Project design document form
(Version 11.0)

Complete this form in accordance with the instructions attached at the end of this form.

BASIC INFORMATION	
Title of the project activity	Biogas recovery and Utilization project in Tay Ninh Province, Vietnam
Scale of the project activity	☐ Large-scale ☒ Small-scale
Version number of the PDD	7.0
Completion date of the PDD	Date : 03/09/2021
Project participants	MIWON VIETNAM CO., Ltd
Host Party	Vietnam
Applied methodologies and standardized baselines	AMS-I.C. ver. 19 - Thermal energy production with or without electricity AMS-III.H. ver. 16 - Methane recovery in wastewater treatment AMS-III.I. ver. 8 - Avoidance of methane production in wastewater treatment through replacement of anaerobic systems by aerobic systems
Sectoral scopes	1: Energy industries (renewable - / non renewable sources) 13: Waste handling and disposal
Estimated amount of annual average GHG emission reductions	23,985

SECTION A. Description of project activity

A.1. Purpose and general description of project activity

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Purpose :

The project includes methane recovery, methane avoidance and biogas utilization in tapioca factory owned by Miwon Vietnam. Miwon Vietnam factory in Tay Ninh that produces tapioca (henceforth "Tay Ninh factory") is located in Tay Ninh Province of Vietnam. The Tay Ninh factory processes about 30,000 tons of tapioca starch and starch-syrup products per year.

During the production of tapioca starch, huge amount of wastewater with a high concentration of organic matter is generated. The wastewater with a high COD-content is treated in open lagoon systems. The lagoon system has twelve ponds and the wastewater is treated anaerobically due to their deepness. Because of the anaerobic conditions of the lagoon system, there is a high release of methane gas to the atmosphere.

In the baseline scenario, Tay Ninh factory has open lagoons under anaerobic conditions with methane emissions, and B-C oil fired boilers and cashew nut oil fired dryers are utilized to supply the heat required for the starch production.

The purpose of this project is (1) to reduce the methane emissions in the lagoon system through the implementation of covered anaerobic lagoons, (2) to avoid the methane emissions from the lagoon system by aerobic wastewater treatment system, and (3) to reduce the greenhouse gas emissions by substituting fossil fuel with recovered biogas.

The first pond of the lagoon systems will be covered with a membrane in order to capture methane produced in the lagoon. COD of the inflow and outflow wastewater of the anaerobic digester is about 10,000 ppm and 1,200 ppm, each. The treatment efficiency, COD removal rate, is about 90%.

After the covered anaerobic lagoon, the wastewater flows through aerobic wastewater treatment system and final treated water is discharged to the river at 2012. After constructing aerobic wastewater treatment system, the COD level of the outflow wastewater from the Tay Ninh factory will decrease below 50 ppm. By constructing aerobic wastewater treatment system, methane emission from the open lagoon system can be avoided.

The produced biogas will be utilized in the factory for the generation of heat, so it will substitute B-C oil and cashew nut oil. The electricity consumption for the improved treatment systems will be counted for project emission.

In the absence of the project, the existing lagoon system would be kept and the heat would be generated with fossil fuel. The lagoon system is legally compliant and the most economic option and would thus continue to operate. With the project activity methane emissions are avoided and GHG emissions from fossil fuel usage are reduced.

The project contributes in a significant manner to sustainable development. Concerning environmental aspects the project contribution next to reduced GHG emissions are:

- Reduced usage of fossil fuels
- Reduced air pollution basically being particle matter, sulfur dioxide and NOx emissions caused by fossil fuel combustion.
- Covering of the first ponds of the lagoon system will also reduce the odor emissions significantly in the vicinity of the factory.

The contribution to sustainable development in technological aspects is:

- The membrane used for recovery of methane from open lagoons is based on US technology.

The contribution to sustainable development in social aspects is:

- Less respiratory diseases caused through air pollution basically by particle matter. Fossil fuel powered boilers emit large amount of particle matter which can cause respiratory diseases.

The contribution to sustainable development in economic aspects is:

- Savings of fossil fuel reduce the dependence of the economy on fossil fuel usage while the methane is currently not used.

The improvement of the lagoon system with covered ponds and aerobic treatment system, and the use of renewable energy will lead to total estimated emission reduction of 239,850 tons of CO2 equivalent over one crediting period (10 years) for Tay Ninh factory.

A.2. Location of project activity

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Host Party

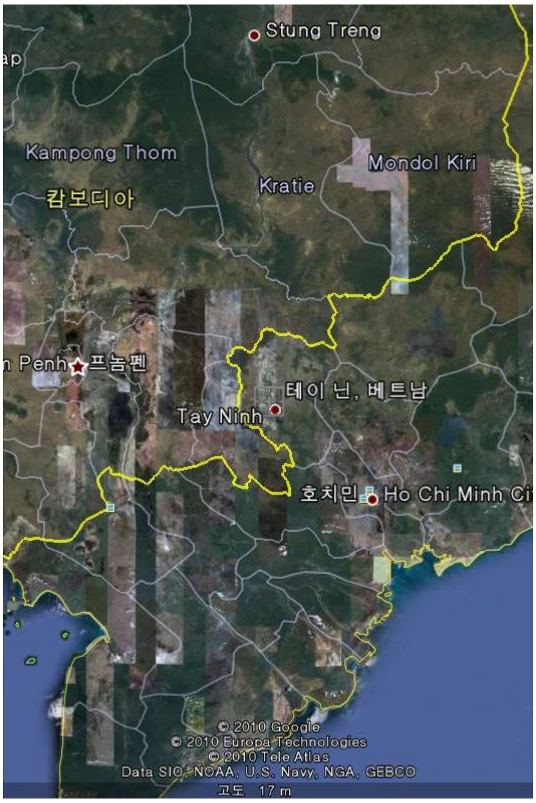
Vietnam

Region/State/Province etc.

Tay Ninh Province

City/Town/Community etc.

B2 Hamlet, Phuoc Minh Commune, Duong Minh Chau Dist.



Physical/Geographical location

The exact coordinate of the Plant is:
Latitude: 11.3272 N;
Longitude: 106.3194 E

A.3. Technologies/measures

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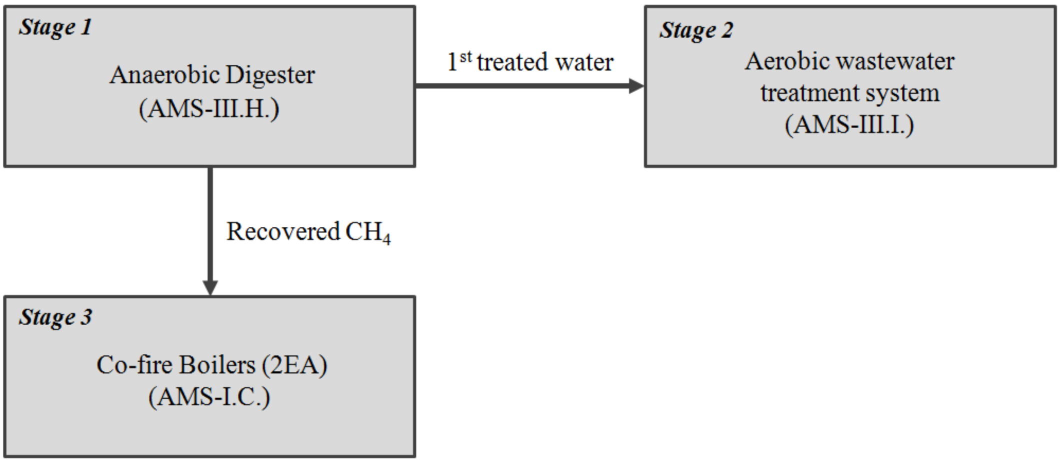
The project activity described in this document is a three-stage wastewater treatment and biogas utilization system. Methane recovery is classified as Type III - Other Project Activities, and AMS-III.H. Ver. 16, Methane recovery in wastewater treatment can be applied. This stage of the proposed project activity will recover methane from biogenic organic matter in wastewaters according to scenario (d) of the methodology, 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. Aerobic wastewater treatment system is classified as Type III - Other Project Activities, and AMS-III.I. Ver. 8, Avoidance of methane production in wastewater treatment through replacement of anaerobic systems by aerobic systems can be applied. This stage will avoid methane generation by adopting aerobic wastewater treatment system. Biogas utilization is classified as Type 1 - Renewable Energy Projects, and AMS-I.C. Ver. 19, Thermal energy production with or without electricity can be applied. This stage will utilize the biogas recovered from the first stage, replacing the use of fossil fuel, which is used on-site.



(1) Wastewater treatment system_ Anaerobic system

From the anaerobic wastewater treatment system, biogas is recovered and supplied to the factory. Biogas capture system is constructed in 2010.

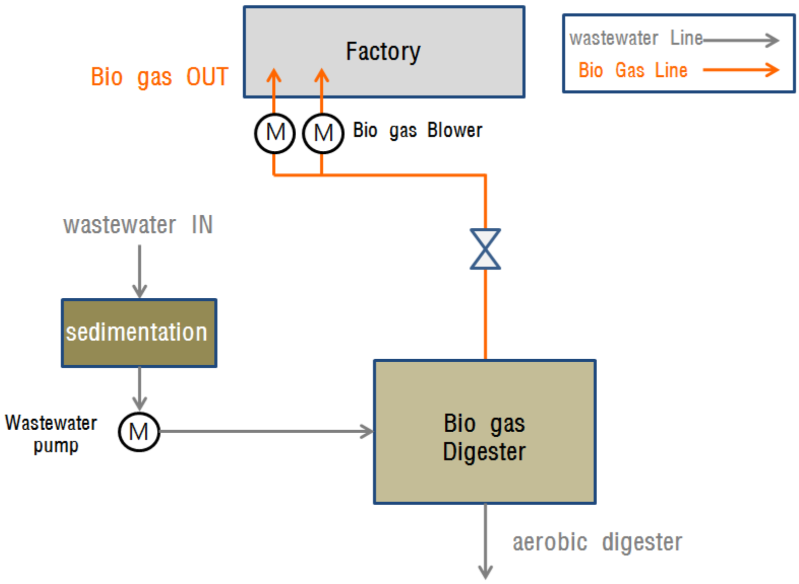
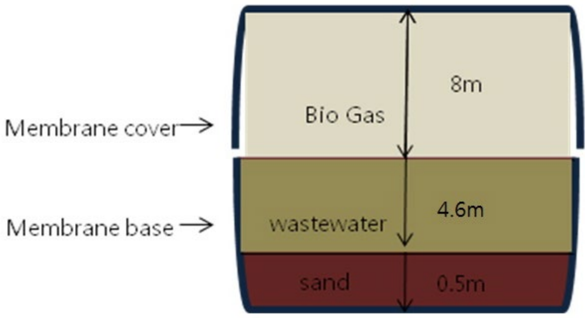


Table A-1. Description of anaerobic wastewater treatment system

System	Picture	Remarks

Anaerobic digester	 	- 60m * 140 m - amount of wastewater storage : about 40,000 m^3 - COD of input stream : 9,863 ppm

(2) Wastewater treatment system_Aerobic system

The wastewater from the anaerobic digester will flow to the aerobic wastewater treatment system to avoid methane emission. Aerobic wastewater treatment system will be built in 2012.

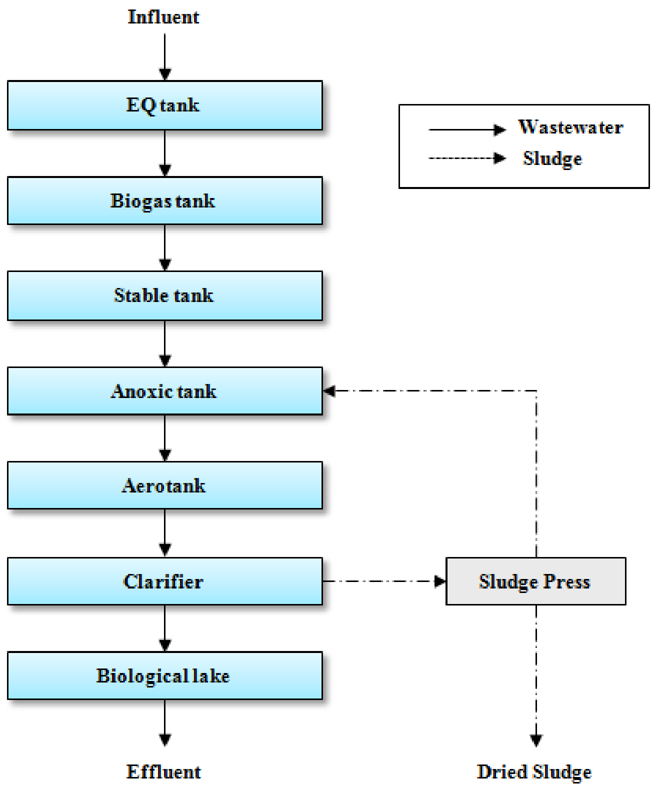
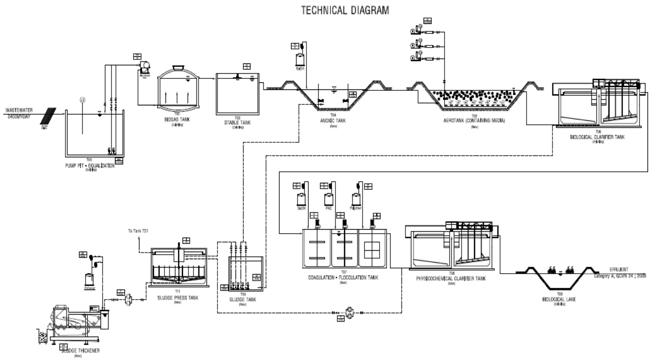


Table A-2. Description of aerobic wastewater treatment system

System	Picture	
Aerobic wastewater treatment system		- amount of wastewater treated: 2,400 m^3/day - COD of out stream : 49 ppm

(3) Biogas boiler

Two co-fire boilers utilizing biogas and coal will be built in Tay Ninh factory. Wood will be used as a start-up fuel for heating the boilers before coal is utilized. Two dryers, on the other hand, will be kept and not substituted to other dryers. The specification of each boiler is shown in table below

1. Co-fire boilers:

Table A-3. Description of co-fire boilers

Item	Description	Q'ty
#1 boiler	Martech hybrid steam boiler - Model: MCO-5(Hybrid boiler) - Capacity: 5 tons/hr - Fuel type : + Powder coal type: 3A ,3B, 3C, 4A (size 1 - 15mm) + Biogas	1 set
#2 boiler (back-up)	Martech hybrid steam boiler - Model: MCO-5(Hybrid boiler) - Capacity: 5 tons/hr - Fuel type : + Powder coal type: 3A ,3B, 3C, 4A (size 1 - 15mm) + Biogas	1 set

2. Option equipments:

Table A-4. Description of option equipments of co-fire boilers

Item	Description	Q'ty
1	Martech steam boiler package - Blower fan, burner fan, Induced draft fan etc. - Capacity: 72.56 kW	2 sets

A.4. Parties and project participants

Parties involved	Project participants	Indicate if the Party involved wishes to be considered as project participant (Yes/No)
Vietnam (host)	Private entity : MIWON VIETNAM CO., LTD	

A.5. Public funding of project activity

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No public funding is being provided for this project.

A.6. History of project activity

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The project was firstly registered as CDM project activity on 02 Jun 06, renewed on 11 Apr 13.

1. The PPs confirmed that:
   (a) The proposed CDM project activity is neither registered as a CDM project activity nor included as a component project activity (CPA) in a registered CDM programme of activities (PoA);
   (b) The CDM project activity is not a project activity that has been deregistered.

2. The PPs declared that:
   (a) The CDM project activity is not a CPA and has not been excluded from a registered CDM PoA;
   (b) There is no other registered CDM project activity or CPA under any registered CDM PoA whose geographical location as the proposed CDM project activity.

A.7. Debundling

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Based on the Compendium of guidance on the debundling for SSC project activities (EB36, Annex 27), this project is not debundled according to the following definition: “A proposed small-scale project activity shall be deemed to be a debundled stage of a large project activity if there is a registered small-scale CDM project activity or an application to register another small-scale CDM project activity:

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

The project participant has other plants in Vietnam. But other plant doesn’t have any plan for CDM and greater than 1 km apart from Tay Ninh factory.

SECTION B. Application of methodologies and standardized baselines

B.1. References to methodologies and standardized baselines

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The following small-scale methodologies are used:

- ✓ AMS-III.H. “Methane Recovery in Wastewater Treatment”, Version 16
- ✓ AMS-III.I. “Avoidance of methane production in wastewater treatment through replacement of anaerobic
- ✓ systems by aerobic systems”, Version 8
- ✓ AMS-I.C. “Thermal energy production with or without electricity”, Version 19
- ✓

Additionally the following tools are used:

- ✓ “Project emissions from flaring” (Version 02.0.0, EB 68)
- ✓ “Tool to calculate baseline, project and/or leakage emissions from electricity consumption” (Version 01, EB 39)
- ✓ “Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion” (Version 02, EB 41)
- ✓ “Tool for the demonstration and assessment of additionality” (Version 7.0, EB 70)

B.2. Applicability of methodologies and standardized baselines

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Table below lists the applicability criteria for the three involved methodologies and the corresponding project conditions.

Methodology	Application in methodology	Project situation
AMS-III.H.	This methodology comprises measures that recover biogas from biogenic organic matter in wastewater by means of one, or a combination, of 6 different options described.	Option (d) of the methodology is applicable: 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. In this project, open lagoon will be covered with a membrane to recover biogas, and covered biogas will be utilized by installing biogas-coal co-fire boilers.
	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.	The depth of lagoon is 4.6 m.
	Ambient temperature above 15°C, at least during part of the year, on a monthly average basis	The average temperature is 27.4 °C refer to Tay Ninh Province homepage (http://www.tayninh.gov.vn/gioithieu/pages/gioi-thieu-chung.aspx). Also, every monthly average temperatures of Tay Ninh Province are above 20 °C throughout the year.

Methodology	Application in methodology	Project situation
	The minimum interval between two consecutive sludge removal events shall be 30 days.	The anaerobic digester in this project will be completely covered with a methane recovery membrane. Therefore, sludge can be removed only when the membrane is replaced. As the lifetime of the membrane is 5 years, membrane replacement and sludge removal will be done every 5 years.
	The recovered biogas from the above measures may also be utilized for the 5 different applications instead of combustion/flaring. (in paragraph 3, check again)	Application (a) of the methodology is applicable: Thermal or mechanical, electrical energy generation directly. In this project, recovered biogas will be utilized directly biogas-coal co-fire boilers.
	Measures are limited to those that result in aggregate emissions reductions of less than or equal to 60 kt CO_2 equivalent annually from all Type III components of the project activity.	The emission reduction is under 60 kt CO_2 equivalent annually.
AMS-III.I.	This methodology comprises technologies and measures that avoid the production of methane from biogenic organic matter in wastewaters being treated in anaerobic systems. Due to the project activity, the anaerobic systems[1] (without methane recovery) are substituted by aerobic biological systems[2]. The project activity does not recover or combust methane in wastewater treatment facilities (unlike AMS-III.H.).	Before the project, discharged wastewater from the first stage (anaerobic digester) would be treated in open lagoon system. With an aerobic wastewater treatment system, it is able to avoid the production of methane from open lagoon system. There is no methane recovery system in aerobic wastewater treatment system.
	Measures are limited to those that result in emission reductions of less than or equal to 60 kt CO_2 equivalent annually.	The emission reduction is under 60 kt CO_2 equivalent annually.
AMS-I.C.	This category comprises renewable energy technologies that supply users with thermal energy that displaces fossil fuel use.	Biogas produced by the project displaces B-C oil.
	Biomass-based cogeneration systems are included in this category. For the purpose of this methodology “cogeneration” shall mean the simultaneous generation of thermal energy and electrical energy in one process.	This project is not a cogeneration project as it only supplies steam, not electricity.
	The total installed/rated thermal energy generation capacity of the project equipment is equal to or less than 45 MW thermal.	The total inbuilt capacity of two boilers is 10 ton/hr. It is equivalent to about 7,000,000 kcal/hr or 8 MW thermal, which is far below the threshold value of 45 MW thermal.

[1] As defined in 2006 IPCC Guidelines for National Greenhouse Gas inventories, Volume 5, Chapter 6, Wastewater treatment and discharge, table 6.3 and 6.8. Under this methodology anaerobic lagoons are ponds deeper than 2 meters, without aeration, ambient temperature above 15°C, at least during part of the year, on a monthly average basis, and with a volumetric loading rate of Chemical Oxygen Demand above 0.1 kg $COD.m^{-3}.day^{-1}$.

[2] Systems using oxygen and microbial action to treat wastewaters.

Methodology	Application in methodology	Project situation
	For co-fired systems, the total installed thermal energy generation capacity of the project equipment, when using both fossil and renewable fuel, shall not exceed 45 MW thermal.	Boiler will incinerate both coal and biogas but, the total inbuilt capacity of the boilers is about 7,000,000 kcal/hr. It is equivalent to 8 MW thermal, which is far below the threshold value of 45 MW thermal.

B.3. Project boundary, sources and greenhouse gases (GHGs)

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The project boundary covers the physical, geographical site where the wastewater and sludge treatment takes place, in the baseline and project scenario. In the baseline scenario, project boundary covers open lagoon system, the previous wastewater treatment system, and previous boilers which utilized B-C oil. In project scenario, project boundary covers anaerobic digester equipped with biogas recovery system and aerobic wastewater treatment system. Recovered biogas is utilized by 2 boilers and 2 dryers, and generated heat from the boilers and dryers is supplied to the starch processing factory. Also, there is a vent between anaerobic digester and biogas utilizing facilities to prevent the explosion of the digester in the case of excessive methane production.

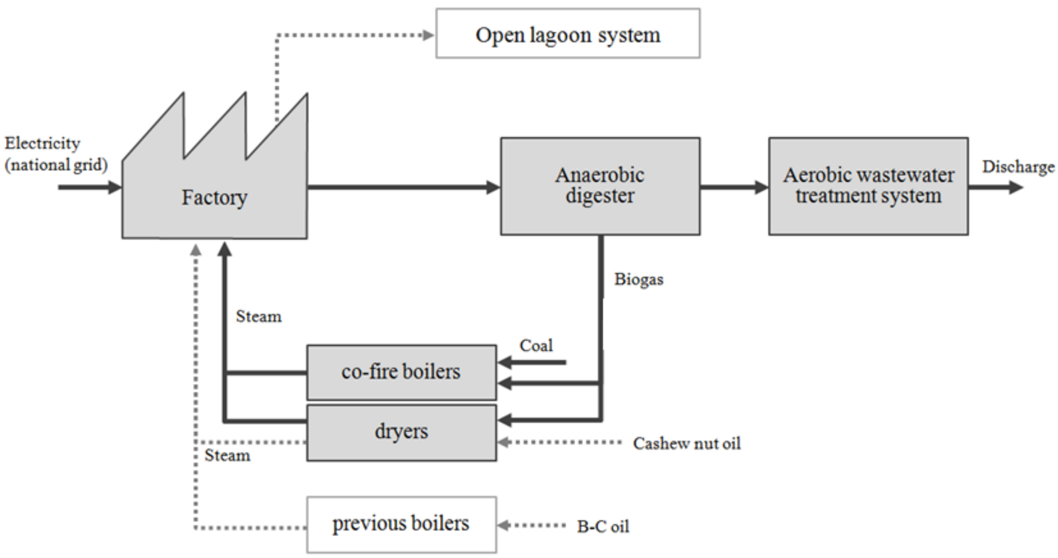

Figure B-1. Schematic diagram of the project boundary in the baseline (dotted line) and project (solid line) scenario

Table B-2. Emissions sources included in or excluded from the project boundary

	Source	Gas	Included?	Justification/Explanation
Baseline	Emission from wastewater treatment at the lagoon treatment system	CH_4	Yes	The major source of the emissions in the baseline.
	Emissions from fossil fuel consumption	CO_2	Yes	Fossil fuel consumed from boiler in starch producing process.
	Emissions from electricity consumption	CO_2	No	There are no facilities which use electricity from grid in baseline scenario.
Project Activity	Emissions from fossil fuel consumption	CO_2	Yes	Coal may be consumed from Boiler co-fired with Biogas
	Emission from methane fugitive emissions due to inefficiencies in capture systems	CH_4	Yes	Physical leakage from the digester system.
	Emission from on-site electricity use	CO_2	Yes	Electricity may be consumed from new constructed facility.

B.4. Establishment and description of baseline scenario

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Baseline scenario of this project

To develop baseline scenario, steps defined in the paragraph 22 of the "General Guidelines to SSC CDM methodologies (EB 69 annex 27)" has been applied.

Step 1:

Identify the various alternatives available to the project proponent that deliver comparable levels of service, including the proposed project activity or PoA undertaken without being registered as a CDM project activity or PoA.

There are four alternatives which could be undertaken without being registered as a CDM project activity;

Alternative 1: Maintain the status quo
The wastewater is treated in sequential lagoon system without biogas recovery or utilization.

Alternative 2: Direct wastewater discharge without any treatment
The wastewater is not treated in lagoon system, and discharge the wastewater outward of the factory directly.

Alternative 3: Methane recovery and avoidance without CDM revenue
Install anaerobic and aerobic wastewater treatment system, biogas recovery and utilization system without considering CDM revenue.

Alternative 4: Application of another wastewater treatment system
Install another anaerobic wastewater treatment system, IC-Reactor Type, which is installed in parent company of Miwon Vietnam with CDM revenue.

Step 2:

List the alternatives identified in Step 1 that are in compliance with local regulations. If any of the identified baselines is not in compliance with local regulations, then exclude that alternative from further consideration.

If alternative 2 is undertaken, the COD level of the wastewater would exceed the local environment regulation which is limited to 50 mg/L. Therefore, alternative 2 can be excluded.
All the other alternatives do not violate any local regulations.

Step 3:

Eliminate and rank the alternatives identified in Step 2 taking into account barrier tests specified in the “Guidelines on the demonstration of additionality of small-scale project activities”.

If alternative 3 is undertaken, the cost should be invested but economic benefit, the CDM credits, can not be achieved (see the details in B.5. Demonstration of additionality). Therefore, alternative 3 can be excluded.
Also, alternative 4 is not likely to be implemented as the investment cost of the IC-Reactor Type wastewater treatment system is relatively higher than the wastewater treatment system which is applied in this project (see the details in B.5. Demonstration of additionality). The investment cost of the IC-Reactor Type wastewater treatment system of the similar wastewater treatment capacity would exceed 30 billion VND, about 4 times more expensive than biogas recovery system of this project. Therefore, alternative 4 can be excluded.

Step 4:

If only one alternative remains that:

(a) Is not the proposed project activity or PoA undertaken without being registered as a CDM project activity or PoA; and
(b) Corresponds to one of the baseline scenarios provided in the methodology; then the project activity or PoA is eligible under the methodology.

In turn, the only left alternative is alternative 1, to keep the sequential lagoon system as a wastewater treatment system without biogas recovery or utilization in the absence of the project activity.

The project activity of this project can be classified into three stages, and the baseline for each stage is identified as follows.

(1) methane capture and combustion in a wastewater treatment system : Stage 1
(2) methane avoidance by adopting aerobic wastewater treatment system : Stage 2
(3) replacement of fossil fuel used for heat generation at starch processing with captured methane
(4) (thermal energy for the user) : Stage 3

• **Stage 1:** Methane recovery (AMS- III.H. Methane Recovery in Wastewater Treatment)

In methodology,
This methodology comprises measures that recover biogas from biogenic organic matter in wastewater by means of one, or a combination, of the following options:

(a) Substitution of aerobic wastewater or sludge treatment systems with anaerobic systems with biogas recovery and combustion;
(b) Introduction of anaerobic sludge treatment system with biogas recovery and combustion to a wastewater treatment plant without sludge treatment;
(c) Introduction of biogas recovery and combustion to a sludge treatment system;
(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;
(e) Introduction of anaerobic wastewater treatment with biogas recovery and combustion, with or without anaerobic sludge treatment, to an untreated wastewater stream;
(f) Introduction of a sequential stage of wastewater treatment with biogas recovery and combustion, with or without sludge treatment, to an anaerobic wastewater treatment system without biogas recovery.

Option (d) fits well with the conditions of this project as described above.

• **Stage 2:** Methane avoidance (AMS- III.I. Avoidance of methane production in wastewater treatment through replacement of anaerobic systems by aerobic systems)

In methodology,

(a) The baseline scenario is the situation where, in the absence of the project activity, degradable organic matter in wastewater is treated in anaerobic systems and methane is emitted to the atmosphere. Baseline emissions are:
(b) Methane produced in the anaerobic baseline wastewater treatment system(s) that is/are being replaced with the biological aerobic system(s) ($BE_{ww,treatment,y}$);
(c) Methane emissions on account of inefficiencies in the baseline wastewater treatment systems and presence of degradable organic carbon in the treated wastewater discharged into river/lake/sea etc. ($BE_{ww,discharge,y}$);
(d) Methane produced in the baseline sludge treatment system(s) ($BE_{s,treatment,y}$);
(e) Methane emissions from anaerobic decay of the final sludge produced in the baseline situation. 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 ($BE_{s,final,y}$).
(f) Only option (a) was applied to baseline. The options (b), (c) and (d) are already included in AMS-III.H. baseline scenario.

• **Stage 3**: Biogas utilization (AMS- I.C. Thermal energy production with or without electricity)

The captured biogas in the stage 1 will be used to produce thermal energy for starch processing. Without the implementation of installing project facilities, it is impossible to use renewable energy for production of thermal energy.
In this case, the baseline scenario is to continue using B-C oil to generate heat energy for the starch drying process. Therefore, large amount of carbon dioxide is emitted into the atmosphere with exhaust gas from starch processing by B-C oil combustion.

B.5. Demonstration of additionality

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Timeline

Date	Content
2009.11	Project design including CDM benefit analysis
2009.12	Permit project by board meeting of Miwon Vietnam
2010.1.12	Starting date (purchase equipment)
2010.6.21	MOU with RCC (CDM consulting company) 1st Feasibility study by RCC
2010.6.28	Prior consideration of project (submit “Prior Consideration of the CDM Form” to UNFCCC and Vietnam DNA)
2010.8	Starting anaerobic digester operation
2011.5	Starting 2nd Feasibility study for CDM project with LIG system
2011.6	Install #1 boiler
2011.12	CDM contract with LIG system
2012.5	Sign a contract of #2 boiler

Additionality

With the implementation of the proposed project, the emissions of GHGs will be reduced below the level that would have occurred in the absence of the registered CDM project activity. The proposed project is as small scale project activity. According to “Attachment A to Appendix B of the simplified modalities and procedures for CDM small-scale project activities”, the project participant is required to demonstrate that the proposed project would not have occurred anyway due to at least one of the following barriers:

(a) Investment barrier, i.e., a financially more viable alternative to the project activity would have led to higher emissions:
(b) Technological barrier, i.e., a less technologically advanced alternative to the project activity, though would involves lower risks due to the performance uncertainty or low market share of the new technology adopted by the project activity and so would have led to higher emissions:
(c) Barrier due to prevailing practice, i.e., prevailing practice or existing regulatory or policy requirements would have led to the implementation of a technology with higher emissions;
(d) Other barriers, i.e., without the project activity, for another specific reason identified by the project participant, such as institutional barriers or limited information, managerial resources, organizational capacity, financial resources, or capacity to absorb new technologies, emissions would have been higher

Then investment barrier is the main obstacle for the proposed project. According to “Non-binding best practice examples to demonstrate additionality for SSC project activities”: Best practice examples include but are not limited to, the application of investment comparison analysis using a relevant financial indicator, application of a benchmark analysis or a simple cost analysis (Where CDM is the only revenue stream such as end-use energy efficiency). It is recommended to use national or global accounting practices and standards for such an analysis. Since the project can get income by saving fuel costs, the benchmark analysis is selected for the proposed project’s financial analysis.

The internal return rate (IRR) of the total investment is selected as the financial indicator. A project IRR before tax is calculated for the proposed project and this is compared with a benchmark to prove the financial unattractiveness of the project.

According to EB 62 Report Annex 5, "Guidelines on the Assessment of Investment Analysis" (Version 05): In cases where a benchmark approach is used, the applied benchmark shall be appropriate to the type of IRR calculated. Local commercial lending rates or weighted average cost of capital (WACC) are appropriate benchmarks for a project IRR. Thus for the proposed project, a conservative local commercial lending rate at the time for decisions to proceed with the project is selected as the benchmark. This is defined according to the steps outlined below:

The average basic interest rate set up by the State Bank of Vietnam from 2007 to 2009 was 8.84%. According to the Vietnamese civil law, commercial banks may charge 150% of the base lending rate, i.e. 13.25%.

The project developer has selected 13.25% as the benchmark as it covers the cost of the loan described in the feasibility study, and also provides a return on equity

1. **Investment cost**

Table B-4. Financial parameters (investment cost) of the proposed project

Category	Value	Unit	Value in USD
Boiler	13,248,000,000	VND	716,922
Biogas recovery system	8,000,000,000	VND	432,924
Aerobic wastewater treatment system	30,000,000,000	VND	1,623,464
TOTAL	51,248,000,000	VND	2,773,310

2. **O&M cost**

Table B-5. Financial parameters (O&M cost) of the proposed project

Category	Value	Unit	Value in USD
Personnel expenses	30,000,000	VND/year	1,623
Fuel expenses	1,000,000,000	VND/year	54,115
Maintenance cost	1,060,000,000	VND/year	57,362
Expenses for chemicals	2,000,000,000	VND/year	108,231
TOTAL	4,090,000,000	VND/year	221,332

In accordance with the benchmark analysis if the financial indicators (such as the IRR) of a project are lower than the benchmark, the project is not considered to be financially attractive. From the table above, it could be found that the project IRR is lower than the selected benchmark (13.25%) and therefore the proposed project is not financially attractive.

With the CDM revenue, the project IRR will be significantly improved and will exceed the benchmark. Therefore, the project with CDM revenue can be considered as financially attractive to investors.

IRR analysis

Table B-6. IRR analysis of the proposed project

Unit: 10^6 VND

Parameter	2011	2012	2013	2014	2015	2016	2017	2018	2019
Investment cost	51,248	-	-	-	-	-	-	-	-
Operational costs	-	4,090	4,090	4,090	4,090	4,090	4,090	4,090	4,090
Income (savings)	-	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000
Cash Flow	(51,248)	5,910	5,910	5,910	5,910	5,910	5,910	5,910	5,910

Parameter	2020	2021	2022	2023	2024	2025	2026	2027	2028
Total Investment	-	-	-	-	-	-	-	-	-
Operationa l costs	4,090	4,090	4,090	4,090	4,090	4,090	4,090	4,090	4,090
Income (savings)	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000
Cash Flow	5,910	5,910	5,910	5,910	5,910	5,910	5,910	5,910	5,910

Parameter	2029	2030	2031	2032	2033	2034	2035	2036
Total Investment	-	-	-	-	-	-	-	-
Operational costs	4,090	4,090	4,090	4,090	4,090	4,090	4,090	4,090
Income (savings)	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000
Cash Flow	5,910	5,910	5,910	5,910	5,910	5,910	5,910	5,910

IRR	10.60%
benchmark IRR	13.25%

Sensitivity analysis

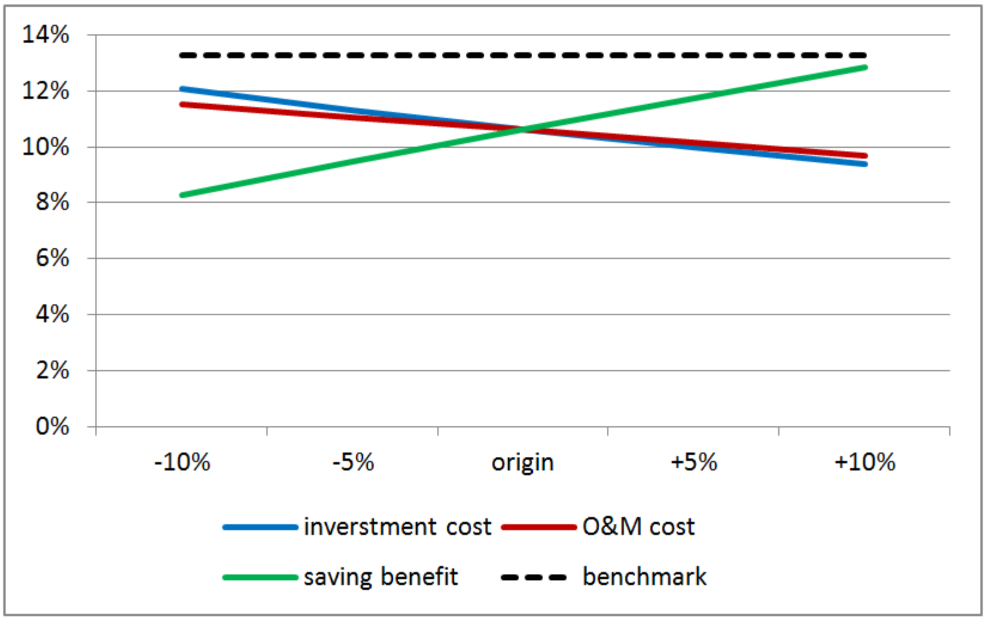
For the proposed project, the following parameters were considered in the sensitivity analysis:

- ✓ Total investment cost
- ✓ O&M cost
- ✓ Saving benefit

The impacts on each project IRR of the proposed project are shown in the following tables and figures.

Table B-7. Sensitivity analysis of the proposed project

Category \ Range	-10%	-5%	origin	+5%	+10%
investment cost	12.07%	11.30%	10.60%	9.96%	9.37%
O&M cost	11.52%	11.07%	10.60%	10.14%	9.66%
saving benefit	8.27%	9.45%	10.60%	11.73%	12.82%
benchmark	13.25%	13.25%	13.25%	13.25%	13.25%



B.6. Estimation of emission reductions

B.6.1. Explanation of methodological choices

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Baseline Emissions

The baseline emission calculations for methane recovery and fossil fuel switch of this project activity are described in the following paragraphs.

Stage 1 (methane recovery)

The amount of methane that would be emitted to the atmosphere in the absence of the project activity can be estimated by referring to UNFCCC-approved methodology AMS III.H., version 16, *Methane recovery in wastewater treatment.*

The baseline emission applicable to this project is in accordance with paragraph 17,

> Wastewater and sludge treatment systems equipped with a biogas recovery facility in the baseline shall be excluded from the baseline emission calculations.

And paragraph 18,

> Baseline emissions for the systems affected by the project activity may consist of:
>
> (a) Emissions on account of electricity or fossil fuel used ($BE_{power,y}$);
>
> (b) Methane emissions from baseline wastewater treatment systems ($BE_{ww,treatment,y}$);
>
> (c) Methane emissions from baseline sludge treatment systems ($BE_{s,treatment,y}$);
>
> (d) Methane emissions on account of inefficiencies in the baseline wastewater treatment systems and presence of degradable organic carbon in the treated wastewater discharged into river/lake/sea ($BE_{ww,discharge,y}$);
>
> (e) Methane emissions from the decay of the final sludge generated by the baseline treatment systems ($BE_{s,final,y}$).

In this project, only option (b) is applied. There is no sludge treatment system, and no wastewater is discharged from the plant in the baseline situation.

<u>EX-ANTE CALCULATION</u>

Therefore,

$$BE_{y,Stage1} = BE_{ww,treatment,y,Stage1} \quad \textbf{(1)}$$

Where:

$BE_{y,Stage1}$ Baseline emissions of the stage 1 in year *y* (tCO_2e)

$BE_{ww,treatment,y,Stage1}$	Baseline emissions of the wastewater treatment systems affected by the project activity of the stage 1 in year *y* (tCO_2e)

Methane emissions from the baseline wastewater treatment systems affected by the project ($BE_{ww,treatment,y,Stage1}$) are determined using the COD removal efficiency of the baseline plant:

$$BE_{ww,treatment,y,Stage1} = Q_{ww,y,Stage1} * COD_{\inf flow,anaerobic} * \eta_{COD,BL} * MCF_{ww,treatment,BL} * B_{o,ww} * UF_{BL,Stage1} * GWP_{CH4} \quad \textbf{(2)}$$

Where:

$Q_{ww,y,Stage1}$	Volume of wastewater treated in baseline wastewater treatment system of the stage 1 in year *y* (m^3). For *ex ante* estimation, forecasted wastewater generation volume or the designed capacity of the wastewater treatment facility can be used. However, the *ex post* emissions reduction calculation shall be based on the actual monitored volume of treated wastewater
$COD_{\inf low,anaerobic}$	Chemical oxygen demand of the wastewater inflow to the baseline anaerobic treatment system in year *y* (t/m^3). Average value may be used through sampling with the confidence/precision level 90/10
$\eta_{COD,BL}$	1. COD removal efficiency of the baseline treatment system
$MCF_{ww,treatment,BL}$	Methane correction factor for baseline wastewater treatment system (*MCF* values as per Table B-8)
$B_{o,ww}$	Methane producing capacity of the wastewater (IPCC value of 0.25 kg CH_4/kg COD)[3]
$UF_{BL,Stage1}$	Model correction factor of the stage 1 to account for model uncertainties (0.89)[4]
GWP_{CH4}	Global Warming Potential for methane (value of 21)

If the baseline treatment system is different from the treatment system 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 Methane Correction Factor (*MCF*) shall be determined based on the following table:

2. **Table B-8. IPCC default values[5] for Methane Correction Factor (*MCF*)**

3. **(Table III.H.1. from the AMS-III.H. ver. 16)**

Type of wastewater treatment and discharge pathway or system	***MCF* value**
Discharge of wastewater to sea, river or lake	0.1
Aerobic treatment, well managed	0.0

[3] Project activities may use the default value of 0.6 kg CH_4/kg BOD, if the parameter $BOD_{5,20}$ is used to determine the organic content of the wastewater. In this case, baseline and project emissions calculations shall use BOD instead of COD in the equations, and the monitoring of the project activity shall be based in direct measurements of $BOD_{5,20}$, i.e. the estimation of BOD values based on COD measurements is not allowed.

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

[5] Default values from chapter 6 of volume 5. Waste in 2006 IPCC Guidelines for National Greenhouse Gas Inventories.

Type of wastewater treatment and discharge pathway or system	*MCF* value
Aerobic treatment, poorly managed or overloaded	0.3
Anaerobic digester for sludge without methane recovery	0.8
Anaerobic reactor without methane recovery	0.8
Anaerobic shallow lagoon (depth less than 2 metres)	0.2
Anaerobic deep lagoon (depth more than 2 metres)	0.8
Septic system	0.5

Project activity emissions from the systems affected by the project activity are:

(i) CO_2 emissions from electricity and fuel used by the project facilities ($PE_{power,y}$);

(ii) Methane emissions from wastewater treatment systems affected by the project activity, and not equipped with biogas recovery in the project scenario ($PE_{ww,treatment,y}$);

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

(iv) Methane emissions on account of inefficiency of the project activity wastewater treatment systems and presence of degradable organic carbon in treated wastewater ($PE_{ww,discharge,y}$);

(v) Methane emissions from the decay of the final sludge generated by the project activity treatment systems ($PE_{s,final,y}$);

(vi) Methane fugitive emissions due to inefficiencies in capture systems ($PE_{fugitive,y}$);

(vii) Methane emissions due to incomplete flaring ($PE_{flaring,y}$);

(viii) Methane emissions from biomass stored under anaerobic conditions which would not have occurred in the baseline situation ($PE_{biomass,y}$).[6]

In this project, (i) and (vi) will be included for project emission.

Therefore,

$$PE_{y,Stage1} = PE_{power,y} + PE_{fugitive,y} \quad (3)$$

Where:

$PE_{y,Stage1}$	Project emissions of the stage 1 in year y (tCO_2e)
$PE_{power,y}$	Emissions from electricity or fuel consumption in the year y (tCO_2e). For the situation of the project scenario, these emissions shall be calculated using energy consumption data of all equipment/devices used in the project activity wastewater and sludge treatment systems and systems for biogas recovery and flaring/gainful use

[6] For instance in the baseline situation Palm Kernel Shells (PKS) are used as fuel in a boiler. In the project situation PKS is replaced by biogas captured at a wastewater treatment system. The PKS will no longer be used as fuel in the boiler, but sold on the market. Before it is sold it is likely it will be stored for a period of time (few months or longer) on site which might lead to methane emissions from anaerobic decay.

$PE_{fugitive,y}$	Methane emissions from biogas release in capture system in year *y*

$$PE_{Power,y} = EC_{consumption,y} * EF_{grid,y} \quad \textbf{(4)}$$

Where:

$EC_{consumption,y}$	Electricity consumption for the project facilities in the year *y* (MWh)
$EF_{grid,y}$	Emission factor of the grid supplying the factory in year *y* (tCO_2e/MWh)

$$PE_{fugitive,y} = PE_{fugitive,ww,y} + PE_{fugitive,s,y} \quad \textbf{(5)}$$

Where:

$PE_{fugitive,ww,y}$	Fugitive emissions through capture inefficiencies in the anaerobic wastewater treatment systems in the year *y* (tCO_2e)
$PE_{fugitive,s,y}$	Fugitive emissions through capture inefficiencies in the anaerobic sludge treatment systems in the year *y* (tCO_2e)

4.

$$PE_{fugitive,ww,y} = (1 - CFE_{ww}) * MEP_{ww,treatment,y} * GWP_{CH4} \quad \textbf{(6)}$$

Where:

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

$$MEP_{ww,treatment,y} = Q_{ww,y,Stage1} * B_{o,ww} * UF_{PJ,Stage1} * COD_{removed,y,Stage1} * MCF_{ww,treatment,PJ} \quad \textbf{(7)}$$

Where:

$UF_{PJ,Stage1}$	Model correction factor to account for model uncertainties (1.12)
$COD_{removed,y,Stage1}$	The chemical oxygen demand removed[7] by the treatment system of the project activity equipped with biogas recovery in the year *y* (t/m^3)
$MCF_{ww,treatment,PJ}$	Methane correction factor for the project wastewater treatment system equipped with biogas recovery equipment (*MCF* values as per Table B-8)

In this project, sludge will flow into lagoons together with wastewater through the methane fermentation facilities. As there will be no process to separate sludge from wastewater, calculation of $PE_{fugitive,s,y}$ can be excluded.

If the technology is using equipment transferred from another activity, leakage effects at the site of the other activity are to be considered and estimated. However, there is no equipment to be transferred for this project and leakage emissions can be ignored.

Therefore, emissions reductions of the stage 1 can be estimated using the equations for baseline, project and leakage emissions above. Emissions reductions shall be estimated as follows:

$$ER_{y,Stage1} = BE_{y,Stage1} - PE_{y,Stage1} \quad \textbf{(8)}$$

<u>EX-POST CALCULATION</u>

The emission reductions achieved by the project will be calculated with actual monitored data. The emission reductions achieved in any year are the lowest value of the following:

$$ER_{ww,\,y,\,ex\,post} = \min((BE_{y,\,ex\,post} - PE_{y,\,ex\,post}), (MD_y - PE_{power,\,y})) \quad \textbf{(9)}$$

Where:

$ER_{ww,\,y,\,ex\,post}$	Emission reductions achieved by the project activity based on monitored values for year *y* (tCO_2e)
$BE_{y,\,ex\,post}$	Baseline emissions calculated as per equation **(1)** using ex post monitored values
$PE_{y,\,ex\,post}$	Project emissions calculated as per equation **(3)** using ex post monitored values
MD_y	Methane captured and destroyed/gainfully used by the project activity in the year *y* (tCO_2e)

In the case of flaring/combustion MD_y will be measured using the conditions of the flaring process:

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[7] Difference between the inflow COD and the outflow COD.

$MD_y = BG_{burnt,y} * w_{CH4,y} * D_{CH4} * FE * GWP_{CH4}$ **(10)**

5. Where:

$BG_{burnt,y}$	Biogas flared/combusted in year *y* (m^3)
$w_{CH4,y}$	Methane content of the biogas in the year *y* (volume fraction)
D_{CH4}	Density of methane at the temperature and pressure of the biogas in the year *y* (t/m^3)
FE	Flare efficiency in year *y* (fraction). If the biogas is combusted for gainful purposes, e.g. fed to an engine, an efficiency of 100% may be applied

Stage 2 (methane avoid)

The baseline scenario is the situation where, in the absence of the project activity, degradable organic matter in wastewater is treated in anaerobic systems and methane is emitted to the atmosphere. Baseline emissions are:

(a) Methane produced in the anaerobic baseline wastewater treatment system(s) that is/are being replaced with the biological aerobic system(s) ($BE_{ww,treatment,y}$);

(b) Methane emissions on account of inefficiencies in the baseline wastewater treatment systems and presence of degradable organic carbon in the treated wastewater discharged into river/lake/sea etc. ($BE_{ww,discharge,y}$);

(c) Methane produced in the baseline sludge treatment system(s) ($BE_{s,treatment,y}$);

(d) Methane emissions from anaerobic decay of the final sludge produced in the baseline situation. 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 ($BE_{s,final,y}$).

In this project, only option (a) is applied.

EX-ANTE CALCULATION

Therefore,

$$BE_{y,Stage2} = BE_{ww,treatment,y,Stage2} \quad \textbf{(11)}$$

Where:

$BE_{y,Stage2}$	Baseline emissions of the stage 2 in the year *y* (tCO_2e)
$BE_{ww,treatment,y,Stage2}$	Methane produced in the anaerobic baseline wastewater treatment system that is being replaced with the biological aerobic system (tCO_2e)

Methane emissions from the baseline wastewater treatment systems affected by the project ($BE_{ww,treatment,y,Stage2}$) are determined using the COD removal efficiency of the baseline plant. In the stage 2, methane emissions should be estimated only for the months with ambient average

temperature above 15 °C. On the other hand, every monthly average temperatures of Tay Ninh Province are above 20 °C throughout the year and annual average parameters can be applied:

$$BE_{ww,treatment,y,Stage2} = Q_{ww,y,Stage2} * COD_{removed,y,Stage2} * MCF_{anaerobic,Stage2} * B_o * UF_{BL,Stage2} * GWP_{CH4} \quad \textbf{(12)}$$

Where:

$Q_{ww,y,Stage2}$	Volume of the wastewater treated in the stage 2 during year *y*
$COD_{removed,y,Stage2}$	Chemical oxygen demand removed by the anaerobic wastewater treatment system in the baseline situation of the stage 2 in the year *y* (tonnes/m^3)
$MCF_{anaerobic,Stage2}$	Methane correction factor for the anaerobic baseline wastewater treatment system of the stage 2 replaced by the project activity, value as per Table B-8
B_o	6. Methane producing capacity of the wastewater (IPCC value of 0.21 kg CH_4/kg COD)
$UF_{BL,Stage2}$	7. Model correction factor of the stage 2 to account for model uncertainties (0.94)
GWP_{CH4}	Global Warming Potential for methane (value of 21)

To determine $COD_{removed,y,Stage2}$ as the baseline treatment system is different from the treatment system 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 project activity emissions consists of:

(i) CO_2 emissions related to the power and fossil fuel used by the project activity facilities ($PE_{power,y}$);

(ii) Methane emissions during the treatment of the wastewater in biological aerobic wastewater treatment systems ($PE_{ww,treatment,,y}$);

(iii) Methane emissions from degradable organic carbon in treated wastewater discharged in sea/river or lake ($PE_{ww,discharge,y}$);

(iv) Methane emissions from sludge treatment in the project activity ($PE_{s,l,y}$);

(v) Methane emissions from the decay of the final sludge generated by the project activity, if the sludge is disposed to decay anaerobically in a landfill without methane recovery ($PE_{s,final,y}$);

In this project, (i), (ii) and (iii) will be included for project emission. However, option (i) will not be included in the stage 2 as it is already applied in the stage 1, and option (ii) is neglected as the wastewater will be treated in well managed system. Since the project activity does not involve the modification of the sludge treatment from the baseline, these project emissions are not considered.

Therefore,

$$PE_{y,Stage2} = PE_{ww,discharge,y} \quad \textbf{(13)}$$

Where:

$PE_{y,Stage2}$	Project emissions of the stage 2 in year *y* (tCO_2e)
$PE_{ww,discharge,y}$	Methane emissions from the biological aerobic wastewater treatment in the year *y* (tCO_2e)

$$PE_{ww,discharge,y} = Q_{ww,y,Stage2} * GWP_{CH4} * B_o * UF_{PJ,Stage2} * COD_{outflow,aerobic} * MCF_{ww,discharge} \quad \textbf{(14)}$$

Where:

$UF_{PJ,Stage2}$	8. Model correction factor of the stage 2 to account for model uncertainties (1.06)
$COD_{outflow,aerobic}$	Chemical oxygen demand of the final treated wastewater discharged into sea, river or lake (tonnes/m^3)
$MCF_{ww,discharge}$	Methane correction factor based on discharge pathway of the wastewater (fraction), value as per Table B-8

If the technology is using equipment transferred from another activity, leakage effects at the site of the other activity are to be considered and estimated. However, there is no equipment to be transferred for this project and leakage emissions can be ignored.

Therefore, emissions reductions of the stage 2 can be estimated using the equations for baseline and project emissions above. Emissions reductions shall be estimated as follows:

$$ER_{y,Stage2} = BE_{y,Stage2} - PE_{y,Stage2} \quad \textbf{(15)}$$

<u>EX-POST CALCULATION</u>

The emission reductions achieved by the project will be calculated with actual monitored data. The equation and parameters for the emission reductions in any year are the same as ex-ante calculation.

Stage 3 (biogas utilization)

The amount of emissions that would occur in the absence of the project activity can be estimated according to UNFCCC approved methodology AMS-I.C., Ver. 19, *Thermal energy production with or without electricity.*

The baseline scenario in this project meets the requirements of paragraph 16 of the methodology: *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 coefficient for the fossil fuel displaced. IPCC default values for emission coefficients may be used.

EX-ANTE CALCULATION

As fossil fuel (B-C oil of the boilers) in the baseline scenario is displaced with biogas and coal, the total baseline emissions of the stage 3 is the sum of baseline emissions from each energy sources.

$$BE_{y,Stage3} = (EG_{thermal,y} / \eta_{BL,thermal}) * EF_{CO_2,B-C} \qquad \textbf{(16)}$$

Where:

$BE_{y,Stage3}$	Baseline emissions of the stage 3 in year *y* (tCO_2e)
$EG_{thermal,y}$	The net quantity of steam/heat supplied by the project activity during the year *y* (TJ)
$\eta_{BL,thermal}$	The efficiency of the plant using fossil fuel that would have been used in the absence of the project activity (100%)[8]
$EF_{CO_2,B-C}$	The CO_2 emission factor of the B-C oil that would have been used in the baseline plant (tCO_2/TJ)

Project emissions of the stage 3 include CO_2 emissions from on-site consumption of fossil fuels, and can be calculated using the latest version of the “Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion”. The emissions from utilizing biogas are not included as it is not a fossil fuel.

$$PE_{y,Stage3} = FC_{coal,y} * NCV_{coal} * EF_{CO2,coal} \qquad \textbf{(17)}$$

Where:

$PE_{y,Stage3}$	Project emissions of the stage 3 from fossil fuel combustion during the year *y* (tCO_2e)
$FC_{coal,y}$	The quantity of coal combusted during the year *y* (Gg/yr)
NCV_{coal}	Net calorific value of coal (TJ/Gg)
$EF_{CO2,coal}$	The CO_2 emission factor of coal (tCO_2/TJ)

To estimate the quantity of coal needed, the net quantity of steam/heat has to be supplied by coal and biogas to fully displace that has to be supplied by B-C oil in the baseline scenario is calculated as follows:

$$FC_{coal,y} = (EG_{thermal,boiler} - EG_{thermal,CH4}) / NCV_{coal} \qquad \textbf{(18)}$$

8 Default efficiency of 100% is applied in accordance with AMS-I.C., Ver. 19, paragraph 30 (c).

Where:

$EG_{thermal,boiler}$	The annual average net quantity of steam/heat supplied to the boilers in the baseline scenario (TJ)
$EG_{thermal,CH4}$	The estimated net quantity of steam/heat supplied to the boiler from the methane recovered in the project scenario of the stage 1(TJ)

As the recovered methane will be supplied to the dryers first and only the remainder will be supplied to the boilers, the net quantity of steam/heat supplied to the project scenario of the stage 3 is calculated as follows:

$$EG_{thermal,CH4} = (BE_{y,Stage1} - PE_{fugitive,ww,y}) / GWP_{CH4} * NCV_{CH4} - EG_{thermal,dryer} \quad \textbf{(19)}$$

Where:

NCV_{CH4}	Net calorific value of CH_4 (TJ/Gg)
$EG_{thermal,dryer}$	The annual average net quantity of steam/heat supplied to the dryers in the baseline scenario (TJ)

If the technology is using equipment transferred from another activity, leakage effects at the site of the other activity are to be considered and estimated. However, there is no equipment to be transferred for this project and leakage emissions can be ignored.

Therefore, emissions reductions of the stage 3 can be estimated using the equations for baseline and project emissions above. Emissions reductions shall be estimated as follows:

$$ER_{y,Stage3} = BE_{y,Stage3} - PE_{y,Stage3} \quad \textbf{(20)}$$

<u>EX-POST CALCULATION</u>

The emission reductions achieved by the project will be calculated with actual monitored data. The equation and parameters for the baseline emissions in any year are the same as ex-ante calculation. However, project emissions will be calculated as per equation **(18)** with actual monitored quantity of fuel type *i* combusted, and equation **(19)** and **(20)** will not be applied.

B.6.2. Data and parameters fixed ex ante

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Data / Parameter	$MCF_{ww,treatment,BL}$
Unit	-
Description	Methane correction factor for baseline wastewater treatment system
Source of data	Default values from chapter 6 of volume 5. Waste in 2006 IPCC Guidelines for National Greenhouse Gas Inventories.
Value(s) applied	Anaerobic deep lagoon (depth more than 2 metres): 0.8
Choice of data or Measurement methods and procedures	
Purpose of data	Calculating AMS-III.H. baseline emission
Additional comment	-

Data / Parameter	$B_{o,ww}$
Unit	kg CH_4/kg COD
Description	Methane producing capacity of the wastewater
Source of data	IPCC value
Value(s) applied	0.25
Choice of data or Measurement methods and procedures	IPCC default value from paragraph 20 of AMS-III.H. version 16
Purpose of data	Calculating AMS-III.H. baseline and project emission
Additional comment	Project activities may use the default value of 0.6 kg CH_4/kg BOD, if the parameter BOD_5, 20 is used to determine the organic content of the wastewater. In this case, baseline and project emissions calculations shall use BOD instead of COD in the equations, and the monitoring of the project activity shall be based in direct measurements of BOD5, 20, i.e. the estimation of BOD values based on COD measurements is not allowed.

Data / Parameter	$UF_{BL,Stage1}$
Unit	-
Description	Model correction factor of the stage 1 to account for model uncertainties
Source of data	Default value from paragraph 20 of AMS-III.H. version 16.
Value(s) applied	0.89
Choice of data or Measurement methods and procedures	FCCC/SBSTA/2003/10/Add.2, page 25
Purpose of data	Calculating AMS-III.H. baseline emission
Additional comment	-

Data / Parameter	GWP_{CH4}
Unit	-
Description	Global warming potential for methane
Source of data	IPCC value
Value(s) applied	21
Choice of data or Measurement methods and procedures	Default value from 2006 IPCC guideline
Purpose of data	Calculating AMS-III.H., -III.I. baseline and project emission
Additional comment	-

Data / Parameter	$EF_{grid,y}$
Unit	tCO_2/MWh
Description	Emission factor for project electricity consumption sources
Source of data	"Tool to calculate baseline, project and/or leakage emissions from electricity consumption" (Version 01), Option A2(a)
Value(s) applied	0.5764
Choice of data or Measurement methods and procedures	-
Purpose of data	Calculating AMS-III.H. project emission
Additional comment	-

Data / Parameter	CFE_{ww}
Unit	-
Description	Capture efficiency of the biogas recovery equipment in the wastewater treatment systems
Source of data	Default value from paragraph 30 of AMS-III.H. version 16
Value(s) applied	0.9
Choice of data or Measurement methods and procedures	-
Purpose of data	Calculating AMS-III.H. project emission
Additional comment	-

Data / Parameter	$UF_{PJ,Stage1}$
Unit	-
Description	Model correction factor to account for model uncertainties
Source of data	Default value from paragraph 30 of AMS-III.H. version 16
Value(s) applied	1.12
Choice of data or Measurement methods and procedures	
Purpose of data	Calculating AMS-III.H. project emission
Additional comment	-

Data / Parameter	$MCF_{ww,treatment,PJ}$
Unit	-
Description	Methane correction factor for the project wastewater treatment system equipped with biogas recovery equipment
Source of data	MCF values as per Table III.H.1
Value(s) applied	Anaerobic deep lagoon (depth more than 2 metres): 0.8
Choice of data or Measurement methods and procedures	
Purpose of data	Calculating AMS-III.H. project emission
Additional comment	-

Data / Parameter	D_{CH4}
Unit	kg/m^3
Description	Density of methane at the temperature and pressure of the biogas
Source of data	Default value from “Project emissions from flaring” version 2.0, EB68
Value(s) applied	0.716 (0 °C, 1 atm)
Choice of data or Measurement methods and procedures	-
Purpose of data	Calculating AMS-III.H. emission reduction
Additional comment	-

Data / Parameter	*FE*
Unit	%
Description	Flare efficiency in year y
Source of data	Default value from paragraph 35 of AMS-III.H. version 16
Value(s) applied	100
Choice of data or Measurement methods and procedures	-
Purpose of data	Calculating AMS-III.H. emission reduction
Additional comment	-

Data / Parameter	$MCF_{anaerobic,Stage2}$
Unit	-
Description	Methane correction factor for the anaerobic baseline wastewater treatment system in the baseline situation of the stage 2 replaced by the project activity
Source of data	value as per Table III.I.1
Value(s) applied	Anaerobic deep lagoon (depth more than 2 metres): 0.8
Choice of data or Measurement methods and procedures	
Purpose of data	Calculating AMS-III.I. baseline emission
Additional comment	-

Data / Parameter	B_o
Unit	kg CH_4/kg COD
Description	Methane producing capacity of the wastewater
Source of data	IPCC value
Value(s) applied	0.21
Choice of data or Measurement methods and procedures	IPCC default value from paragraph 7 of AMS-III.I. version 8
Purpose of data	Calculating AMS-III.I. baseline emission
Additional comment	-

Data / Parameter	$UF_{BL,Stage2}$
Unit	-
Description	Model correction factor of the stage 2 to account for model uncertainties
Source of data	Default value from paragraph 7 of AMS-III. I. version 08
Value(s) applied	0.94
Choice of data or Measurement methods and procedures	FCCC/SBSTA/2003/10/Add.2, page 25
Purpose of data	Calculating AMS-III.I. baseline emission
Additional comment	-

Data / Parameter	$UF_{PJ,Stage2}$
Unit	-
Description	Model correction factor of the stage 2 to account for model uncertainties
Source of data	Default value from paragraph 16 of AMS-III. I. version 08
Value(s) applied	1.06
Choice of data or Measurement methods and procedures	FCCC/SBSTA/2003/10/Add.2, page 25
Purpose of data	Calculating AMS-III.I. project emission
Additional comment	-

Data / Parameter	$MCF_{ww,discharge}$
Unit	-
Description	Methane correction factor based on discharge pathway of the wastewater (fraction)
Source of data	value as per table III.I.1
Value(s) applied	Discharge of wastewater to sea, river or lake: 0.1
Choice of data or Measurement methods and procedures	
Purpose of data	Calculating AMS-III.I. project emission
Additional comment	-
Data / Parameter	$\eta_{BL,thermal}$
Unit	-
Description	The efficiency of the plant using fossil fuel that would have been used in the absence of the project activity
Source of data	Default value from paragraph 30 of AMS-I. C. version 19
Value(s) applied	100%
Choice of data or Measurement methods and procedures	Default efficiency of 100%
Purpose of data	Calculating AMS-I.C. baseline emission
Additional comment	-

Data / Parameter	$EF_{CO_2,B-C}$
Unit	tCO_2/TJ
Description	The CO_2 emission factor of the B-C oil that would have been used in the baseline plant
Source of data	2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 2: Energy, Table 1.4
Value(s) applied	Other residual oil: 77.4
Choice of data or Measurement methods and procedures	-
Purpose of data	Calculating AMS-I.C. baseline emission
Additional comment	-

Data / Parameter	NCV
Unit	MJ/kg equivalent to TJ/Gg
Description	Net calorific value of each fuel
Source of data	2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 2: Energy, Table 1.2
Value(s) applied	NCV_{coal} : 25.8 (Other bituminous coal) NCV_{CH4} : 50.4 (Other biogas) NCV_{B-C} : 40.4 (Residual fuel oil) $NCV_{cashew-nut}$: 27.4 (Other liquid biofuels)
Choice of data or Measurement methods and procedures	-
Purpose of data	Calculating AMS-I.C. emission reduction
Additional comment	-

Data / Parameter	$EF_{CO_2,coal}$
Unit	tCO_2/TJ
Description	Emission factor of coal, applied to Other bituminous coal in IPCC default value
Source of data	2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 2: Energy, Table 1.4
Value(s) applied	Coal: 94.6
Choice of data or Measurement methods and procedures	-
Purpose of data	Calculating AMS-I.C. project emission
Additional comment	-

Data / Parameter	$EG_{thermal,boiler}$
Unit	TJ
Description	The annual average net quantity of steam/heat supplied to the boilers in the baseline scenario
Source of data	On site historical data
Value(s) applied	46.6
Choice of data or Measurement methods and procedures	The annual average quantity of B-C oil utilized for 2 years are multiplied by net calorific value from 2006 IPCC guideline (Volume 2: Energy, Table 1.2, other residual oil).
Purpose of data	Calculating AMS-I.C. project emission
Additional comment	-

Data / Parameter	$EG_{thermal,dryer}$
Unit	TJ
Description	The annual average net quantity of steam/heat supplied to the dryers in the baseline scenario
Source of data	On site historical data
Value(s) applied	18.8
Choice of data or Measurement methods and procedures	The annual average quantity of cashew nut oil utilized for 2 years are multiplied by net calorific value from 2006 IPCC guideline (Volume 2: Energy, Table 1.2, other liquid biofuels).
Purpose of data	Calculating AMS-I.C. project emission
Additional comment	-

B.6.3. Ex ante calculation of emission reductions

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Parameter	Value	Unit	Source
$Q_{ww,y,Stage1}$	729,600	m^3/yr	Designed capacity
$COD_{\inf low,anaerobic}$	9,863	mg/L	On site historical data
$\eta_{COD,BL}$	0.78	-	Designed capacity
$MCF_{ww,treatment,BL}$	0.8	-	Table AMS-III.H.1 Anaerobic deep lagoon (depth more than 2 meters)
$B_{o,ww}$	0.25	kg CH_4/kg COD	AMS-III.H.
$UF_{BL,Stage1}$	0.89	-	AMS-III.H.
GWP_{CH4}	21	-	IPCC 2nd report
$EC_{consumption,y}$	1,866	MWh	Designed capacity
$EF_{grid,y}$	0.5764	tCO_2e/MWh	Tool to calculate baseline, project and/or leakage emissions from electricity consumption
CFE_{ww}	0.9	-	AMS-III.H.
$UF_{PJ,Stage1}$	1.12	-	AMS-III.H.
$COD_{removed,y,Stage1}$	0.007725	t/m^3	On site historical data, designed capacity
$MCF_{ww,treatment,PJ}$	0.8	-	Table AMS-III.H.1 Anaerobic deep lagoon (depth more than 2 meters)
$Q_{ww,y,Stage2}$	729,600	m^3/yr	Designed capacity
$COD_{removed,y,Stage2}$	0.002089	tonnes/m^3	On site historical data, designed capacity
$MCF_{anaerobic,Stage2}$	0.8	-	AMS-III.I.
B_o	0.21	kg CH_4/kg COD	AMS-III.I.
$UF_{BL,Stage2}$	0.94	-	AMS-III.I.
$UF_{PJ,Stage2}$	1.06	-	AMS-III.I.
$COD_{outflow,aerobic}$	49	mg/L	On site historical data
$MCF_{ww,disch\arg e}$	0.1	-	Table AMS-III.I.1 for sea, river and lake discharge
$EG_{thermal,y}$	46.6	TJ	On site historical data
$\eta_{BL,thermal}$	100	%	AMS-I.C.
$EF_{CO_2,B-C}$	77.4	tCO_2/TJ	IPCC 2nd report

NCV_{coal}	25.8	TJ/Gg	IPCC 2nd report
$EF_{CO2,coal}$	94.6	tCO_2/TJ	IPCC 2nd report
$EG_{thermal,boiler}$	46.6	TJ	On site historical data
NCV_{CH4}	50.4	TJ/Gg	IPCC 2nd report
$EG_{thermal,dryer}$	18.8	TJ	On site historical data

The description of the ex-post emission reductions can be found under B.7.1.

The ex-ante approach described in this section is used for an estimation of the emission reductions.

• **Stage 1:** AMS- III.H. Methane Recovery in Wastewater Treatment

Ex-ante estimation of the baseline emissions:

The ex-ante baseline emissions of the stage 1 are calculated by using the equations **B.6.1-(1)**, **(2)**. With using the values given in Section B.6.2, the ex-ante baseline emissions of Stage 1 are calculated as follows.

$$BE_{y,Stage1} = Q_{ww,y,Stage1} * COD_{\inf low,anaerobic} * \eta_{COD,BL} * MCF_{ww,treatment,BL} * B_{o,ww} * UF_{BL,Stage1} * GWP_{CH4}$$

= 729,600 (m^3/yr) * 0.009863(t/m^3) * 0.78 * 0.8 * 0.25 (kgCH_4/kgCOD) * 0.89 * 21

= 21,067 (tCO2e/yr)

Ex-ante estimation of the project activity emissions:

(i) CO_2 emissions on account of power used by the project activity facilities;

CO_2 emissions on account of power used by the project activity facilities are calculated by using the equation **B.6.1-(4)**. With using the values given in Section B.6.2, CO_2 emissions on account of power used by the project activity facilities are calculated as follows.

$$PE_{power,y} = EC_{consumption,y} * EF_{grid,y}$$

= 1,866 (MWh/yr) * 0.5764 (tCO_2e/MWh)

= 1,076 (tCO_2e/yr)

(ii) Project activity emissions from methane release in capture and utilization/combustion/flare systems;

Project activity emissions from methane release in capture and utilization/combustion/ flare systems are calculated by using the equations **B.6.1-(5)**, **(6)** and **(7)**. With using the values given in Section B.6.2, project activity emissions from methane release in capture and utilization/combustion/flare systems are calculated as follows.

$$MEP_{ww,treatment,y} = Q_{ww,y,Stage1} * B_{o,ww} * UF_{PJ,Stage1} * COD_{removed,y,Stage1} * MCF_{ww,treatment,PJ}$$

= 729,600 (m^3/yr) * 0.25 (kgCH_4/kgCOD) * 1.12 * 0.007725 (ton/m^3) * 0.8

= 1,262 (tCH_4/yr)

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

= (1- 0.9) *1,262 (tCH_4/yr) * 21

= 2,651 (tCO_2e/yr)

Therefore, project activity emissions of the stage 1 are calculated as follows.

$$PE_{y,Stage1} = PE_{power,y} + PE_{fugitive,ww,y}$$

= 1,076 (tCO_2e/yr) + 2,651 (tCO_2e/yr)

= 3,727 (tCO_2e/yr)

Ex-ante estimation of the emission reductions:

$$ER_{y,Stage1} = BE_{y,Stage1} - PE_{y,Stage1}$$

= 21,067 (tCO_2e/yr) – 3,727 (tCO_2e/yr)

= 17,340 (tCO_2e/yr)

• **Stage 2:** AMS- III.I. Methane avoidance by aerobic wastewater treatment

Ex-ante estimation of the baseline emissions:

The ex-ante baseline emissions of Stage 2 are calculated by using the equations **B.6.1-(11)**, **(12)**. With using the values given in Section B.6.2, the ex-ante baseline emissions of the stage 2 are calculated as follows.

$$BE_{y,Stage2} = Q_{ww,y,Stage2} * COD_{removed,y,Stage2} * MCF_{anaerobic,Stage2} * B_o * UF_{BL,Stage2} * GWP_{CH4}$$

= 729,600 (m^3/yr) * 0.002089 (ton/m^3) * 0.8 * 0.21 ($kgCH_4$/kgCOD) * 0.94 * 21

= 5,056 (tCO_2e/yr)

Ex-ante estimation of the project activity emissions:

The ex-ante baseline emissions of Stage 2 are calculated by using the equations **B.6.1-(13)**, **(14)**. With using the values given in Section B.6.2, the ex-ante baseline emissions of the stage 2 are calculated as follows.

$$PE_{y,Stage2} = Q_{ww,y,Stage2} * GWP_{CH4} * B_o * UF_{PJ,Stage2} * COD_{outflow,aerobic} * MCF_{ww,discharge}$$

= 729,600 (m^3/yr) * 21 * 0.21 ($kgCH_4$/kgCOD) * 1.06 * 0.000049 (ton/m^3) * 0.1

= 17 (tCO_2e/yr)

Ex-ante estimation of the emission reductions:

$$ER_{y,Stage2} = BE_{y,Stage2} - PE_{y,Stage2}$$

= 5,056 (tCO_2e/yr) - 17 (tCO_2e/yr)

= 5,039 (tCO_2e/yr)

• **Stage 3:** AMS- I.C. Thermal energy production with or without electricity

Ex-ante estimation of the baseline emissions:

The ex-ante baseline emissions of Stage 3 are calculated by using the equation **B.6.1-(16)**. With using the values given in Section B.6.2, the ex-ante baseline emissions of the stage 3 are calculated as follows.

$$BE_{y,Stage3} = (EG_{thermal,y} / \eta_{BL,thermal}) * EF_{CO_2,B-C}$$

= 46.6 (TJ) / 100% * 77.4 (tCO_2/TJ)

= 3,605 (tCO_2e/yr)

Ex-ante estimation of the project activity emissions:

The ex-ante project emissions of Stage 3 are calculated by using the equations **B.6.1-(17)**, **(18)**, and **(19)**. With using the values given in Section B.6.2, the ex-ante project emissions of the stage 3 are calculated as follows.

$$EG_{thermal,CH4} = (BE_{y,Stage1} - PE_{fugitive,ww,y}) / GWP_{CH4} * NCV_{CH4} - EG_{thermal,dryer}$$

= { 21,067 (tCO_2e/yr) – 2,651 (tCO_2e/yr) } / 21 * 0.0504 (TJ/ton) – 18.8 (TJ)

= 25.4 (TJ/yr)

$$PE_{y,Stage3} = (EG_{thermal,boiler} - EG_{thermal,CH4}) * EF_{CO2,coal}$$

= { 46.6 (TJ/yr) – 25.4 (TJ/yr) } * 94.6 (tCO_2/TJ)

= 2,000 (tCO_2e/yr)

Ex-ante estimation of the emission reductions:

$$ER_{y,Stage3} = BE_{y,Stage3} - PE_{y,Stage3}$$

= 3,605 (tCO_2e/yr) – 2,000 (tCO_2e/yr)

=1,606 (tCO_2e/yr)

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

B.6.5. Table B-10.Estimated emission reductions of the proposed project

Year	Baseline emissions (tCO_2e)	Project emissions (tCO_2e)	Leakage (tCO_2e)	Emission reductions (tCO_2e)
Year 1	29,728	5,743	0	23,985
Year 2	29,728	5,743	0	23,985
Year 3	29,728	5,743	0	23,985
Year 4	29,728	5,743	0	23,985
Year 5	29,728	5,743	0	23,985
Year 6	29,728	5,743	0	23,985
Year 7	29,728	5,743	0	23,985
Year 8	29,728	5,743	0	23,985
Year 9	29,728	5,743	0	23,985
Year 10	29,728	5,743	0	23,985
Total	297,283	57,432	0	239,850
Total number of crediting years	10			
Annual average over the crediting period	29,728	5,743	0	23,985

B.7. Monitoring plan

B.7.1. Data and parameters to be monitored

Data / Parameter	$Q_{ww,y,Stage1}$
Unit	m^3/yr
Description	Volume of wastewater treated in baseline wastewater treatment system of the stage 1 in year *y*
Source of data	Directly measured by flow meter
Value(s) applied	729,600
Measurement methods and procedures	The net quantity of the wastewater flowed into the anaerobic digester will be monitored continuously.
Monitoring frequency	Monitoring will be done continuously and reported monthly.
QA/QC procedures	Flow meter is to be calibrated every 3years following Vietnamese standard No. 23/2013/TTBKHCN issued by Ministry of Science and Technology of Vietnam. Calibration cycle: 1 time/3 year
Purpose of data	Calculating AMS-III.H. baseline and project emission
Additional comment	For ex ante estimation, the designed capacity of the wastewater treatment facility (2,400 m^3/day) and the number of working days in Vietnam (304 days) is applied.

Data / Parameter	$COD_{\inf low,anaerobic}$
Unit	t/m^3
Description	Chemical oxygen demand of the wastewater inflow to the anaerobic digester
Source of data	Sampling and analyzing
Value(s) applied	0.009863
Measurement methods and procedures	Measure the COD by requesting analysis to officially approved institutions. The wastewater for COD analysis will be collected through representative sampling.
Monitoring frequency	Sampling and measurement will be done once a month.
QA/QC procedures	-
Purpose of data	Calculating AMS-III.H. baseline and project emission
Additional comment	For ex ante estimation, on site historical data, an average value with the confidence/precision level 90/10 is applied.

Data / Parameter	$COD_{outflow,anaerobic}$
Unit	t/m^3
Description	Chemical oxygen demand of the wastewater outflow from the anaerobic digester
Source of data	Sampling and analyzing
Value(s) applied	0.002138
Measurement methods and procedures	Measure the COD by requesting analysis to officially approved institutions. The wastewater for COD analysis will be collected through representative sampling.
Monitoring frequency	Sampling and measurement will be done once a month.
QA/QC procedures	-
Purpose of data	Calculating AMS-III.H. baseline and project emission
Additional comment	For ex ante estimation, estimated COD with the designed capacity of the wastewater treatment facility is applied.

Data / Parameter	$\eta_{COD,BL}$
Unit	-
Description	COD removal efficiency of the baseline treatment system
Source of data	Calculating from the COD concentration analyzed
Value(s) applied	0.78
Measurement methods and procedures	$(COD_{\inf low,anaerobic} - COD_{outflow,anaerobic}) / (COD_{\inf low,anaerobic})$
Monitoring frequency	Calculation will be done with monthly results.
QA/QC procedures	-
Purpose of data	Calculating AMS-III.H. baseline emission
Additional comment	For ex ante estimation, the designed capacity of the wastewater treatment facility (0.88) is multiplied by 0.89 to account for the uncertainty range.

Data / Parameter	$EC_{consumption,y}$
Unit	MWh
Description	Electricity consumption for the project facilities
Source of data	Calculating from the designed capacity and working hours
Value(s) applied	1,866
Measurement methods and procedures	As the electricity consumption due to the facilities for the project activity only cannot be separated from other electricity consumption, the designed capacity of the facilities and working hours of wastewater treatment system will be used. If it is impossible to reasonably assess working hours, 8,760 hour will be applied.
Monitoring frequency	Monitoring and report will be done once a month
QA/QC procedures	-
Purpose of data	Calculating AMS-III.H. project emission
Additional comment	For ex ante estimation, the designed capacity and working hour of each facility which is installed for wastewater treatment system and boilers is applied.

Data / Parameter	$COD_{removed,y,Stage1}$
Unit	t/m^3
Description	The chemical oxygen demand removed by the treatment system of the project activity equipped with biogas recovery in the year y
Source of data	Calculating from the COD concentration analyzed
Value(s) applied	0.007725
Measurement methods and procedures	$(COD_{\inf low,anearobic}) - (COD_{outflow,anearobic})$
Monitoring frequency	Calculation will be done with monthly results.
QA/QC procedures	-
Purpose of data	Calculating AMS-III.H. project emission
Additional comment	-

Data / Parameter	$w_{CH_4,y}$
Unit	%
Description	Volume percentage of methane in the biogas
Source of data	Measured by gas analyzer
Value(s) applied	To be monitored
Measurement methods and procedures	The methane fraction will be measure and registered quarterly within a measurement campaign. The measurement will be made with a continuous infrared analyzer over 24 hours (20 values/hour). For the fraction of methane (CH_4) a 90/10 confidence level will be used. The biogas will be measured on a wet base.
Monitoring frequency	Monitoring will be done either continuously or periodically (more than 12 measurements per hour) at confidence/precision level of 90/10, and reported monthly.
QA/QC procedures	The gas analyzer will be calibrated according to manufacturer's specification. If it's not available, national standard will be applied.
Purpose of data	Calculating AMS-III.H. emission reduction
Additional comment	-

Data / Parameter	$BG_{burnt,y}$
Unit	m^3/yr
Description	Amount of captured biogas
Source of data	Measured by gas flow meter
Value(s) applied	To be monitored
Measurement methods and procedures	The total amount of the biogas utilized by the boilers and dryers will be measured using 2 gas flow meters installed before boilers and dryers after the anaerobic tank. The total gas flow from both meters will be used as amount of captured biogas. The pressure and temperature will be monitored at the same time, and automatically normalized volume will be monitored.
Monitoring frequency	Monitoring will be done either continuously or periodically (more than 12 measurements per hour) at confidence/precision level of 90/10, and reported monthly.
QA/QC procedures	The gas flow meter will be calibrated at every 3 years according to Decision 23/2013/TTBKHCN from Ministry of Science and Technology in Vietnam. Calibration cycle: 1 time/3 year
Purpose of data	Calculating AMS-III.H. emission reduction
Additional comment	-

Data / Parameter	$Q_{ww,y,Stage2}$
Unit	m^3/yr
Description	Volume of wastewater treated in the stage 2 during year *y*
Source of data	Directly measured by flow meter
Value(s) applied	729,600
Measurement methods and procedures	The net quantity of the wastewater flowed into the aerobic wastewater treatment system will be monitored continuously.
Monitoring frequency	Monitoring will be done continuously and reported monthly.
QA/QC procedures	Flow meter is to be calibrated every 2 years following Vietnamese standard No. 23/2013/TTBKHCNissued by Ministry of Science and Technology of Vietnam. Calibration cycle: 1 time/2 year
Purpose of data	Calculating AMS-III.I. baseline emission
Additional comment	For ex ante estimation, the designed capacity of the wastewater treatment facility (2,400 m^3/day) and a number of working days in Vietnam (304 days) is applied. As every monthly average temperatures of Tay Ninh Province are above 20 °C throughout the year, annual average can be applied.

Data / Parameter	$COD_{outflow,aerobic}$
Unit	t/m^3
Description	Chemical oxygen demand of the wastewater outflow from the aerobic wastewater treatment system
Source of data	Sampling and analyzing
Value(s) applied	0.000049
Measurement methods and procedures	Measure the COD by requesting analysis to officially approved institutions. The wastewater for COD analysis will be collected through representative sampling.
Monitoring frequency	Sampling and measurement will be done once a month.
QA/QC procedures	-
Purpose of data	Calculating AMS-III.I. baseline emission
Additional comment	For ex ante estimation, on site historical data, an average value with the confidence/precision level 90/10 is applied.

Data / Parameter	$COD_{removed,y,Stage2}$
Unit	t/m^3
Description	Chemical oxygen demand removed by the anaerobic wastewater treatment system in the baseline situation in the year *y*
Source of data	Calculating from the COD concentration analyzed
Value(s) applied	0.002089
Measurement methods and procedures	$(COD_{outflow,anearobic}) - (COD_{outflow,aerobic})$
Monitoring frequency	Calculation will be done with monthly results.
QA/QC procedures	-
Purpose of data	Calculating AMS-III.I. baseline emission
Additional comment	As every monthly average temperatures of Tay Ninh Province are above 20 °C throughout the year, annual average can be applied for ex ante estimation.

Data / Parameter	$EG_{thermal,y}$
Unit	TJ
Description	The net quantity of steam/heat supplied by the project activity during the year *y*
Source of data	Indirect measurement using on site data
Value(s) applied	46.6
Measurement methods and procedures	As all the steam/heat supplied by the project activity will be generated only from the combustion of biogas and coal, net quantity of energy supplied to the boilers (the quantity of biogas and coal) will be monitored instead. This assumption is reasonable as the applied boiler efficiency is 100%. For net calorific values for methane and coal, the default values of 2nd IPCC guideline will be applied.
Monitoring frequency	Monitoring and report will be done once a month.
QA/QC procedures	-
Purpose of data	Calculating AMS-I.C. baseline emission
Additional comment	-

Data / Parameter	$BG_{boiler,y}$
Unit	m^3/yr
Description	Amount of biogas utilized to the boilers
Source of data	Measured by gas flow meter
Value(s) applied	To be monitored
Measurement methods and procedures	The total amount of the biogas utilized by the boilers will be measured using a gas flow meter before the boilers. The pressure and temperature will be monitored at the same time, and automatically normalized volume will be monitored.
Monitoring frequency	Monitoring will be done either continuously or periodically (more than 12 measurements per hour) at confidence/precision level of 90/10, and reported monthly.
QA/QC procedures	The gas flow meter will be calibrated at every 3 years according to Decision 23/2013/TTBKHCN from Ministry of Science and Technology in Vietnam. Calibration cycle: 1 time/3 year
Purpose of data	Calculating AMS-I.C. baseline emission
Additional comment	-

Data / Parameter	$FC_{coal,y}$
Unit	kg/yr
Description	The quantity of coal combusted during the year *y*
Source of data	Measured by a load cell
Value(s) applied	To be monitored
Measurement methods and procedures	The net quantity of the coal supplied to the boilers will be monitored.
Monitoring frequency	Monitoring will be done either continuously or periodically (more than 12 measurements per hour) at confidence/precision level of 90/10, and reported monthly.
QA/QC procedures	The load cell will be calibrated according to manufacturer's specification. If it's not available, national standard will be applied. The net quantity of the coal purchased will be monitored as a cross-check.
Purpose of data	Calculating AMS-I.C. project emission
Additional comment	-

B.7.2. Sampling plan

>>
N/A

B.7.3. Other elements of monitoring plan

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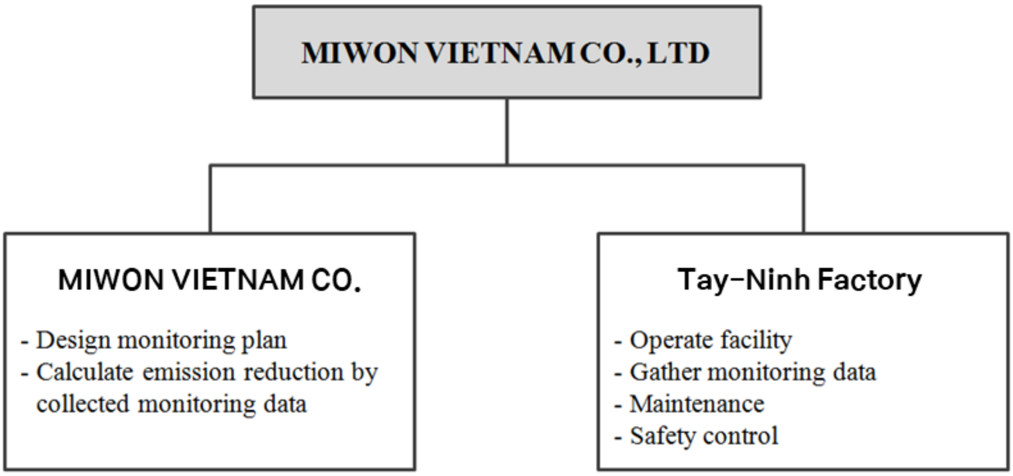
The monitoring plan aims to ensure that all the emission reductions can be successfully realised during crediting period, and will be implemented by the project owner

1. Monitoring organization



1.1 Baseline emission

According to the methodology, following parameters need to be monitored for baseline emission;

- The volume of wastewater treated in the anaerobic digester ($Q_{ww,y,Stage1}$): W1
- The volume of wastewater treated in the aerobic wastewater treatement system ($Q_{ww,y,Stage2}$): W2
- The COD content of the inflow wastewater to the anaerobic digester ($COD_{inflow,anaerobic}$): W1
- The COD content of the outflow wastewater from the anaerobic digester ($COD_{outflow,anaerobic}$): W2
- The COD content of the outflow wastewater from the aerobic wastewater treatment system ($COD_{outflow,aerobic}$): W3
- The normalized volume of CH_4 supplied to the boilers ($BG_{boiler,y}$, $w_{CH_4,y}$): M1, G2

(1) Volume of wastewater treated in the system ($Q_{ww,y,Stage1}$, $Q_{ww,y,Stage2}$)

The volumetric flow of the wastewater will be monitored before anaerobic digester (W1) and aerobic wastewater treatment system (W2).

(2) COD content of the wastewater ($COD_{inflow,anaerobic}$, $COD_{outflow,anaerobic}$, $COD_{outflow,aerobic}$)

The COD of the wastewater will be monitored before anaerobic digester (W1), after anaerobic digester (W2), and after aerobic wastewater treatment system (W3). For the representative sampling, all the samples will be taken twice at the same place, at the middle of working hours, on the same date each month (plus/minus 1 day) with average starch production.

(3) Volume of CH_4 supplied to the boilers ($BG_{boiler,y}$, $w_{CH_4,y}$)

The pressure and temperature normalized volume of biogas utilized by the boilers will be monitored at the point before the boilers (G2). To calculate the volume of CH_4, the volume fraction of CH_4 in the biogas will be monitored at the same time (M1).

1.2 Project emission

According to the methodology, following parameters need to be monitored for project emission;

- The volume of wastewater treated in the anaerobic digester ($Q_{ww,y,Stage1}$): W1
- The COD content of the inflow wastewater to the anaerobic digester ($COD_{\inf low,anearobic}$): W1
- The COD content of the outflow wastewater from the anaerobic digester ($COD_{outflow,anearobic}$): W2
- The net quantity of coal supplied to the boilers ($FC_{coal,y}$): C1

(1) Volume of wastewater treated in the system ($Q_{ww,y,Stage1}$)

The volumetric flow of the wastewater will be monitored before anaerobic digester (W1).

(2) COD content of the wastewater ($COD_{\inf low,anearobic}$, $COD_{outflow,anearobic}$)

The COD of the wastewater will be monitored before anaerobic digester (W1), after anaerobic digester (W2). For the representative sampling, all the samples will be taken twice at the same place, at the middle of working hours, on a monthly basis.

(3) Net quantity of coal utilized ($FC_{coal,y}$)

The net quantity of coal utilized by the boilers will be monitored at the point of coal is supplied (C1).

1.3 Emission reduction

According to the methodology, following parameters need to be monitored for emission reduction;

- The normalized volume of CH_4 captured ($BG_{burnt,y}$, $w_{CH_4,y}$): M1, G1, G2

(1) Normalized volume of CH_4 ($BG_{burnt,y}$, $w_{CH_4,y}$)

The pressure and temperature normalized volume of captured biogas will be monitored at the point of biogas is captured (G1, G2). To calculate the volume of CH_4, the volume fraction of CH_4 in the biogas will be monitored at the same time.(M1)

1. Calibration & maintain procedure

Procedures should be implemented in accordance with national standards, industrial standards or the manufacturer's instructions. All the flow meters and gas analyzers of monitoring system will be calibrated by a qualified party, and the calibration reports will be available to DOE. The calibration procedures will be carried out according the related industry standards. Detailed guidelines of the calibration procedures will be summarized as a monitoring manual.

2. Error handling procedure and corrective actions

If the reading of the measure meters is not precise, out of allowed ranges, or if the function of meter is abnormal, the error will be applied in a conservative manner according to "Guidelines for assessing compliance with the calibration frequency requirements"

3. Data management

The management of data records should be undertaken as follows: All data collected shall be kept both in soft copy and archived at the end of every month, and printed and saved as hard copy documents. Other hard copy documents, such as maps, forms, the EIA report, etc., should be used to support the monitoring plan to check the authenticity of data. In order to expediently obtain the relevant documentation and all project information for the verification DOE, the project owner shall provide and index of relevant materials and monitoring reports. All hard copy data and information should be kept in the archives by the CDM group, and all documents should have one copy as back-up. All data should be saved for 2 years after the crediting period.

4. Training

Training includes technical training and CDM training. The technical training focuses on principles and basics of maintenance and repair. CDM training includes an introduction to the CDM and its reporting requirements and procedures. All staff involved in any of the procedures related with the proposed project will be trained before the start of the crediting period in order to perform the task specified in the monitoring plan.

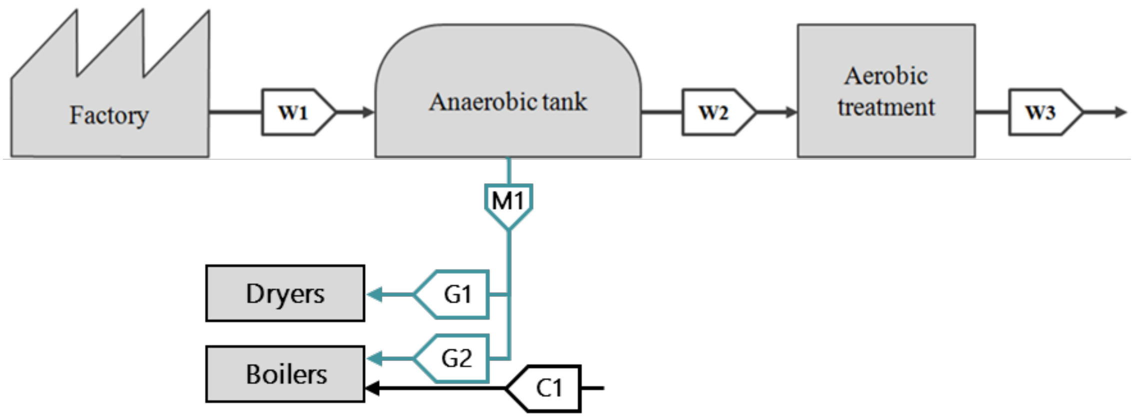


Table B-11. Description for the monitoring parameters of the proposed project

Monitoring point	Analysis target	Description
G1	Gas flow quantity: m^3	Gas pipeline for the dryers
G2	Gas flow quantity: m^3	Gas pipeline for the boilers
M1	Gas flow quantity: m^3 Methane fraction: %	Main gas pipeline
W1	Water flow: m^3 COD concentration: t/m^3	Before anaerobic digestion
W2	Water flow: m^3 COD concentration: t/m^3	After anaerobic digestion
W3	COD concentration: t/m^3	After aerobic wastewater treatment system
C1	Quantity of coal: kg	The quantity of coal supplied to the boilers

SECTION C. Start date, crediting period type and duration

C.1. Start date of project activity

>>
Jan 12/2010

C.2. Expected operational lifetime of project activity

>>
25 years

C.3. Crediting period of project activity

C.3.1. Type of crediting period

>>
10 years

C.3.2. Start date of crediting period

>>
It was 01/Jul/0213 when applying for registration, but after registration, it was changed to 01/Jul/2014 approved by EB

C.3.3. Duration of crediting period

>>
10 years

SECTION D. Environmental impacts

D.1. Analysis of environmental impacts

>>
In Vietnam, The EIA conducted by professional consulting company. But it is not normal form about in this project situation. The environmental-raw office said that it is not need to conduct EIA procedure case by case. In Tay Ninh factory performed “Environmental Protection Commitment Registration” of project. It is a simplified about EIA. It permitted by Tay Ninh local EPA at 2011.

a) Impacts on the air environment:

The latent sources influence on the air environment has been recognized in the above include:

(i) The leak and dispersion of biogas on the surface of the anaerobic digestion tank.
(ii) The burning of the surplus biogas (flame).
(iii) The noise caused by the operation of machinery and equipment.

- *(i) The leak and dispersion of biogas on the surface of the anaerobic digestion tank*: the unwanted problem. This problem happens when the polyethylene cover on the tank’s surface (HDPE) is holed, ragged and opened in the joints. It can also happen at air pipe on the surface of pond according to the requirements of the technical design. This loss biogas amount can stimulate to burn if contact with fire as well as cause the air pollution at a specific level. The main composition of the raw biogas includes CH_4 and CO_2 which are the chemicals cause greenhouse phenomenon when are generated. However, the main purpose of this project is collecting biogas, so the project will apply all best methods to avoid leaking and loss of biogas into the surrounding environment. At that time, we can expect that the impact on the air environment by biogas leaking is very low.
- *(ii) The release of the surplus biogas (vent):* also an unwanted problem. Because the constant operation regime of equipment generates energy with the capacity as predicted design, but the biogas amount is generated unstably over time and is brought to energy providing system continuously, sometimes the remaining biogas is generated for the using equipment in the plant. At that time, the remaining gas amount is automatically released to the atmosphere without combustion from the vent. The product of this process is mainly CH_4 gas – a chemical does not cause air pollution but contributes to increase the global greenhouse effect-causing gas – generated into the atmosphere. However, it must pay attention that this process sometimes happens because the main purpose of the project is collecting gas for production of the more energy, but is not waste this energy source.

- *(iii) The noise caused by the operation of machinery and equipment during the Project:* contributes to raise the general noise level in the surrounding area of the plan. However, because the plan is located far from the residential area, the noise just causes the locally influence inside the production area of the plan.

b) Impacts on the water environment

The project's operations will generally influence on the water environment in the surrounding area in a more positive direction than the Project is not implemented. The Project went into operation contribute to reduce environmental pollution by wastewater from production activities of cassava starch processing plant - branch of Miwon Vietnam Co., Ltd in Tay Ninh (handling about 90% BOD_5 and COD, even 95%). With the existing wastewater treatment pond system of the company (6 ponds), the reduction of BOD_5 and COD to over 95% compared to the past will certainly help to significantly improve the treatment effect of this pond system and opportunity to achieve waste emission standards as prescribed is opened to the plant. This will contribute significantly to improve the water environmental situation in the area of plant.

c) Impacts on the soil environment

The above analysis shows that the soil environment in the project area may be partial influence if the Project does not good control and manage the impurity amount is separated from wastewater at the stage of pre-treatment, domestic solid waste, oil sludge and industrial waste. However, even if it happens, the state of soil pollution is not too serious because the amount of solid waste generated by the Project is not large and the polluted area is also located within the project area where the land can only be used for agricultural purposes.

d) Impacts on flora and fauna environment

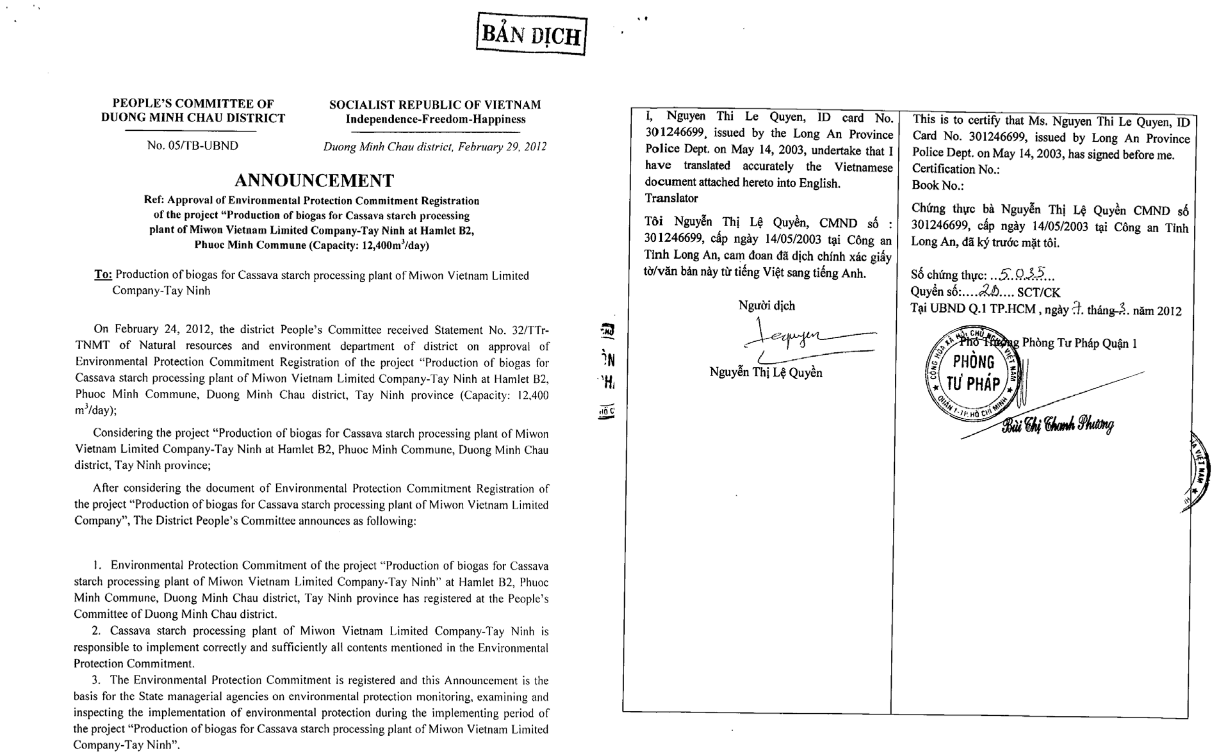
Three environmental factors have the negative impact on flora and fauna are water pollution, air pollution and soil contamination. However, as explained above, the ability to pollute water, air and soil environment of the project is very small and under the control, so the impacts on flora and fauna around the project area is expected to be very low or no impact at all.

e) Impact on the community health

Similarly, the project's operations hardly cause the remarkable impact on the surrounding community health because it does not make the negative change on the quality of surrounding environment. The circumstance can be occurred is the partial impacts for employees directly work in the company such as odor from material wastewater, smell of biogas because of leaking and dispersion, noise from machinery equipment.

f) Impact on other socio-economic conditions of the local

The project's operations are mainly taken place in the area of the plant as well as the input materials and output products of the Project all are from the only address is cassava starch processing plant - branch of Miwon Vietnam Co., Ltd in Tay Ninh, so the project's operations do not influence on the socio-economic conditions of the area as well as the conditions of water supply and drainage, traffic, culture and history.



BẢN DỊCH

PEOPLE'S COMMITTEE OF DUONG MINH CHAU DISTRICT

No. 05/TB-UBND

SOCIALIST REPUBLIC OF VIETNAM
Independence-Freedom-Happiness

Duong Minh Chau district, February 29, 2012

ANNOUNCEMENT

Ref: Approval of Environmental Protection Commitment Registration of the project "Production of biogas for Cassava starch processing plant of Miwon Vietnam Limited Company-Tay Ninh at Hamlet B2, Phuoc Minh Commune (Capacity: 12,400m^3/day)

To: Production of biogas for Cassava starch processing plant of Miwon Vietnam Limited Company-Tay Ninh

On February 24, 2012, the district People's Committee received Statement No. 32/TTr-TNMT of Natural resources and environment department of district on approval of Environmental Protection Commitment Registration of the project "Production of biogas for Cassava starch processing plant of Miwon Vietnam Limited Company-Tay Ninh at Hamlet B2, Phuoc Minh Commune, Duong Minh Chau district, Tay Ninh province (Capacity: 12,400 m^3/day);

Considering the project "Production of biogas for Cassava starch processing plant of Miwon Vietnam Limited Company-Tay Ninh at Hamlet B2, Phuoc Minh Commune, Duong Minh Chau district, Tay Ninh province;

After considering the document of Environmental Protection Commitment Registration of the project "Production of biogas for Cassava starch processing plant of Miwon Vietnam Limited Company", The District People's Committee announces as following:

1. Environmental Protection Commitment of the project "Production of biogas for Cassava starch processing plant of Miwon Vietnam Limited Company-Tay Ninh" at Hamlet B2, Phuoc Minh Commune, Duong Minh Chau district, Tay Ninh province has registered at the People's Committee of Duong Minh Chau district.
2. Cassava starch processing plant of Miwon Vietnam Limited Company-Tay Ninh is responsible to implement correctly and sufficiently all contents mentioned in the Environmental Protection Commitment.
3. The Environmental Protection Commitment is registered and this Announcement is the basis for the State managerial agencies on environmental protection monitoring, examining and inspecting the implementation of environmental protection during the implementing period of the project "Production of biogas for Cassava starch processing plant of Miwon Vietnam Limited Company-Tay Ninh".

I, Nguyen Thi Le Quyen, ID card No. 301246699, issued by the Long An Province Police Dept. on May 14, 2003, undertake that I have translated accurately the Vietnamese document attached hereto into English. Translator Tôi Nguyễn Thị Lệ Quyền, CMND số : 301246699, cấp ngày 14/05/2003 tại Công an Tỉnh Long An, cam đoan đã dịch chính xác giấy tờ/văn bản này từ tiếng Việt sang tiếng Anh. Người dịch Nguyễn Thị Lệ Quyền	This is to certify that Ms. Nguyen Thi Le Quyen, ID Card No. 301246699, issued by Long An Province Police Dept. on May 14, 2003, has signed before me. Certification No.: Book No.: Chứng thực bà Nguyễn Thị Lệ Quyền CMND số 301246699, cấp ngày 14/05/2003 tại Công an Tỉnh Long An, đã ký trước mặt tôi. Số chứng thực: ...5035... Quyển số:....20.... SCT/CK Tại UBND Q.1 TP.HCM , ngày 7. tháng 3. năm 2012 Phó Trưởng Phòng Tư Pháp Quận 1 PHÒNG TƯ PHÁP Bùi Thị Thanh Phương

D.2. Environmental impact assessment

>>

This proposed project is not mandatory project to assess Environment Impact Assessment.

SECTION E. Local stakeholder consultation

E.1. Modalities for local stakeholder consultation

>>

The project participant held the local resident's meeting of this project at December, 2009. The members of this meeting were Superintendent and employees of factory, local residents and local civil servants. The presentation included summary of project, environmental impacts and advantages of the project. After presentation, opinions of the participants on this project were gathered.

**DANH SÁCH THAM DỰ HỘI NGHỊ THUYẾT TRÌNH
DỰ ÁN CDM (CƠ CHẾ PHÁT TRIỂN SẠCH)
BẰNG KHÍ SINH HỌC BIOGAS**

HỌ VÀ TÊN	CHỮ KÝ XÁC NHẬN
Trần Bá Lộc	
Lê Đức Anh Phương	
Vương Phước Chính	
Đỗ Thanh Hùng	
Hoàng Trọng Hải	
Dương Thanh Toàn	
Phạm Thị Thùy Hằng	
Phan Thị Huyền Trang	
Nguyễn T. Mỹ Châu	
Phạm Văn Sang	
Lê Đức Anh Đức	
Đoàn Thanh Phong	
Trần Phi Hùng	
Nguyễn Thế Hiệp	
Lê Hà Tính	
Bùi Văn Cảnh	
Nguyễn Tấn Đức	
Trương Dũng Chơn	
Nguyễn Thị Lâm Khoa	
Ngô Hoài Hạnh	
Ngô Văn Hải	
Trần Văn Giàu	
Nguyễn Thị Thùy Linh	

**DANH SÁCH THAM DỰ HỘI NGHỊ THUYẾT TRÌNH
DỰ ÁN CDM (CƠ CHẾ PHÁT TRIỂN SẠCH)
BẰNG KHÍ SINH HỌC BIOGAS**

HỌ VÀ TÊN	CHỮ KÝ XÁC NHẬN
Võ Văn Thắng	
Trần Đức Thắng	
Nguyễn Văn Tám	
Võ Văn Thủy	
Nguyễn Văn Ngoan	
Nguyễn Liêu	
Huỳnh Văn Mật	
Nguyễn Trung Khương	
Nguyễn Chí Tiến	
Dương Chấn Cảnh	
Trịnh Thị Ngọc Châu	

E.2. Summary of comments received

>>

There were some supportive comments and no negative opinions about the project.

- It will be helpful to benchmark similar CDM projects which have been registered in Tay Ninh Province through business progress.
- This project is expected to be a good example of wastewater treatment and trigger of introducing new technology to other plants in Tay Ninh Province.

E.3. Consideration of comments received

>>

All the comments received will be considered during implementing and operating this proposed project.

SECTION F. Approval and authorization

>>

The project was approved by the Vietnam Designated Natioanl Authority and received a letter of approval on 4 October 2012.

Appendix 1. Contact information of project participants

Organization name	MIWON VIETNAM CO., Ltd
Country	Vietnam
Address	19-8 Str . ，Miwon B/D，Ha Noi，Cau Giay Dist.,
Telephone	84-4-7680216~8
Fax	84-4-7680220
E-mail	bsh@daesang.com
Website	
Contact person	Baek Song Ho

Appendix 2. Affirmation regarding public funding

Appendix 3. Applicability of methodologies and standardized baselines

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

Appendix 5. Further background information on monitoring plan

Appendix 6. Summary report of comments received from local stakeholders

Appendix 7. Summary of post-registration changes

At the time of registration, it was 01 Jul 13 - 30 Jun 23, but it was changed to 01 Jul 14 - 30 Jun 24 (Fixed) through a change request for Crediting period.

During constructon of the project, venting line was not been installed, so monitoring aspect has been changed. In this reason, PP decided to proceed this post registration changes.

Document information

Version	*Date*	*Description*
11.0	31 May 2019	Revision to: • Ensure consistency with version 02.0 of the “CDM project standard for project activities” (CDM-EB93-A04-STAN); • Make editorial improvements.
10.1	28 June 2017	Revision to make editorial improvement.
10.0	7 June 2017	Revision to: • Improve consistency with the “CDM project standard for project activities” and with the PoA-DD and CPA-DD forms; • Make editorial improvement.
09.0	24 May 2017	Revision to: • Ensure consistency with the “CDM project standard for project activities” (CDM-EB93-A04-STAN) (version 01.0); • Incorporate the “Project design document form for small-scale CDM project activities” (CDM-SSC-PDD-FORM); • Make editorial improvement.
08.0	22 July 2016	EB 90, Annex 1 Revision to include provisions related to automatically additional project activities.
07.0	15 April 2016	Revision to ensure consistency with the “Standard: Applicability of sectoral scopes” (CDM-EB88-A04-STAN) (version 01.0).
06.0	9 March 2015	Revision to: • Include provisions related to statement on erroneous inclusion of a CPA; • Include provisions related to delayed submission of a monitoring plan; • Provisions related to local stakeholder consultation; • Provisions related to the Host Party; • Make editorial improvement.
05.0	25 June 2014	Revision to: • Include the Attachment: Instructions for filling out the project design document form for CDM project activities (these instructions supersede the "Guidelines for completing the project design document form" (Version 01.0)); • Include provisions related to standardized baselines; • Add contact information on a responsible person(s)/ entity(ies) for the application of the methodology (ies) to the project activity in B.7.4 and Appendix 1; • Change the reference number from F-CDM-PDD to CDM-PDD-FORM; • Make editorial improvement.
04.1	11 April 2012	Editorial revision to change version 02 line in history box from Annex 06 to Annex 06b.

Version	*Date*	*Description*
04.0	13 March 2012	Revision required to ensure consistency with the “Guidelines for completing the project design document form for CDM project activities” (EB 66, Annex 8).
03.0	26 July 2006	EB 25, Annex 15
02.0	14 June 2004	EB 14, Annex 06b
01.0	03 August 2002	EB 05, Paragraph 12 Initial adoption.

Decision Class: Regulatory
Document Type: Form
Business Function: Registration
Keywords: project activities, project design document