary

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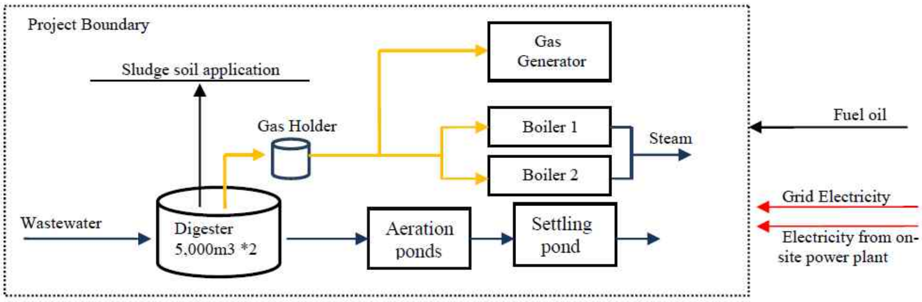
According to approved small scale CDM baseline methodology III.H, the project boundary is the physical, geographical site where the wastewater and sludge treatment takes place in baseline and project situation. It covers all facilities affected by the project activity including sites where the processing, transportation and application or disposal of waste products as well as biogas takes place.

The project boundary for the proposed project activity is from the entry point of raw wastewater into the digesters to the soil application point where the sludge is applied to soil, and up to the point of utilization of the generated biogas as a fuel.

Furthermore, since only the anaerobic waste water treatment system will be affected by the project activity which introduce biogas recovery and utilization systems on the anaerobic digesters, while others remain the same, according to the methodology AMS-III.H (Version 16), the emissions from those parts of the waste water treatment plants will not be accounted for baseline and project emission calculation, because the same emissions would occur in both baseline and project scenarios.

According to approved small scale CDM baseline methodology I.C., the project boundary is the physical and geographical site of the renewable energy generation. A representation of the project boundary can be seen in the figure <Figure B.3.1> below

<Figure B.3.1>



B.4. Establishment and description of baseline scenario

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The baseline for the project activities involves two components, the methane avoidance component and the heat generation component. For two components, the baseline can be defined as;

<u>Methane avoidance component</u>

Since the project is the Greenfield (New facility) project, baseline can be defined in line with the Paragraph 12 of AMS III.H version 16(EB 58) as "Greenfield projects are only eligible to apply this methodology if they comply with the relevant requirements in the 'General Guidelines to SSC CDM methodologies'".

As per paragraph 19 of the 'General Guidelines to SSC CDM methodologies(version17)', Type III Greenfield project (new facilities) may use a Type III small scale methodology provided that they can demonstrate that the most plausible baseline scenario for this project activity is the baseline provided in the Type III small-scale methodology. The demonstration should include the assessment of the alternatives of the project activity using the following steps;

Step1. Identify the various alternatives

The three alternatives could be applied for the project activity as stated on <Table B.4>.

<Table B.4> Alternatives for the project

Alternatives	Details
1	Anaerobic digester with methane recovery (the proposed project activity undertaken without being registered as a CDM project activity);
2	The untreated wastewater being discharged into sea, river, lake, stagnant sewer or flowing sewer

3	The anaerobic lagoon wastewater treatment system without methane recovery

Step2. Compliance with the local regulations

Wastewater generated from the MH ethanol process have to be discharged to the lake, lower than 100 mg/l of COD value, which is mandatory wastewater quality standard (Sub-decrees on Water Pollution Control). Since wastewater from the ethanol plant before treatment contain the very high level of COD content (around 40,000mg/l), wastewater should be treated and discharged compliance with the local regulation. Therefore, the alternative 2 (untreated wastewater) has to be excluded due to infringe the mandatory applicable laws and regulations.

Step 3. Barrier test

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

Investment barrier
The easiest alternative to MH is the open anaerobic lagoons, no extra investment would be necessary to install and operate the system. Using this system, methane is emitted naturally to the atmosphere, without emission control. But, since Cambodian environmental regulation does not prohibit the methane evaporation to the atmosphere, this alternative has not barrier to apply.

The choice of an anaerobic wastewater treatment system was made in order to keep attending the Cambodian environmental regulations and to use the biogas as a fuel in the boilers. But, huge amount of capital investment should be needed to apply this system. Project participant do not like new investment to the Cambodian plant due to lower feasibility of the project. Generally, financial indicator NPV or IRR take into account to check the project feasibility. To check investment feasibility for this project, IRR indicator is calculated and considered as to test the investment barrier. As stated section B.5 (a) in this PDD, significantly lower value of IRR is clearly mentioned that the project has an investment barrier.

Except investment barrier, other barriers e.g technical barrier, prevailing barrier and business culture barrier are exited. But the core barrier is the investment barrier for this project. Therefore, alternative 1 (the proposed project activity undertaken without being registered as a CDM project activity) shall be excluded for the baseline scenario.

In Cambodia, ethanol plants apply an open lagoon wastewater treatment system due to the system requires low-tech and skills as well as there are very low risks associated with technology. Therefore alternative3 (the anaerobic lagoon wastewater treatment system without methane recovery) remained as the most plausible baseline scenario for this project activity.
Therefore only one alternative (the anaerobic lagoon wastewater treatment system without methane recovery) remains as the baseline scenario for this project activity.

Step 4
Since only one remained alternative is not the proposed project activity undertaken without being registered as a CDM project activity; and it corresponds to one of the baseline scenarios provided in the methodology, the project activity is eligible under the methodology (AMS III.H version 16).
Therefore, baseline scenario can be defined as ‘the anaerobic wastewater treatment system without biogas recovery’, as mention in paragraph 1 (d) of methodology AMS III.H version 16.

Heat generation component

For the heat generation component, the baseline is the continuation of current practices of using residual fuel oil (RFO) as fuel for the steam boilers to supplement the heat (steam) for the ethanol manufacturing process. In the project activity a steam boilers for the purpose of ethanol process is installed with a dual fuel burner capable of burning both biogas and fuel oil.

B.5. Demonstration of additionality

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Prior consideration of CDM

In early planning stage of the ethanol plant, the MH was aware of the concept of CDM and considered possible application of CDM in its wastewater treatment process as digester technology was sophisticated but required much more cost compared to popular wastewater treatment by anaerobic open lagoons. In order to assess eligibility for CDM and its environmental / financial benefit, the MH asked the CDM consultant company to prepare a Feasibility Study Report (FSR). The FSR concluded that project would be financially acceptable only when CER revenue was considered. Based on the results of the FSR, MH decided to invest the project. The history is as summarized in <Table B.5.1>

<Table B.5.1> Prior Consideration

History	On /within time schedule	details
Land-breaking for the Bio ethanol plant construction	Nov. 2006	Bio ethanol factory
Final decision to execute CDM project	Feb. 14. 2008	Internal decision

<Table B.5.2> Project starting date and onwards

Schedule	On /within time schedule	details
The starting date of project	Mar. 15. 2008	The internal document regarding the main equipment purchase decision
The stakeholders meeting	May. 15. 2008	
DNA approval (Cambodia)	June. 29. 2009	

Additionality

To demonstrate and assess additionality, an investment analysis is carried out to ascertain that the proposed project activity is not economically or financially feasible, without the revenues from certified emission reductions (CERs). According to Attachment A to Appendix B of the ‘simplified modalities and procedures for CDM small scale project activities’, demonstration of the proposed project’s additionality may be presented under the following categories: (a) investment barrier, (b) technological barrier, (c) prevailing practice, and (d) other barriers. The project activities demonstrate barriers in the investment barrier aspects.For the financial assessment of the project activity; an investment analysis according to benchmark approach is selected.

(a) Investment barrier analysis

The project developer performed an investment analysis to prove that the project would not have happened in the absence of the income from the CDM. According to *Guidelines on the Assessment of Investment Analysis (Version 05),* the benchmark approach is adopted because that the baseline of proposed project does not require additional investment. To determine the proposed project shall be implemented or not, the internal rate of return (IRR) of total investment is identified as the financial indicator.

The benchmark IRR is applied 16.3% in accordance with lend rate of interest during 2005~2007 referred in the Cambodia Economic Watch (World Bank publication). The key parameters investment analysis is summarized on <Table B.5.3>.

<Table B.5.3> input data for financial analysis

Parameters	Unit	Value	Reference
Investment cost			
Construction Equipments	U$ U$	2,620,000 1,392,000	
Cost			
O&M cost	U$/year	809,194	See note 1
Revenues			

RFO displaced RFO price	U$/year U$/kl*	1,026,300 311	Since recovered methane is used for energy generation by boiler, the amount of fuel displaced should take into account project revenue.
Other parameters			
Diesel price	U$/kl**	780	

*http://tonto.eia.doe.gov/dnav/pet/hist/LeafHandler.ashx?n=pet&s=rfo180sin5&f=a
(Average; RFO price averaged from Jan. 2005 to Dec. 2007 is 31.1 Cents per liter)
**http://siteresources.worldbank.org/INTCAMBODIA/newsletters/22357036/Oil-and-Gas-English-Note-17.pdf?cid=EXTEAPMonth1 (Diesel price is estimated conservatively)

1. Annual O&M cost break down list reported by MH technical team. Labour and chemical costs and electricity tariff were considered and other costs neglect due to conservativeness. Reported below;

Cost		Amount(U$)	Detail
Operating Cost	Labor	79,403	Cambodian 15 persons : total 36,414US$ Korean 1 person: 36,372US$
	Chemical	200,000	Estimated cost to purchase chemical material (Polymer &Ferric chloride).
	Electricity cost	529,791	Estimated by designed capacity of electricity devices installed times runtime 7,920 hours. MH installed four units of Caterpillar Diesel Generator set since the Cambodian grid electricity is unstable. 3 units of 600kVA and 1 unit of 635kVA are installed. The manufacture's technical data* for fuel consumption is 122.8 liter for 600kVA (480Kw) and 130.6 liter for 635kVA (508Kw). Therefore, diesel consumption per kwh of electricity generation is 0.256 liter. Therefore, project participant applied the electricity cost per kWh as 0.200U$ (0.256 liter * U$ 0.78/liter .diesel).
Sub total		809,194	

*Caterpillar 3 units of 600kVA and 1 unit of 635kVA installed. By the technical data for fuel consumption per hour, 122.8 liter and 130.6 liter is consumed respectively. Therefore, average fuel consumption per kWh of electricity generation is 0.256 liter.

Based on the above assumption, the project IRR summarized as below;

IRR in the project scenario without CDM revenue: 0.8%
This means, even considering the revenue from fuel saving from the utilization of biogas, the proposed project activity undertaken without being registered as a CDM project activity is lower than the benchmark and financially un-attractive.

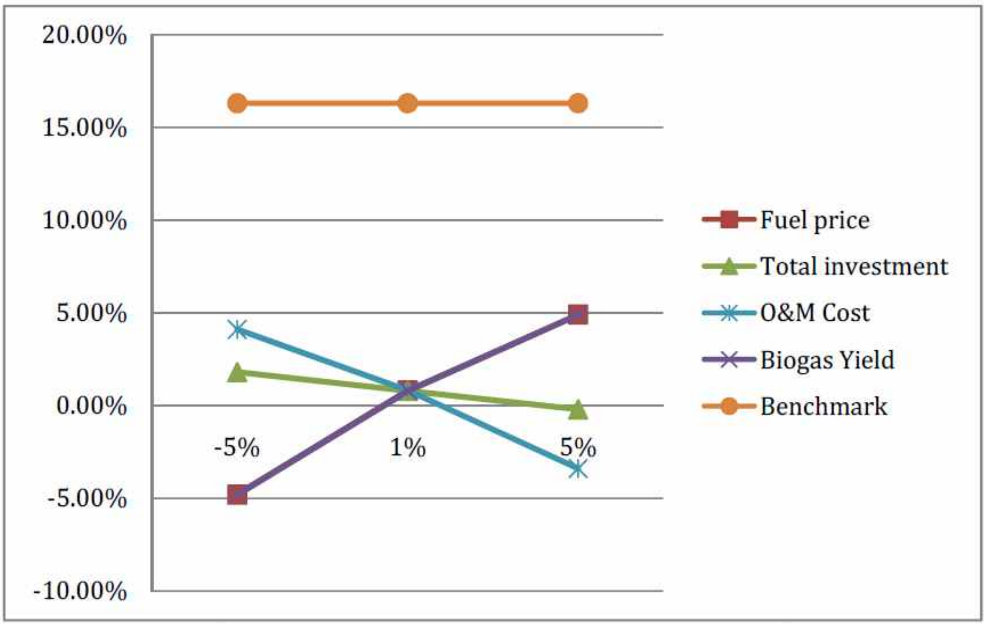
Sensitivity analysis is frequently used method to assess perceived uncertainties by identifying the potential changing ranges of some key factors such as price, amount of investment and costs etc.

Factors that influences the IRR for the proposed project activity includes;
- Fuel price
- Investment
- O&M costs
- Biogas Yield

The outcome of the sensitivity analysis is presented on <Table B.5.4>.

<Table B.5.4>Sensitivity analysis

Rate of change	-10%	0%	10%
Fuel price	-4.8%	0.8%	4.9%
Total investment	1.8%	0.8%	-0.2%
O&M Cost	4.1%	0.8%	-3.4%
Biogas Yield	-4.8%	0.8%	4.9%
Benchmark		16.3%	



The above sensitivity analysis shows that the +/-10% variation of IRR could not reach to the benchmark rate of return (IRR) of 16.3%.

Conclusion:

It is demonstrated that the proposed project activity is financially un-attractive and thus would not have occurred anyway without CDM revenue. The proposed project activity is only viable option for the project participant when registered as CDM project activity. Therefore, it is concluded that the proposed project activity is additional.

B.6. Emission reductions

B.6.1. Explanation of methodological choices

>>
The emission reductions for the methane recovery are estimated by use of approved small scale CDM baseline methodology *Methane recovery in wastewater treatment* III.H./Version 16_Scope 13, EB 58
.
The emission reductions resulting from the generation of heat are estimated by use of approved small-scale CDM baseline methodology *Thermal Energy production with or without electricity* I.C./Version 18_Sectoral Scope 01_EB56.
The estimated emission reductions are calculated from the expected amount of replaced RFO.

Step 1: Project Emissions

Project emission which would be emitted GHG from the project activity consist as below;
$PE_y = PE_{bio,y} + PE_{thermal,y}$
Where
Project emissions from methane recovery component ($PE_{bio,y}$) –AMS III.H
Project emissions from thermal generation component ($PE_{thermal,y}$) –AMS I.C

Step 1.1: Methane recovery (AMS III.H version 16)
The project emission by the methane recovery activity is calculated ex-ante following the guidance provided in paragraph 29 of Category-III.H(version 16) of Appendix B. and using the following equations;

$$PE_{bio.y} = PE_{power,y} + PE_{ww,treatment,y} + PE_{s,treatment,y} + PE_{s,final,y} + PE_{fugitive,y} + PE_{ww,discharge,y} + PE_{biomass,y} + PE_{flaring,y}$$

Where:

$PE_{bio.y}$	Project emissions from methane recovery component "y" (tonnes of CO_2 equivalent)
$PE_{power,y}$	Emissions through electricity or fuel consumption in the year "y" (tonnes of CO_2 equivalent)
$PE_{ww,treatment,y}$	Methane emissions from wastewater treatment systems affected by the project activity, and not equipped with biogas recovery, in the project situation year "y" (tonnes of CO_2 equivalent)
$PE_{s,treatment,y}$	Methane emissions from sludge treatment systems affected by the project activity, and not equipped with biogas recovery, in year y(tCO_2e)
$PE_{s,final,y}$	Emissions through anaerobic decay of the final sludge produced in the year "y" (tonnes of CO2 equivalent)
$PE_{fugitive,y}$	Emissions through methane release in capture systems in the year "y" (tonnes of CO_2 equivalent)
$PE_{ww,discharge,y}$	Methane emission from degradable organic carbon in treated wastewater in year "y" (tCO_2e).
$PE_{biomass,y}$	Methane emissions from biomass stored under anaerobic conditions. (tCO_2e)
$PE_{flaring,y}$	Methane emissions due to incomplete flaring in year "y" as per the "Tool to determine project emissions from flaring gases containing methane"(tCO_2e)

Step 1.1.1: Methane emissions from wastewater treatment systems affected by the project activity, and not equipped with biogas recovery, in year y (tCO_2e) are calculated as per equation

$$PE_{ww.treatment.y} = Q_{ww.treated.y} * COD_{outflow.y} * \eta_{COD,PJ,i} * MCF_{ww.treatment.PJ.aero} * B_{0.ww} * UF_{PJ} * GWP_{CH4}$$

Where:

$Q_{ww.treated.y}$ = Volume of treated wastewater after digester before aerobic system (m^3)

$COD_{outflow.y}$ = Chemical oxygen demand after digester before aerobic system.

$\eta_{COD,PJ,i}$ = COD removal efficiency of the aerobic wastewater system

$$\eta_{COD,PJ,i} = \frac{COD_{outflow.y} - COD_{ww.discharge.PJ.y}}{COD_{outflow.y}}$$

$MCF_{ww.treatment.PJ.aero}$ =Methane correction factor for the project wastewater treatment system not equipped with biogas recovery equipment (MCF values as per table III.H.1)

UF_{PJ} = 1.12 and $MCF_{ww.treatment.PJ.aero}$,as per MCF values in table III.H.1, value is zero (Aerobic treatment, well managed)

Therefore,

$\mathbf{PE_{ww,treatment,y} = 0}$

Step 1.1.2: Methane emissions from sludge treatment systems affected by the project activity.
As per the methodology, if the sludge is controlled combusted, disposed in a landfill with methane recovery, or used for soil application, this term can be neglected, and the final disposal of the sludge shall be monitored during the crediting period. In this project, sludge is used for soil application on its own cassava plantation located at Kampong spoe province far 110km from the MH factory.
Therefore,

$\mathbf{PE_{s,treatment,y} = 0}$

Step 1.1.3: Emissions through anaerobic decay of the final sludge produced
As per AMS III.H(version16) paragraph 29, "If the sludge is controlled combusted, disposed in a landfill with biogas recovery, or used for soil application in aerobic conditions in the project activity, this term shall be neglected" The final sludge derived from the project will be applied for the soil treatment (aerobic conditions) at its cassava plantation.

Therefore,

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

Step 1.1.4: Methane emissions from biomass stored under anaerobic conditions

Biomass is not included in this project. Therefore,

$PE_{biomass,y} = 0$

Step 1.1.5: Methane emissions due to incomplete flaring

Methane emissions due to incomplete flaring in year *y* as per the "Tool to determine project emissions from flaring gases containing methane"(tCO_2e). This project has no flaring component and all the recovered biogas will be fueled through the technology which is thermal.

During scheduled maintenance period, the remained gas will be used to generate electricity for office use. Therefore none of biogas excess to dissipated into the atmosphere during the crediting period. Since this biogas generator does not be operated continuously, project participant will not claim the CER benefit and this activity neglected from the project activity. Therefore, none of emission will be computed.

$PE_{flaring,\ y} = 0$

Step1.1.6: Emissions through electricity or fuel consumption in the year "y" (tonnes of CO_2 equivalent) ($PE_{power.y}$)

$$PE_{power.y} = EC_y \times EF_{elect} \quad (tCO_2/y)$$

Where:

EC_y	Electrical energy consumed by the circulation pumps/wastewater pumps in the Year, y (in MWh). This amount can be calculated based on the rated capacity and its operating hours.
EF_{elect}	Emission factor of electricity consumed/displaced by project activity The emission factor should be determined as per "Tool to calculate baseline, project and/or leakage emissions from electricity consumption".

Step1.1.7: Methane emissions from degradable organic carbon in treated wastewater discharged in e.g., a river, sea or lake in the project situation are determined as follows

$$PE_{ww,discharge,y} = Q_{ww,\ y} * COD_{ww.discharge,PJ,\ y} * MCF_{ww,PJ,dischargey} * B_{0,ww} * UF_{PJ} * GWP_{CH4}$$

Where:

$Q_{ww,y}$	Volume of treated wastewater discharged in year y (m^3)
$COD_{ww,discharge,J,y}$	Chemical oxygen demand of the treated wastewater discharged into sea, river or lake in the project situation in the year y ($tonnes/m^3$).
$MCF_{ww,PJ,discharge,,,y}$	Methane correction factor based on discharge pathway in the project situation (e.g., into sea, river or lake) of the wastewater (fraction) (MCF values as per table III.H.1 of AMS III-H (version 16) paragraph 21) Therefore, value is zero
$B_{0,ww}$	Methane producing capacity of the wastewater (IPCC value of 0.25 kg CH_4/kg COD)
UF_{PJ}	Model correction factor to account for model uncertainties (1.12)
GWP_CH_4	Global Warming Potential for methane (value of 21)

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

Step1.1.8: Methane emissions from biogas release in capture systems in year "y" (tCO_2e) ($PE_{fugitive.y}$)

$$PE_{fugitive.y} = PE_{fugitive.ww.y} + PE_{fugitive,s.y}$$

Where:

$PE_{fugitive,ww.y}$	Fugitive emissions through capture inefficiencies in the anaerobic wastewater treatment

systems in the year "y" (tonnes of CO_2 equivalent)

$PE_{fugitive,s.y}$ Fugitive emissions through capture inefficiencies in the anaerobic sludge treatment systems in the year "y" (tonnes of CO_2 equivalent)

In this project, the sludge treatment system is not equipped because the sludge is soil application.

$PE_{fugitive,s.y} = 0$

Therefore,

$PE_{fugitive.y} = PE_{fugitive,ww.y}$

$PE_{fugitive,ww.y} = (1 - CFE_{ww}) * MEP_{ww,treatment,y} * GWP\_CH_4$

Where:

CFE_{ww}	Capture efficiency of the methane recovery equipment in the wastewater treatment system (a IPCC default value of 0.9 shall be used, given no other appropriate value)
$MEP_{ww,treatment.y}$	Methane emission potential of wastewater treatment systems equipped with biogas recovery system in year "*y*" (tonnes),
GWP_CH_4	Global Warming Potential for CH4 (21)

EQ7: $$MEP_{ww.treatment,y} = Q_{ww,y} * B_{0,ww} * UF_{PJ} * \sum_k COD_{removed,PJ,y} * MCF_{ww.treatment,PJ}$$

where:

$COD_{removed,PJ,y}$	The chemical oxygen demand removed by the treatment system of the project activity equipped with biogas recovery in the year "y"(tonnes/m^3)
$MCF_{ww.treatment,PJ}$	Methane correction factor for the project wastewater treatment system *k* equipped with biogas recovery equipment (MCF values as per table III.H.1 of AMS III-H (version 16) paragraph 21)
UF_{PJ}	Model correction factor to account for model uncertainties (1.12)

Step1.2. Thermal energy for the user (AMS I.C)

Since the biogas used for the thermal energy generation is the amount of the displacement of fossil fuel oil which is consumed at the co-fired boilers, anthropogenic emissions due to the steam supply component of the project activity are zero as this project is utilizing biogas with biogenic origins.

Therefore,

$PE_{thermal,y} = 0$

Step2. Calculate Baseline Emissions

As stated in Section B.4, the equation for baseline emissions is:

$BE_y = BE_{bio,y} + BE_{thermal,y}$

Where:

BE_y	Baseline emissions
$BE_{bio,y}$	Baseline emissions from methane recovery component
$BE_{thermal,y}$	Baseline emissions from heat generation component

The following section shows the process of calculation for **$BE_{bio,y}$** and **$BE_{thermal,y}$,** separately.

Step 2.1: Methane Recovery Component ($BE_{bio,y}$)

Baseline emissions for the systems affected by the project activity may consist of:

$BE_{bio.y} = BE_{power.y} + BE_{ww.treatment.y} + BE_{s.treatment.y} + BE_{ww.discharge.y} + BE_{s.final.y}$

$BE_{bio.y}$	Baseline emissions from methane recovery components in year y (tCO_2e)
$BE_{power,y}$	Baseline emissions from electricity/fuel consumption in year y (tCO_2e)
$BE_{ww.treatment.y}$	Baseline emissions of the wastewater treatment systems affected by the project activity in year y (tCO_2e)
$BE_{s.treatment.y}$	Baseline emissions of the sludge treatment systems affected by the project activity in year y (tCO_2e)
$BE_{ww.discharge,y}$	Baseline methane emissions from degradable organic carbon in treated wastewater discharged into sea/river/lake in year y (tCO_2e). The value of this term is zero for the case 1(ii)
$BE_{s.final.y}$	Baseline methane emissions from anaerobic decay of the final sludge produced in year *y* (tCO_2e). If the sludge is controlled combusted, disposed in a landfill with biogas recovery, or used for soil application in the baseline scenario, this term shall be neglected.

Where,
Baseline emission from electricity or fuel consumption ($BE_{power.y}$) is not considered since the power and fuel are not used in the baseline situation.
Baseline emission of the sludge treatment system affected by project activity ($BE_{s.treatment.y}$) shall be neglected since the sludge will be transported to own plantation used for soil application. As under the same conditions for the sludge treatment, baseline methane emission from anaerobic decay of the final sludge produced ($BE_{s.final.y}$) shall be neglected.

Therefore,
$$BE_{bio.y} = BE_{ww.treatment.y} + BE_{ww.discharge.y}$$

Step2.1.1: On-site methane emission from the baseline situation ($BE_{ww.treatment.y}$)

The baseline emissions from the baseline wastewater treatment systems affected by the project ($BE_{ww.treatment.y}$) are determined using the Methane Generation Potential of the wastewater treatment system ;

$$BE_{ww.treatment,y} = \sum_{k} (Q_{ww.y} * COD_{inflow,i,y} * \eta_{COD,BL,I} * MCF_{ww.treatment.Bl,y}) * B_{0,ww} * UF_{BL} * GWP\_CH_4$$

Where:

$Q_{ww.y}$	Volume of wastewater treated in the year "y" (m^3)
$COD_{inflow,i,y}$	Chemical oxygen demand of the wastewater inflow to the baseline treatment system *i* in year *y* (t/m3).
$\eta_{COD,BL,i}$	COD removal efficiency of the baseline treatment system *i* The COD removal efficiency of the baseline system will be determined in line with the AMS III.H(v16) paragraph 28(2)(b) by applying average values from the top 20 percent plants with lowest emission rate per ton COD removed among the plants installed in the last five years designed for the same country/region to treat the same type of wastewaters as the project activity. As a result of searching by project participant, the plant installed in the last 5 years designed for the Cambodia is only one plant (the project plant) which treated same type of wastewater of bio ethanol using dried cassava as its raw material. (Source: http://www.thebioenergysite.com/news/2314/cassava-ethanol-plant-for-cambodia) Therefore, not to apply an average values from the top 20 percent plants with lowest emission rate per ton COD removed among the plants installed in the last five years but to apply the designed value (95%) provided by plant designing company. Designed diagram and details will be reported to DOE.
$MCF_{ww,treatment.BL,y}$	factor for the anaerobic decay of the untreated wastewater (IPCC default value of 0.8 for anaerobic systems.

$B_{0.ww}$ Methane producing capacity of the wastewater (IPCC value of 0.25 $kgCH_4$/kg COD
UF_{BL} Model correction factor to account for model uncertainties (0.89)
GWP_CH_4 Global Warming Potential for methane (value of 21)

Step 2.1.2 Methane emissions from degradable organic carbon in treated wastewater discharged in e.g., a river, sea or lakes in the baseline situation are determined as follows:

$$BE_{ww.discharge,y} = Q_{ww.y} * GWP\_CH_4 * B_{0.ww} * UF_{BL} * COD_{ww.discharge.BL.y} * MCF_{ww.BL.discharge}$$

Where:

$Q_{ww.y}$ Volume of treated wastewater discharged in year y (m^3)
UF_{BL} Model correction factor to account for model uncertainties (0.89)
$COD_{ww,discharge,BL,y}$ Chemical oxygen demand of the treated wastewater discharged into sea, river or lake in the baseline situation in the year y (tonnes/m3).
If the baseline scenario is the discharge of untreated wastewater, the COD of untreated wastewater shall be used
$MCF_{ww, BL, discharge}$ Methane correction factor based on discharge pathway in the baseline situation (e.g., into sea, river or lake) of the wastewater (fraction)
(MCF values as per tableIII.H.1of the AMS III-H (version16) Paragraph 21)

To determine $COD_{ww,discharge,BL}$: if the baseline treatment system(s) is different from the treatment system(s) in the project scenario, the monitored values of the COD inflow during crediting period will be used to calculate the baseline emissions *ex post*. The COD of the baseline systems will be estimated , as per paragraphs 28 (2) (b) of AMS III-H(version 16).

Step 2.2.Thermal generation component ($BE_{thermal,y}$)

According to AMS I.C. (version 18) paragraph 13, for renewable energy technologies that displace technologies using fossil fuels, the simplified baseline is the fuel consumption of the technologies that would have been used in the absence of the project activity times an emission factor for the fossil fuel displaced.

For steam/heat produced using fossil fuels the baseline emissions are calculated as per paragraph 18.

$$BE_{cofire,y} = \frac{(FC_{biogas,y} \times NCV_{biogas,y})}{SEC_{biogas} \times \eta_{BL}} \times EF_{BL}$$

Where:

$BE_{cofire,y}$ Baseline emissions during the year y(tCO_2e)
FC_{biogas} Quantity of CH_4 combusted in the project activity during the year *y*
NCV_{biogas} Net calorific value of CH_4 combusted during the year *y* (TJ)
EF_{BL} The CO_2 emission factor of the fossil fuel that would have been used in the baseline units; tCO_2/TJ, obtained from reliable local or national data if available, otherwise, IPCC default emission factors are used
η_{BL} Energy efficiency of the equipment that would have been used in the baseline
SEC_{biogas} Specific energy consumption of biogas of the project activity in year *y* (TJ/TJ)
This value will be clarified ex-ante in line with the paragraph 40 of AMS I.C (v.18).

Step3 : Leakage

The technology as well as the equipments of the project activity is not transferred from another activity. Therefore no leakage emission is considered.
$L_y = 0$

Step 4: Emission reductions
Emission reduction(s) will be calculated by the difference value between baseline emission and project emission.

Therefore
ER_y=BE_y - PE_y (tCO_2e)

B.6.2. Data and parameters fixed ex ante

(Copy this table for each piece of data and parameter.)

Data / Parameter:	**$Q_{ww,y}$**
Data unit:	m^3/day
Description:	Quantity of wastewater from the process
Source of data used:	Calculated by project developer through industry common method.
Value applied:	1,200
Justification of the choice of data or description of measurement methods and procedures actually applied :	Real data calculated by industries' common methods.
Any comment:	

Data / Parameter:	**$COD_{ww,discharge,BL,y}$**
Data unit:	tonnes/m^3
Description:	The Chemical Oxygen Demand the treated wastewater discharged into sea, river or lake in the baseline situation
Source of data used:	Environmental regulation in Cambodia
Value applied:	0.0001
Justification of the choice of data or description of measurement methods and procedures actually applied :	Reference: Sub-Decree on Water Pollution Control (NO 27 ANRK BK Phnon penh, April 06, 1999)
Any comment:	The data used for only ex-ante calculation

Data / Parameter:	**$COD_{inflow,i,y}$**
Data unit:	tonnes/m^3
Description:	The Chemical Oxygen Demand per m3 of wastewater entering into the digester
Source of data used:	Designed value
Value applied:	0.04
Justification of the choice of data or description of measurement methods and procedures actually applied :	As per AMS III.H (version 16) Paragraph 28 (2) (b), provided value of conservative mode from system manufacture have to be used. Technical provider is MH ethanol Korea technical team.
Any comment:	The data used for only ex-ante calculation

Data / Parameter:	$\eta_{COD,BL,y}$
Data unit:	**%**
Description:	Chemical oxygen demand removal efficiency of the baseline wastewater treatment system
Source of data used:	designed value
Value applied:	95
Justification of the	The designed value provided by plant designing company.

choice of data or description of measurement methods and procedures actually applied :	
Any comment:	$\eta_{COD,BL,y}$ is the difference between COD inflow and COD outflow divided by CODinflow. This value will be fixed during the following monitoring period to calculate the baseline emission.

Data / Parameter:	**CFE_{ww}**
Data unit:	-
Description:	Capture efficiency of the methane recovery equipment in the wastewater treatment
Source of data used:	2006 IPCC default value
Value applied:	0.9
Justification of the choice of data or description of measurement methods and procedures actually applied :	
Any comment:	

Data / Parameter:	**$MCF_{ww,treatment,BL}$**
Data unit:	-
Description:	Methane correction factor for the baseline wastewater treatment system
Source of data used:	Table III.H.1of AMS III.H
Value applied:	0.8
Justification of the choice of data or description of measurement methods and procedures actually applied :	MCF value in Table III.H.1 of AMS III-H (version 16) Paragraph 21 - Anaerobic deep lagoon (depth more than 2 meters) - is used for calculation of $BE_{y,ww}$
Any comment:	

Data / Parameter:	**$MCF_{ww,treatment,PJ}$**
Data unit:	-
Description:	Methane correction factor for baseline wastewater treatment system
Source of data used:	Table III.H.1of AMS III.H
Value applied:	0.8
Justification of the choice of data or description of measurement methods and procedures actually applied :	MCF value in Table III.H.1 of AMS III-H (version 16) Paragraph 21 – The value of anaerobic digester system –will be used for calculation of $PE_{fugitive,y,ww}$
Any comment:	

Data / Parameter:	**$MCF_{ww,discharge,PJ,}$ / $MCF_{ww,BL,discharge}$**
Data unit:	-
Description:	Methane correction factor based on discharge pathway in the project situation

Source of data used:	Table III.H.1of AMS III.H
Value applied:	0.1
Justification of the choice of data or description of measurement methods and procedures actually applied :	MCF value in Table III.H.1 of AMS III-H (version 16) paragraph 21- Discharge of wastewater to sea, river or lake) - is used for calculation of $BE_{y,ww}$
Any comment:	

Data / Parameter:	**$B_{o,ww}$**
Data unit:	kg CH_4 /kg COD
Description:	The rate of conversion of COD to CH_4 within the wastewater
Source of data used:	2006 IPCC recommended value
Value applied:	0.25
Justification of the choice of data or description of measurement methods and procedures actually applied :	IPCC default value (0.25 kgCH_4/kg.COD) is used as described in the methodology AMS III.H./version16_Scope13, EB58.
Any comment:	

Data / Parameter:	**UF_{PJ}**
Data unit:	-
Description:	Model correction factor to account for model uncertainties
Source of data used:	Default value
Value applied:	1.12
Justification of the choice of data or description of measurement methods and procedures actually applied :	Reference: '*Methane recovery in wastewater treatment'* approved small scale CDM baseline methodology III.H./Version 16_Scope 13,EB58
Any comment:	

Data / Parameter:	**UF_{BL}**
Data unit:	-
Description:	Model correction factor to account for model uncertainties
Source of data used:	Default value
Value applied:	0.89
Justification of the choice of data or description of measurement methods and procedures actually applied :	Reference: '*Methane recovery in wastewater treatment'* approved small scale CDM baseline methodology III.H./Version 16_Scope 13,EB58
Any comment:	

Data / Parameter:	**GWP_CH_4**
Data unit:	tCO_2e/CH_4
Description:	Global Warming Potential for methane

Source of data used:	Default value
Value applied:	21
Justification of the choice of data or description of measurement methods and procedures actually applied :	
Any comment:	

Data / Parameter:	$\mathbf{NCV_{diesel,y}}$
Data unit:	TJ/Gg
Description:	NCV of diesel oil
Source of data used:	2006 IPCC default value
Value applied:	43
Justification of the choice of data or description of measurement methods and procedures actually applied :	
Any comment:	

Data / Parameter:	$\mathbf{EF_{CO2,diesel,y}}$
Data unit:	tCO_2/TJ
Description:	Emission factor of diesel oil
Source of data used:	2006 IPCC default value
Value applied:	74.1
Justification of the choice of data or description of measurement methods and procedures actually applied :	
Any comment:	

Data / Parameter:	$\mathbf{EF_{grid,CM,y}}$
Data unit:	tCO_2/MWh
Description:	The emission factor for the Cambodia electricity grid
Source of data used:	Government figures
Value applied:	0.6981
Justification of the choice of data or description of measurement methods and procedures actually applied :	Simple OM: Either once for each crediting period using the most recent three historical years for which data is available at the time of submission of the CDM-PDD to the DOE for validation (ex-ante option) or annually during the crediting period for the relevant year, following the guidance in step 3 of Appendix7 in this PDD as per 'Tool to calculate the emission factor for an electricity system'version02. BM: For the first crediting period, either once *ex-ante* or annually *ex-post*, following the guidance included in step 5 of Appendix 7 in this PDD. For the second and third crediting period, only once *ex-ante* at the start of the second crediting period as per as per 'Tool to calculate the emission factor for an electricity system'version02.

Any comment:	This grid emission factor ($EF_{grid,CM,y}$) should be applied as per the 'tool to calculate baseline, project and/or leakage emissions from electricity consumption(version01)', since grid emission factor is more conservative than captive power plant emission factor ($EF_{EL,diesel}$).

Data / Parameter:	$\mathbf{EF_{FF,CO2}}$
Data unit:	tCO2/TJ
Description:	The CO_2 emission factor of the fossil fuel(RFO) that would have been used in the baseline plant
Source of data used:	2006 IPCC default value
Value applied:	77.4
Justification of the choice of data or description of measurement methods and procedures actually applied :	
Any comment:	

Data / Parameter:	$\boldsymbol{\eta_{BL,thermal}}$
Data unit:	-
Description:	The efficiency of the boilers using fossil fuel (RFO) that would have been used in the absence of the project activity.
Source of data used:	AMS.I-C version18, paragraph 26(c)
Value applied:	1
Justification of the choice of data or description of measurement methods and procedures actually applied :	Assumed 100% in absence of any historical data for conservative estimation
Any comment:	

Data / Parameter:	$\mathbf{SEC_{biogas,y}}$
Data unit:	MJ
Description:	Specific energy consumption of biogas: biogas consumption (in energy basis) per unit of thermal energy generated.
Source of data used:	Ex-ante
Value applied:	1.384
Justification of the choice of data or description of measurement methods and procedures actually applied :	This value is calculated by specification data of co-fired burner.
Any comment:	

Data / Parameter:	$\mathbf{SEC_{RFO,y}}$
Data unit:	MJ
Description:	Specific energy consumption of RFO: RFO consumption(in energy basis) per unit of thermal energy generated.
Source of data used:	Ex-ante
Value applied:	1.55

Justification of the choice of data or description of measurement methods and procedures actually applied :	This value is calculated by specification data of co-fired burner.
Any comment:	

B.6.3. Ex ante calculation of emission reductions

>>

This section describes the ex-ante approach used for an estimation of the emission reductions. Please see [Section B.6.2] about the parameters and values for calculation project emissions below.

Project emissions

Step 1: $\mathbf{PE_y = PE_{bio.y} + PE_{thermal.y}}$

Step 1.1 $\mathbf{PE_{bio.y} = PE_{power,y} + PE_{ww,treatement,y} + PE_{s,treatment,y} + PE_{s,final,y} + PE_{fugitive,y} + PE_{ww,discharge,y} + PE_{biomass,y} + PE_{flaring,y}}$

Step 1.1.1 $\mathbf{PE_{ww,treatment,y} = 0}$

Step 1.1.2 $\mathbf{PE_{s,treatment,y} = 0}$

Step 1.1.3 $\mathbf{PE_{s,final,y} = 0}$

Step 1.1.4 $\mathbf{PE_{biomass,y} = 0}$

Step 1.1.5 $\mathbf{PE_{flaring,\ y} = 0}$

Step 1.1.6 $\mathbf{PE_{power,y} = EC_y}$ x $\mathbf{EF_{elect}}$

This emission factor (EF_{elect}) will be calculated by the "Tool to calculate baseline, project and/or leakage emissions from electricity consumption"(version01).

Step 1.1.7 $\mathbf{PE_{ww\ discharge,\ y} = Q_{ww\ y} * COD_{ww,discharge,PJ\ y} * MCF_{ww\ PJ.discharge,y} * B_{0,ww} * UF_{PJ} * GWP\_CH_4}$

Step 1.1.8 $\mathbf{PE_{fugitive.y} = PE_{fugitive,ww,y}}$

$$\mathbf{PE_{fugitive,ww,y} = (1 - CFE_{ww}) * MEP_{ww,treatment,y} * GWP\_CH_4}$$

$$\mathbf{MEP_{ww.treatment,y} = Q_{ww,y} * B_{0,ww} * UF_{PJ}} * \sum_k COD_{removed,PJ,y} * \mathbf{MCF_{ww.treatment,PJ}}$$

Therefore,

$$\mathbf{PE_{bio.y} = PE_{ww.discharge.y} + PE_{fugitive.y} + PE_{power,y}}$$

Step 1.2 $\mathbf{PE_{thermal.y} = 0}$

Therefore,

$\mathbf{PE_y = PE_{bio.y}} = \mathbf{PE_{ww.discharge.y} + PE_{fugitive.y} + PE_{power,y}}$

<Table B.6.3.1 > Parameters adopted and estimated project emissions for PE_y

Parameter	Description	Value	Unit	Details
$Q_{ww,y}$	Volume of wastewater treated in the year y	396,000	㎥/y	1200m^3*330 days
GWP_ CH_4	Global Warming Potential for methane	21	tCO2/tCH4	
$B_{o.ww}$	Methane producing capacity of the wastewater	0.25	$kgCH_4$/kgCOD	2006 IPCC default value for domestic wastewater

$COD_{removed.PJ,y}$	Chemical Oxygen Demand removed by the wastewater treatment system	0.038	tonnes/㎥	The value calculated by using designed COD value (0.04-0.002=0.038) ex-ante only. During the crediting period, measurement value shall be applied.
$COD_{ww,untreated,y}$	Chemical Oxygen Demand inflow the digester system	0.04	tonnes/㎥	Applied designed value ex-ante. But the value shall be measured during the crediting period.
$COD_{ww,treated,y}$	Chemical Oxygen Demand outflow the digester system	0.002	tonnes/㎥	Calculated applying designed efficiency only for ex-ante. But the value shall be measured during the crediting period.
$COD_{ww,dischargePJ,y}$	Chemical Oxygen Demand final discharge to waterway	0.0001	tonnes/㎥	The value is limited value of discharging under the Raw of Cambodia. Measurement value shall be applied during monitoring.
$MCF_{ww,discharge,PJ}$	Methane correction factor based on discharge pathway in the project situation	0.1	-	(MCF values as per table III.H.1of AMS III-H (version 16) Paragraph 21
UF_{PJ}	Model correction factor to account for model uncertainties	1.12	-	AMS III.H (version16) paragraph 30
CFE_{ww}	Capture efficiency of the biogas recovery equipment in the wastewater treatment system	0.9	-	Default value
$MCF_{ww.treatment,PJ}$	Methane correction factor for the project wastewater treatment system k equipped with biogas recovery equipment	0.8	-	MCF values as per table III.H.1 of AMS III-H (version16) Paragraph 21

EC_y	Electrical energy consumed by the Circulation pumps/wastewater pumps in the year y (in MWh).	2,946	MWh/y	Detailed devices are on the <Table A.4.3-2> in this PDD. And assumed operating hours 7,920 per year.
$EF_{elect,y}$	Emission factor of electricity consumed/displaced by project activity	0.6981	tCO2/MWh	See the Appendix 7
$PE_{power,y}$	Emissions through electricity or fuel consumption in the year "y"	2,056	tCO2/y	
$PE_{ww,discharge,y}$	Methane emissions on account of inefficiency of the project activity wastewater treatment system and presence of degradable organic carbon in treated wastewater	23	tCO_2e/y	
$PE_{fugitive.y}$	Fugitive emissions through capture inefficiencies in the anaerobic wastewater treatment system in the year y	7,079	tCO_2e/y	
PE_y	Project emission	9,158	tCO_2e/y	

Step 2 Baseline Calculation
As stated in Section B.4, the equation for baseline emissions calculation is:

$\mathbf{BE_y = BE_{bio,y} + BE_{thermal,y} + BE_{power.y}}$ (tCO_2/y)

Where:
BE_y Baseline emissions
$BE_{bio,y}$ Baseline emissions from methane recovery component
$BE_{thermal,y}$ Baseline emissions from heat generation component
$BE_{power.y}$ Baseline emissions from electricity generation component

The following section shows the process of calculation for $BE_{bio,y}$, $BE_{thermal,y}$, and $BE_{power.y}$ separately.

Step 2.1 Baseline emissions from methane recovery component ($BE_{bio.y}$)

$\mathbf{BE_{bio.y}=BE_{power.y} + BE_{ww.treatment.y}+ BE_{s.treatment.y} + BE_{ww.discharge.y}+ BE_{s.final.y}}$

Where
Baseline emission from electricity or fuel consumption is not considered ($BE_{power.y}$ =0) since the power and fuel are not used in the baseline scenario for the wastewater treatment. Baseline emission of the sludge treatment system affected by project activity shall be neglected ($BE_{s.treatment.y}$ =0) since the sludge will be transported to their own plantation used for soil application. As under the same conditions for the sludge treatment, baseline methane emission from anaerobic decay of the final sludge produced shall be neglected ($BE_{s.final.y}$=0) .

Therefore
$\mathbf{BE_{bio.y} = BE_{ww.treatment.y}+BE_{ww.discharge.y}}$

Step 2.1.1 Methane emissions from the baseline wastewater treatment systems affected by the project ($BE_{ww,treatment,y}$) are determined using the methane generation potential of the wastewater treatment systems:

$$\mathbf{BE_{ww.treatment\ y} = \sum_{k} (Q_{ww.y} * COD_{inflow,i,y} * \eta_{COD,BL,I} * MCF_{ww.treatment.Bl,y}) * B_{0,ww} * UF_{BL} * GWP\_CH_4}$$

Step 2.1.2 Methane emissions from degradable organic carbon in treated wastewater discharged in e.g., a river, sea or lake in the baseline situation are determined as follows:

$$\mathbf{BE_{ww.discharge,y} = Q_{ww.y} * GWP\_CH_4 * B_{0.ww} * UF_{BL} * COD_{ww.discharge.BL.y} * MCF_{ww.BL.discharge}}$$

<Table B.6.3.2> Parameters adopted and estimated baseline emission ($BE_{bio.y}$)

Parameter	Description	Value	Unit	Detail
$Q_{ww.y}$	Volume of treated wastewater discharged in year y (m3)	396,000	m^3	$1{,}200m^3$*330days
$B_{0.ww}$	Methane producing capacity of the wastewater	0.25	$kgCH_4$/kg COD	2006 IPCC default vale for domestic wastewater
UF_{BL}	Model correction factor to account for model uncertainties	0.89	-	AMS III-H (version 16) Paragraph 20
$COD_{ww.discharge.BL.y}$	Chemical oxygen demand of the treated wastewater discharged into sea, river or lake in the baseline situation in the year y	0.0001	tonnes/m^3	Measurement
$MCF_{ww,BL,discharge}$	Methane correction factor based on discharge pathway in the baseline situation of the wastewater.	0.1	-	MCF value as per table III.H.1 of AMS III-H (version16 paragraph 21
GWP_CH_4	Global Warming Potential for methane (value of 21)	21	tCO_2e/CH_4	
$COD_{inflow,i,y}$	Chemical oxygen demand removed by baseline treatment system i in year y	0.04	tonnes/m^3	Applied designed value ex-ante. But the value will be measured during the crediting period.
$\eta_{COD,BL,i}$	COD Removal efficiency of the baseline treatment system i.	95	%	Applied the designed value provided by plant designing company. But the value will be fixed during the credit period.
$MCF_{ww.treatment,BL,y}$	Methane correction factor for baseline wastewater treatment systems	0.8	Fraction	MCF value as per table III.H.1 of AMS III-H (version16)

				paragraph 21
$BE_{ww.treatment,y}$	Methane emissions from the baseline wastewater treatment systems affected by the project	56,249	tCO_2/y	
$BE_{ww.discharge,y}$	Methane emissions from degradable organic carbon in treated wastewater discharged in the baseline situation	18	tCO_2/y	
$BE_{bio.y}$	Baseline emission from wastewater treatment system	56,268	tCO_2/y	

To define the amount of baseline GHG emission of the thermal energy component, it should be calculated the amount of displacement of fossil fuel consumed by boilers.

Step 2.2 Thermal energy component ($BE_{thermal,y}$)

$$BE_{cofire,y} = \frac{(FC_{biogas,y} \times NCV_{biogas,y})}{SEC_{biogas} \times \eta_{BL}} \times EF_{BL}$$

Where:

$BE_{cofire,y}$	Baseline emissions during the year y(tCO_2e)
SEC_{biogas}	Specific energy consumption of biogas of the project activity in year *y* (TJ/TJ) This value will be clarified ex-ante in line with the paragraph 40 of AMS I.C (v.18)
EF_{BL}	The CO_2 emission factor of the fossil fuel(RFO) that would have been used in the baseline units; tCO2/TJ, obtained from reliable local or national data if available, otherwise, IPCC default emission factors are used
η_{BL}	Energy efficiency of the equipment that would have been used in the baseline

<Table B.6.3.3 > Calculation of thermal energy displaced by project activity

Parameter	Description	Unit	Value	Details
$SEC_{biogas,}$	Specific energy consumption of biogas of the project activity in year *y* (TJ/TJ)	TJ	1.384	Ex-ante value
$FC_{biogas,y}$	Quantity of CH_4 combusted in the project activity during the year *y*	Ton/y	2,829	The balance of biogas calculated ex-ante (reference Appendix 8 in this PDD)
$NCV_{biogas,y}$	Net calorific value of CH_4 combusted during the year *y* (TJ)	TJ/Gg	50.4	2006 IPCC default value
EF_{BL}	The CO_2 emission factor of the fossil fuel(RFO) that would have been used in the baseline plant	tCO2/TJ	77.4	2006 IPCC default value
η_{BL}	Energy efficiency of the equipment that would have been used in the baseline		1	Assumed 100% in absence of any historical data for conservative estimation
$BE_{cofire,y}$	Baseline emission during the year y	tCO_2e	8,310	Calculation

Step 3 Leakage

The technology as well as the equipments of the project activity is not transferred from another activity. Therefore no leakage emission is considered.
L_y= 0

Step 4 Emission reductions
Emission reduction(s) will be calculated by the difference value between baseline emission and project emission.

Therefore;
ER_y=BE_y - PE_y (tCO_2-eq)

BE_y = 56,268 tCO_2 e/y + 11,036 tCO_2 e/y = 67,304-tCO_2 e/y
PE_y =9,158 tCO_2 e/y
ER_y =58,146 tCO_2 e/y

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 ($t CO_2e$)
2012	67,304	9,158	0	58,146
2013	67,304	9,158	0	58,146
2014	67,304	9,158	0	58,146
2015	67,304	9,158	0	58,146
2016	67,304	9,158	0	58,146
2017	67,304	9,158	0	58,146
2018	67,304	9,158	0	58,146
Total	471,128	64,106	0	407,022
Total number of crediting years	7			
Annual average over the crediting period	67,304	9,158	0	58,146

B.7. Monitoring plan

B.7.1. Data and parameters to be monitored

(Copy this table for each piece of data and parameter.)

Data / Parameter:	$Q_{ww,y}$
Data unit:	m^3/month
Description:	Quantity of wastewater from the process
Source of data to be used:	Measurement data by a flow-meter
Value of data	Ex-Post
Description of measurement methods and procedures to be applied:	This flow will be measured with flow-meter or equivalent. The data will be monitored on daily basis. Data are recorded using the flow meter and stored electronically in a data log file.
QA/QC procedures to be applied	Monitored continuously (at least hourly measurements are undertaken, if less, confidence/precision level of 90/10 shall be attained) as per AMS III-H version 16. The meter will be calibrated according to relevant manufactures' recommendation /instruction and national standards as per General Guideline to SSC CDM methodologies version17 paragraph 17.

Any comment	Data are aggregated daily in a data log file.

Data / Parameter:	**$COD_{ww,untreated,y}$**
Data unit:	tonnes/m^3
Description:	Chemical oxygen demand inflow to digester in the year *y*.
Source of data to be used:	Measurement by COD kits
Value of data	Ex-post
Description of measurement methods and procedures to be applied:	The lab data Bi- monthly sampling and analysis will be carried out in the in-house lab. Yearly average values will be used for the calculation of emission reductions.
QA/QC procedures to be applied	Samples and measurements shall ensure a 90/10 confidence /precision level as per AMS III-H version16. COD checking will be requested to external lab once a year according to 'General Guidelines to SSC CDM methodologies' version17, paragraph 17(b).
Any comment	In case of methane flow meter failure, volume of wastewater and COD value can be used for estimation of amount of methane in crediting period.

Data / Parameter:	**$COD_{ww,treated,y}$**
Data unit:	tonnes/m^3
Description:	Chemical oxygen demand outflow from digester in the year *y*.
Source of data to be used:	Measurement
Value of data	Ex-post
Description of measurement methods and procedures to be applied:	The lab data Bi- monthly sampling and analysis will be carried out in the in-house lab. Yearly average values will be used for the calculation of emission reductions.
QA/QC procedures to be applied	Samples and measurements shall ensure a 90/10 confidence /precision level as per AMS III-H version16. COD checking will be requested to external lab once a year according to 'General Guideline to SSC CDM methodologies, version17, and paragraph 17(b).
Any comment	In case of methane flow meter failure, volume of wastewater and COD value can be used for estimation of amount of methane in crediting period.

Data / Parameter:	**$COD_{ww,discharge,PL,y}$**
Data unit:	tonnes/m^3
Description:	Chemical oxygen demand outflow to the lake in the year *y*.
Source of data to be used:	Measurement
Value of data	Ex-post
Description of measurement methods and procedures to be applied:	COD checking will be requested to external lab once a year according to 'General guideline to SSC CDM methodology' paragraph 17(b). COD_{cr} measurement method will be adapted. The data will be monitored bi-monthly basis.
QA/QC procedures to be applied	Samples and measurements shall ensure a 90/10 confidence /precision level as per AMS III-H version16. Measuring equipment will be calibrated according to relevant manufactures' recommendation /instruction and national standards, but at least once in three years as per 'General Guideline to SSC CDM' version17, paragraph 17(c).
Any comment	

Data / Parameter:	**$S_{final,y}$**
Data unit:	Tonnes
Description:	End-use of final sludge
Source of data to be used:	Monitored
Value of data	Ex-post
Description of measurement methods and procedures to be applied:	Because the sludge is used for soil application, the end-use (Amount, site, date of disposal) of the final sludge will be monitored during the crediting period. The total quantity of sludge on a wet basis will be measured as per AMS III-H ver16.
QA/QC procedures to be applied	Monitoring of 100% of the sludge amount through batch measurements and moisture content through representative sampling to ensure the 90/10 confidence/precision level as per AMS III-H version16.
Any comment	

Data / Parameter:	**$w_{CH4,y}$**
Data unit:	%
Description:	Fraction of methane in the biogas in the year “y”
Source of data to be used:	Measurement data by a Gas analyzer :GSR-400P gas analyzer
Value of data	Variable
Description of measurement methods and procedures to be applied:	Once a month measurement by GSR-400P device. The methane content measurement will be carried out close to a location in system where a biogas flow measurement takes place. This parameter will be used to calculate methane fraction and applied to calculate biogas energetic value.
QA/QC procedures to be applied:	The fraction of methane in the gas will be measured with periodical measurements at a 90/10 confidence /precision level as per AMS III-H ver16. Measuring equipment will be calibrated according to relevant manufactures' recommendation /instruction and national standards, but at least once in three years as per 'General Guideline to SSC CDM' version17, paragraph 17(c).
Any comment:	

Data / Parameter:	**EC_y**
Data unit:	MWh
Description:	Electricity consumption in the project devices(blowers, pumps etc) in year “y”
Source of data to be used:	Calculated
Value of data	Ex-post
Description of measurement methods and procedures to be applied:	This value is calculated as follows: EC_y = Rated power of project devices × 8,760 hours + distribution losses 10%
QA/QC procedures to be applied	N/A
Any comment	The actual consumption of the project devices is measured with the relevant electricity meters at respective monitoring point. However, it is not possible to calibrate the meters because there is currently no organization in Cambodia which the project participant can ask for calibration services for electricity

	meters. So, the value is calculated based on the rated power of the project devices (blowers, pumps, etc.), 8,760 hours and 10% to account for distribution losses.

Data / Parameter:	**$FC_{diesel,t}$**
Data unit:	Litre
Description:	Quantity of diesel combusted in diesel generator This value will be used to calculate the Emission factor of electricity consumed/displaced by project activity ($EF_{elect,y}$).
Source of data to be used:	Measurement data by a Gauge
Value of data	Ex-post
Description of measurement methods and procedures to be applied:	The diesel consumption will be continuously measured with oil Gauge.
QA/QC procedures to be applied:	The Gauge will be calibrated according to relevant manufactures' recommendation /instruction and national standards as per 'General Guidelines to SSC CDM methodologies' version17, paragraph 17(c). The data will be cross checked with the diesel purchasing invoice as per "Tool to calculate baseline, project and/or leakage emissions from electricity consumption"(version 01).
Any comment:	

Data / Parameter:	**$EG_{diesel,y}$**
Data unit:	MWh
Description:	Quantity of electricity produced in diesel generator This value will be used to calculate the Emission factor of electricity consumed/displaced by project activity ($EF_{elect,y}$).
Source of data to be used:	Measurement data by a EL-meter
Value of data	Ex-post
Description of measurement methods and procedures to be applied:	The electricity generation will be continuously measured with EL-meter.
QA/QC procedures to be applied:	The meter will be calibrated according to relevant manufactures' recommendation /instruction and national standards, but at least once in three years as per 'General Guidelines to SSC CDM methodologies version17 paragraph 17(c).
Any comment:	

Data / Parameter:	**EF_{elect}**
Data unit:	tCO_2/MWh
Description:	Emission factor of electricity consumed/displaced by project activity
Source of data to be used:	Calculated
Value of data	Ex-post
Description of measurement methods and procedures to be applied:	This monitoring value will be decided by selecting the conservative value between the two parameters emission factor for the diesel generator ($EF_{EL,diesel}$) and emission factor for the grid ($EF_{grid,CM,y}$) as per Government figures or "Tool to calculate baseline, project and/or leakage emissions from electricity consumption".

QA/QC procedures to be applied:	
Any comment:	

Data / Parameter:	$FC_{biogas,y}$
Data unit:	Nm^3/year
Description:	Quantity of biogas combusted during the year *y*
Source of data to be used:	Measurement data by a Gas Flow Meter
Value of data	Ex-post
Description of measurement methods and procedures to be applied:	The biogas flow is measured continuously with volume flow meters, which are employed measures flow, temperature, pressure and displays normalized flow of biogas.
QA/QC procedures to be applied	The meter will be calibrated according to relevant manufactures' recommendation /instruction and national standards, but at least once in three years as per 'General Guidelines to SSC CDM methodologies' version17 paragraph 17(c).
Any comment	

Data / Parameter:	$FC_{RFO,PJ,y}$
Data unit:	Litre/year
Description:	Quantity of RFO combusted in the co-fired boilers
Source of data to be used:	Measurement data by oil gauge.
Value of data	Ex-post
Description of measurement methods and procedures to be applied:	The RFO consumption will be continuously measured with oil gauge.
QA/QC procedures to be applied:	The gauge will be calibrated according to relevant manufactures' recommendation /instruction and national standards, but at least once in three years as per 'General Guidelines to SSC CDM methodologies, version17, paragraph 17(c). The consistency of metered fuel consumption quantities will be cross-checked with an annual energy balance that is based on purchased quantities and stock changes as per AMS I-C, version 18.
Any comment:	

Data / Parameter:	$EG_{thermal,y}$
Data unit:	TJ
Description:	Net quantity of thermal energy produced by the co-fired boilers during the year *y*
Source of data to be used:	On site measurement
Value of data	Ex-post

Description of measurement methods and procedures to be applied:	The steam tables will be used to calculate the enthalpy as a function of temperature and pressure. Heat generation is determined as the difference of the enthalpy of the steam or hot fluid and/or gases generated by the heat generation equipment and the sum of the enthalpies of the feed-fluid and/or gases blow-down and any condensate returns. The respective enthalpies should be determined based on the mass (or volume) flows, the temperatures and, in case of superheated steam, the pressure."
QA/QC procedures to be applied:	Relevant parameter will be monitored continuously by electronic monitoring system equipped at control room.
Any comment:	

B.7.2. Sampling plan

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The following two parameters will be monitored in accordance with the sampling plan on the principle of unbiasedness and reliability. Unbiasedness indicates that the sampling will not systematically overestimate or underestimate the parameter value. Reliability indicates that sample-based parameter value falls within a specified probability interval (denoted as 90/10 confidence/precision) around the population's true parameter value.

- COD measurement plan

The wastewater sample is collected at 3 points, referred to $COD_{inflow.i.y}$($COD_{untreated.y}$), $COD_{outflow,i,y}$($COD_{treated.y}$), $COD_{discharge.BL.y}$, by the trained staff for the internal Lab.

Pararmeters	Chemical Oxygen Demand of the wastewater inflow to the treatment system, ourflow form the system and final discharged value denoted as pararmeters $COD_{inflow.i.y}$($COD_{untreated.y}$), $COD_{outflow,i,y}$($COD_{treated.y}$), $COD_{discharge.BL.y}$ respecrively.
Sampling Objective	- Determining the mean annual value during the crediting period - Meeting 90/10 confidence/precision level
Field measurement and data to be collected	- Data: Chronometric COD value (COD_{cr}) - Measurement method: EPA standard method 410.3 - Frequencies: randomly bur at least 4 times monthly
Target population And sampling frame	- COD value averaged at the inflow, outflow and final discharged points. - Sampling was done randomly i.e. the time, day and frequencies.
Sample method	- Simple random sampling
Desired precision/Expected variance and sample size	- Sample size: over 20 - Desired precision: ±10% within 90% confidence level - Formula: Application of the Student's t-distribution
Procedures for administering data collection and minimizing non-sampling errors	- All data are tested by the trained staff and verified by the supervisor of Lab. All proved data are available in hard copy. - Measurement: In the internal laboratory, measurements done in line with the EPA standard method by the staff specially trained. - Training: On the job training by the Lab supervisor
Implementation	- Sample collector, collecting the sample at the selected points. - Analyzer: Appointment of the lab staffs that are qualified to execute the analysis of the sample and the data are archived on the log book.

- Methane content in the biogas

The biogas sample is collected at the collection point located at just before the boiler inlet pipeline, using a sample collection bag provided by the analyser manufacturer. The potable biogas analyzer(GSR 400

P) manufactured in Korea is prepared to analyse the methane content. The details of sampling plan are stated below;

Pararmeters	Methane content in biogas(W_{CH4})
Sampling Objective	- Determining mean annual value during crediting period - Meeting 90/10 confidence/precision level
Field measurement and data to be collected	- Data: CH_4 content in biogas (W_{CH4}) - Frequencies: randomly but at least 4 times monthly
Target population And sampling frame	- CH_4 content in biogas fed into boiler and Gen Set. - Install a sample collection pot on the pipeline just before boiler No. B - Sampling was done randomly i.e. the time day and frequencies
Sample method	- Simple random sampling
Desired precision/Expected variance and sample size	- Sample size: over15 - Desired precision: ±10% within 90% confidence level - Formula: Application of the Student's t-distribution.
Procedures for administering data collection and minimizing non-sampling errors	- All data are tested by the trained staff and verified by the supervisor of Lab. All proved data are available in hard copy. - Measurement: In the internal laboratory. - Training: On the job training by the Lab supervisor
Implementation	- Sample is analyzed within 2 hours after collection of the sample and the data are archived in the logbook

B.7.3. Other elements of monitoring plan

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1. Monitoring Organization

Appoint one CDM monitoring supervisor (Director in charge of factory), one manager and 4 CDM monitoring staffs. The CDM monitoring group, composed of the above members, will implement data collection, maintenance and calibration of meters, recording and archiving of collected data, preparation of monitoring report, etc. The managing structure is shown in ~~Annex 4~~ Appendix 5 in this PDD.

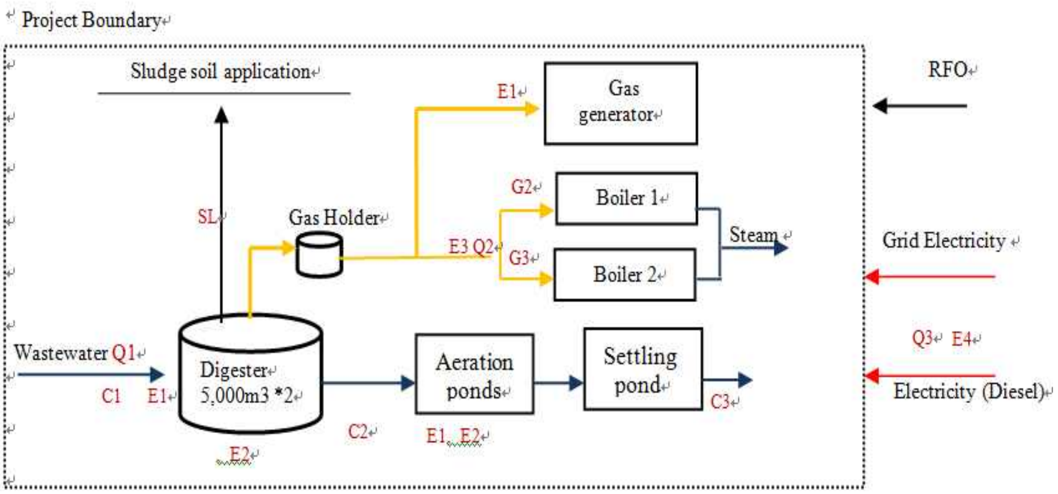
The CDM monitoring supervisor will carry out instruction and training of CDM monitoring staff while receiving a necessary support from third party technical experts. The CDM monitoring supervisor will make the CDM monitoring staff understand the importance of monitoring for the CDM project activity as well as instruct technical matters such as how to use, maintain and calibrate monitoring equipment (include on-site training), procedure for error detection, data processing for calculation of emissions reductions, data archiving system (storage media, frequency of recording and backup, etc.), preparation of internal monitoring report.

Daily monitoring reports from the staff will be reported to the CDM manager for reviewing and signing. And the monitoring reports will be kept at their specific files.

Four persons of monitoring staff are collecting the data and recording the data on the daily report on time regularly.

he third party technical experts, PURESKY Co., Ltd, takes responsible to review and cross check all parameters and will allocate the data on emergency under the 'CDM monitoring contract' signed with MH. The monitoring points are pointed out on <Figure B.7.2> below.

<Figure B.7.2>: Monitoring check point



Parameters	Point	**Monitoring equipment** (Manufacturing Company/Model No.)
$Q_{ww,y}$	Q1	Flow meter will be installed before CDM registration
$FC_{RFO,PJ,y}$	Q2	Integrated part with boilers. Cross check with oil purchasing data
FC_{diesel}	Q3	Integrated part with diesel generator. Cross check with oil purchasing data
$EG_{diesel,y}$	E4	Electricity meter integrated in diesel generator.
$COD_{ww,untreated,y}$	C1	COD kits, Planned
$COD_{ww,treated,y}$	C2	
$COD_{ww,discharge,PJ,y}$	C3	
$FC_{boiler,i,y}$	G2	HONEYWELL (STD924-E1A-00000-SM-SB-1C-B77P)
	G3	VORTEX(VXW1150-N11G-1116)
$S_{final,y}$	SL	Truck scaling installed at the disposal site.
EC_y*	E1	Calculated based on the rated power of the project devices and 8,760 hours.
	E2	Calculated based on the rated power of the project devices and 8,760 hours.
	E3	Calculated based on the rated power of the project devices and 8,760 hours.

***Detailed monitoring check point by electricity consumption devices(EC_y)**

Monitoring point	Wastewater Pump*	Circulation pump**	Aerator	Gas Blower	
				To Gas Generator	To boilers
E1	2 Motors	3 Motors	3 Motors	1 Motor	
E2		1 Motor	1 Motor		
E3					1 Motor

***Wastewater pump: Pumping the wastewater to the digesters**
****Circulation pump: Mixing the wastewater in the digesters**

2. Data Collection and Archiving

The CDM monitoring staff will implement data checking and daily recording. The monitored data will be reported to manager through daily-report file, after signed by manager it takes over recording staff.

The CDM monitoring manager will check the submitted monitoring report by:
• Comparison of *ex-ante* estimation value and *ex-post* measurement/calculation value; and
• Identify errors such as typing error and mistakes in digit and unit and made necessary correction.

The CDM monitoring staff also has to pay special attention for detection and recording of emergency events. If the boilers come under abnormal conditions, the CDM monitoring staff has to record time of start and stop of the boilers and combustion conditions of biogas.

3. Data Management

Data monitored for CDM purposes will be aggregated, summarized, calculated and recorded as an electronic file at the end of every month.

The collected data and relevant documents will be made available to the verifier so that the reliability of the information can be checked. All the data shall be kept until two (2) years after of crediting period.

4. Quality Assurance and Quality Control

All monitoring equipment will be maintained and calibrated in line with manufacturers' instruction or national standards. These activities will assure that the equipment operates at the stated level of accuracy.

5. Monitoring Report

At the end of the year, the PURESKY CO.,LTD will prepare a monitoring report for verification by DOE. The monitoring report includes monitoring data such as biogas flow rate, fraction of methane in biogas, net heat supply and end use of the final sludge, record of calibration of meters, calculations of emission reductions etc.

B.7.4. Date of completion of application of methodology and standardized baseline and contact information of responsible persons/ entities

>>

The final draft of this baseline section has been completed on 21/08/2014.

The baseline has been prepared by PURESKY Co.,Ltd

Company name: PURESKY Company Limited

Visiting address: B 207,Samhwan arnv.Bld., 209,Nonhyundong,Kangnam Ku Seoul, Korea.

Contact person: Mr. J.L.Wee

Telephone number: +82(0)2 515 0380

Fax number: +82(0)2 515 0390

E-mail:weejoo@naver.com

SECTION C. Duration and crediting period

C.1. Duration of project activity

C.1.1. Start date of project activity

>>

The starting date of effective construction-contract for the project is 15/03/2008. Therefore, starting date of the project activity is 15/03/2008.

C.1.2. Expected operational lifetime of project activity

>>

The operational life time of the project activity is 20 years (20 y 0 m)

C.2. Crediting period of project activity

C.2.1. Type of crediting period

>>

Renewal crediting period

C.2.2. Start date of crediting period

>>

01/04/2012, or the date of registration, whichever occurs later.

C.2.3. Length of crediting period

>>
7years

SECTION D. Environmental impacts

D.1. Analysis of environmental impacts

>>
The project is not considered significant environmental impact. But, MH asked SAWAC Consultants Group to prepare Initial Environmental Impact Assessment (IEIA) report in accordance with the Cambodia environmental regulations and was approved by the Ministry of Environmental bureau of the Cambodia in July, 2009.
Also, Environmental Management Plan (EMP) shall be reported to the host party to acquire the project permission. This EMP was reported to DNA on Feb 26, 2009 and accepted July 2009. This document focused on;
Water management plan

- Minimize use of water: Saving water resources from Samarung Lake and underground water by installing water reuse system in the plant.
- Reducing water pollution: Plan to check and control of Samarung lake water pollutants i.e. litter, algal blooms, nitrogen, phosphorous etc by co-work with the Chactomuk Fishery Administration Office. The company taken the responsibility to educate the community.
- Wastewater water quality management plan: Final discharged water must be checked and controlled by Standards of the Sub-Decree on Water Pollution Control, Cambodia.

Waste management plan

– Minimizing waste produced and re-cycling system: For this purpose, specific company is established (MH-Agro System) to produce fertilizer using the waste from the company.

Energy management plan

- Use of renewable energy source: Maximize the biogas yield could be minimized use of fossil energy. For this purpose, company installed high efficient digester system by its own developed technology from Korea, MH ethanol group.
- Energy saving operation: Operation skill is important to save the energy for the ethanol producing process. For this purpose, core system operational staffs that are educated at the MH ethanol group in Korea are positioned.
- Install energy saving system: For this purpose, company has installed Low Pressure Distillation Tower which is known as more 30% of energy saved than conventional system.

Biodiversity management plan

- Company has a plan to protect, restore and establish habitat for indigenous species in the cassava plantation. For this purpose, company has a plan to develop the inventory by area survey and record of number, type and distribution of flora and fauna including aquatic species.

SECTION E. Local stakeholder consultation

E.1. Solicitation of comments from local stakeholders

>>
Public consultation sessions about CDM and one sustainability audit meeting were held. The stakeholder consultation for the CDM issues took place on May 15, 2008 at the plant site of MH Bio-Energy Co., LTD. The invitation letters were sent to the entire stake holder. The consultation was attended by 26 people, including local residents and workers, Governmental officials. Presentations were given about the project and climate change and the Clean Development Mechanism. After the presentations, a question and answer

session was held.
An announcement of the public for the Bio-ethanol project was published in the National broadcasting CTN and many newspapers.

E.2. Summary of comments received

>>
On the Stakeholder's meeting;
Q: How to calculate the Certified Emission Reduction (CER) in this project?
A: In the first step, quantity of emission reduction must be estimated by the calculation of differences of baseline emission and project emission. CER must be certified by the UNFCCC through complicated registering process.
Q: When it will be registered?
A: If every process goes smoothly, it will be registered on end of 2010 and or during year 2011.
Q: What is the volume of the Digester unit and how does it operates?
A: Digester will be constructed with 2 set of concrete buildings with the total volume reached 10,000 m^3.
Q: How the bio gas economic value?
A: The economical value will come from CER's trading and fuel replacement effects. But, the exact amount of economical value couldn't calculate on these days. Only, estimated amount of CERs would be over 50,000 tons per year and the trading value is USD11 per ton.

E.3. Report on consideration of comments received

>>
All of the questions asked during the stakeholder consultation were satisfactorily answered. The project was received only positive comments therefore no further action was necessary.

SECTION F. Approval and authorization

>>

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	MH Bio-Energy Co., LTD
Street/P.O. Box	5 National Road, Duoing village , Preak Phnouv Commune
Building	
City	Phnom Penh Province
State/Region	
Postcode	
Country	Cambodia
Telephone	023-351-404
Fax	017-402-010
E-mail	
Website	www.mh-ethanol.com
Contact person	
Title	Managing Director
Salutation	Mr
Last name	Nicolas
Middle name	
First name	Jeon
Department	
Mobile	+82 10 2387 7838
Direct fax	
Direct tel.	
Personal e-mail	

Appendix 2. Affirmation regarding public funding

No public fund available for the project activity

Appendix 3. Applicability of methodology and standardized baseline

MH distillery design Parameters

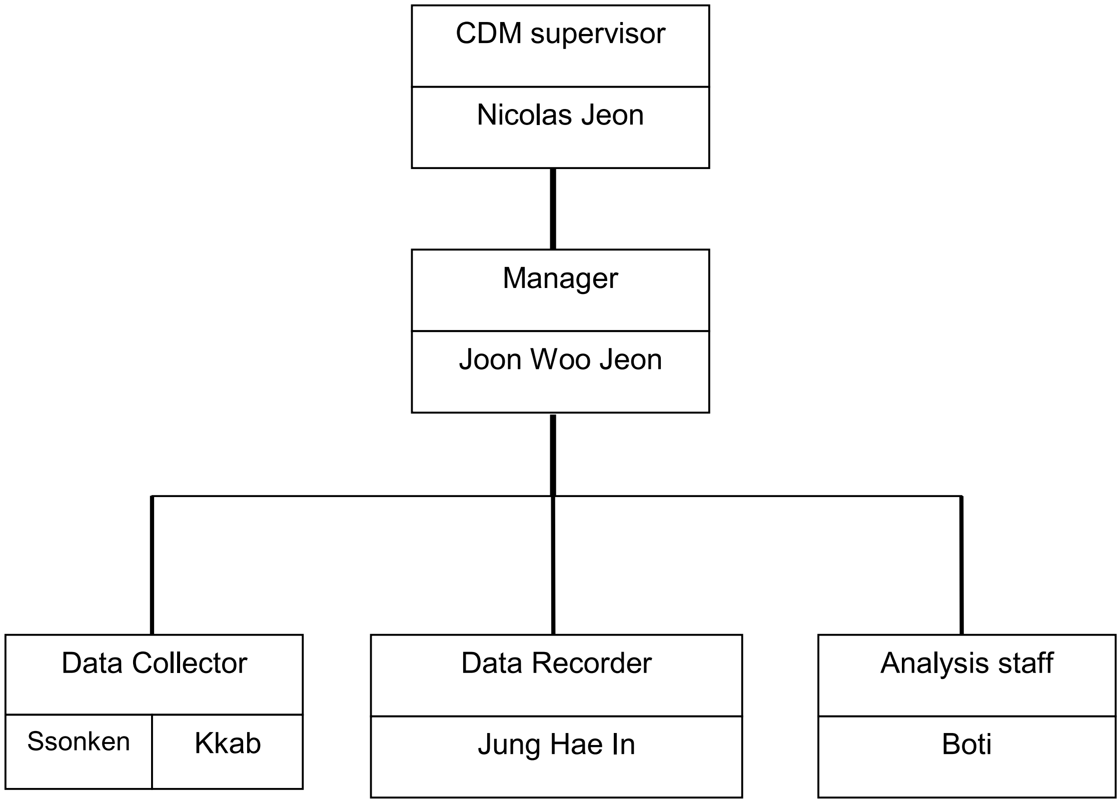
Operational hours per day	24
Operational days annually	330
Effluent flow rate per day	1200 m^3
COD -in to the digester (average)	0.04 t/m^3
COD-out from the digester	0.002 t/m^3
Methane content of biogas	54%

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

N/A

Appendix 5. Further background information on monitoring plan

Monitoring Manager and Staffs



Appendix 6. Summary of post registration changes

The Monitoring method for electricity consumption of the project activity (ECy) is changed as under;

<The monitoring method for ECy>

	Before	After
Monitoring method	Measured by three Electricity meters	Calculated with the rated capacity of the project devices (blowers, pumps, etc.) times 8,760hours, plus 10% to account for distribution losses.

The formula to calculate baseline emissions for heat generation is changed as under;

	Before	After
formula	$BE_{thermal,CO2,y} = (EG_{thermal,y} / \eta_{BL,thermal})*EF_{FF,CO2}$	$BE_{cofire,y} = \frac{(FC_{biogas,y} \times NCV_{biogas,y})}{SEC_{biogas} \times \eta_{BL}} \times EF_{BL}$

The parameters fixed ex-ante is added for specific energy consumption of biogas of the project activity in year y ($SEC_{biogas,y}$) as under;

Parameter	Description	Reason
$SEC_{biogas,y}$	Specific energy consumption is the fuel consumption (in energy basis) per unit of thermal energy	This project is the first bio-ethanol factory in Cambodia so that no historical data and reference data are available in the relevant sector. Therefore, $SEC_{biogas,y}$ is calculated by specification date of co-fired burner.

Appendix7. Emission factor calculation for electricity consumption by the project ($EF_{elect,y}$)

As per the “Tool to calculate baseline, project and/or leakage emissions from electricity consumption(version 01)”, Case C.III (Electricity from both the grid and captive power plant) of Scenario C is applied. The project activities is affected by both the quantity of electricity that is generated in the captive power plants and the quantity of electricity supplied from the grid.

As per the Tool, the emission factor ($EF_{elect,y}$) for electricity consumption should be applied conservative value between the emission factor determined by Scenario A and Scenario B below;

Scenario A: Electricity consumption from the grid

In this case, project participants may choose among the following options:

Option A1: Calculate the combined margin emission factor of the applicable electricity system, using the procedures in the latest approved version of the “Tool to calculate the emission factor for an electricity system” ($EF_{EL,j/k/l,y} = EF_{grid,CM,y}$).

Option A2: Use the following conservative default values

The Option A1 is chosen to calculate the combined margin emission factor of the applicable electricity system, using the procedures in the latest approved version of the ”Tool to calculate the emission factor for an electricity system” ($EF_{EL,j/k/l,y} = EF_{grid,CM,y}$). This emission factor for the Phnom penhn grid is calculated and published by the Cambodian DNA.

At present, there is no Cambodia national electricity Grid but isolated transmission system is operated by capital city, town and provincial town city throughout the country. Furthermore, there is not national grid emission factor published by national authorities. MH which is located 15km far from Phnom Penh city, has been taking the electricity from the Phnom Penh Grid operated by Électricité du Cambodge (EDC). The coverage area of EDC’s Phnom Penh Grid has been extended to suburban areas, to Kandal town, Kampong Speu town and also the area along the national road No. 4. Phnom Penh’s power system is combined by small scale units of Power Plants including EDC’s and IPP’s power plant.
(Sourced: http://www.edc.com.kh/acrobat/annual2007.pdf)

Calculated operation margin (OM)
The operation margin which is calculated by Cambodia DNA is applied. This value is calculated by selecting the simple OM method by the “Tool to calculate the emission factor for an electricity system”.

OM (2007-2009): 0.6379 tCO_2/MWh
(Source: Data published Cambodia DNA)

Calculated build margin (BM)
The operation margin which is calculated by Cambodia DNA is applied. This value is calculated by selecting the sample group (b) The set of power capacity additions in the electricity system that comprise 20% of the system generation (in MWh) and that have been built most recently.

BM (2009): 0.7584 tCO_2/MWh
(Source: Data published Cambodia DNA)

The detail explanation for calculation of emission factor is published by Cambodia DNA through website (http://www.camclimate.org.kh/index.php?page=searchdocument&docid=b43).

Therefore, the emission factor published by the Cambodian DNA is as below;

Application combined margin (CM)

$EF_{grid,CM,y} = 0.6981\ tCO_2/MW$

Scenario B: Electricity consumption from an off-grid captive power plant

As per tool, scenario B, option B1: The emission factor for electricity generation is determined based on the CO_2 emissions from fuel combustion and the electricity generation in the captive power plant(s) installed at the site of the electricity consumption source.

$$FE_{EL,j.t} = \frac{\sum_i FC_{i,n,t} * NCV_i * EF_{CO2,i}}{EG_{n,t}}$$

Where:

$EF_{EL,j,t}$	CO_2 emission factor of power unit *n* in year *y* (tCO_2/MWh)
$FC_{i,n,t}$	Amount of fossil fuel type *i* consumed by power unit *n* in year *y* (Mass or volume unit). This value should be calculated by the technical data for fuel consumption designed by manufacture (Caterpillar). See the <Table B.6.3.5> below;
$NCV_{i,t}$	Net calorific value (energy content) of fossil fuel type *i* in year *y* (GJ/mass or volume unit)
$EF_{CO2,i,t}$	CO2 emission factor of fossil fuel type *i* in year *y* (tCO_2/GJ)
$EG_{n,t}$	Net quantity of electricity generated by power unit *n* in year *y* (MWh)
i	All fossil fuel types(Diesel) combusted in power unit in year *y*
n	Fossil fuel fired captive power plants installed at the site of the electricity consumption source *i*
j	Sources of electricity consumption in the project
t	Time period for which the emission factor for electricity generation

<Table B.6.3.5> Fuel consumption by power units

Power units	Amount of diesel consumption ($FC_{i,n,t}$)(Liter/hr)	Electricity generated by diesel generator ($EG_{n,t}$)(MW)
600kv(480kw)	122.8	0.480
600kv(480kw)	122.8	0.480
600kv(480kw)	122.8	0.480
635kv(508kw)	130.6	0.508

<Table B.6.3.6> Calculation of diesel generator Emission Factor

Parameter	Description	Unit	Value	Details
$FC_{diesel,t}$	Amount of diesel consumed	Liter	499	Rated capacity
	Unit conversion (Amount of diesel consumed)	Gg	0.000424	0.85 kg/liter (source: http://www.nrel.gov/international/pdfs/43710.pdf)
$EG_{diesel,t}$	Net quantity of electricity by diesel generator	MWh	1.948	Rated capacity
NCV_{diesel}	NCV of diesel oil	TJ/Gg	43	2006 IPCC default value
$EF_{CO2,diesel}$	Emission factor of diesel oil	tCO_2/TJ	74.1	2006 IPCC default value
$FE_{EL,diesel}$	Emission factor for the diesel generator which is used for generation electricity	tCO_2/MWh	0.693	Calculation

Therefore, emission factor of on-site diesel generator is 0.693 tCO_2/MWh.

Conclusion

Emission factor of electricity consumed/displaced by project activity ($EF_{elect,y}$) is identified as below;

Between the emission factor of the Grid (0.6981 tCO_2/Mwh) and the Captive power plant (0.693 tCO_2/MWh) in the baseline scenario, the emission factor of the Grid(0.6981 tCO_2/MWh)is the conservative.

Appendix8. Energy balance calculation

Energy Balance				
Methane generation potential : $MEP_{ww.treatment,y}=Q_{y.ww}*COD_{y.removed}*B_{0.ww}* MCF_{ww.treatment}*Ufbl$				
Description	Parameter	unit	value	Detail
Amount of wastewater			$1,200m^3$	
Methane emission potential of the untreated wastewater in the year "y"	$MEP_{ww,treatment,y}$	tonnes of CH4	2,829	Section B.6.3 Step 1.1.8 of this PDD
Volume of waste treated in the year "y"	$Q_{ww,y}$	m^3	396,000	The total effluent generated from the plant. Maximum quantity.
Chemical Oxygen Demand of the wastewater being reduced in the UASB in the year "y"	$COD_{removed,y}$	ton/m^3	0.038	measurement
Methane generation capacity of the treated wastewater	$B_{0.ww}$	kg CH4/kg COD	0.25	IPCC lower value
Methane conversion factor for the anaerobic decay of the untreated wastewater	$MCF_{ww.treatment}$		0.80	IPCC default value for anaerobic system
Model correction factor	UF_{bl}		0.94	IPCC default value for anaerobic system
Total energy generation by wastewater(TJ/year): $MEP_{y.ww.bl} * NCV_{methane} /1000$				
Calorific value of methane	$NCV_{methane}$	TJ/Gg	50.40	IPCC default value
The net quantity of energy (thermal) supplied by the project activity during the year	$EG_{thermal,y}$	TJ	142.58	