VN08-WWS-04 METHANE RECOVERY AND BIOGAS UTILIZATION PROJECT
LAO CAI PROVINCE, VIETNAM

UNFCCC Clean Development Mechanism
Simplified Project Design Document
for
Small Scale Projects

DOCUMENT ID: VN08-WWS-04
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CLEAN DEVELOPMENT MECHANISM
PROJECT DESIGN DOCUMENT FORM (CDM-SSC-PDD)
Version 03 - in effect as of: 22 December 2006

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Annexes

Revision history of this document

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

SECTION A. General description of small-scale project activity

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

VN08-WWS-04, Methane Recovery and Biogas Utilization Project, Lao Cai Province, Vietnam, Version 7, 15 December 2009

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

Purpose: This project will implement a two-stage wastewater treatment system with methane recovery at a large-scale starch processing facility, which, by definition has the capacity to process more than 200 tons per day of fresh cassava roots.[1] The first stage of the treatment system will recover methane caused by the decay of biogenic matter in the effluent stream by introducing a sequential stage of wastewater treatment with methane recovery to the existing wastewater treatment system without methane recovery. The second stage of the treatment system will utilize the biogas generated by the first stage to displace fossil fuel consumption of the existing on-site drying system. By extracting and utilizing biogas, the project activity will reduce the CH_4 emissions that would have otherwise been emitted from the existing open anaerobic lagoons. In addition, the carbon intensive fuels currently used in the drying system are replaced, further reducing the greenhouse gas (GHG) emissions that would have occurred in the absence of this project.

Explanation of GHG emission reductions: The proposed project activities will reduce GHG emissions in an economically sustainable manner, and will result in other environmental benefits, such as improved water quality and reduced odor. In simple terms, the project proposes to move from a high-GHG-emitting open air anaerobic lagoon system, to a lower-GHG-emitting anaerobic tank digester system with capture/utilization/combustion of the resulting biogas. The project reduces greenhouse gas emissions in two ways: (1) by preventing methane emission through biogas capture, and (2) by replacing carbon intensive fuel with biogas to operate the drying system.

Contribution to sustainable development: Worldwide, agricultural operations are becoming progressively more intensive to realize the economies of production and scale. The pressure to become more efficient drives significant operational similarities between facilities of a "type," as inputs, outputs, practices, and technology have become similar around the world.

This is especially true in the starch processing industry. Within cassava starch processing facilities, wastewater is the main source of pollution to the surrounding environment and water resources.[2] For example, the amount of water used to produce 1 ton of starch ranges from 10-30 m^3.[3] Therefore, a factory with the capacity to produce 100 tons of cassava starch discharges between 1,000 and 3,000 m^3 wastewater on a daily basis. The chemical oxygen demand (COD) of this wastewater is high, ranging anywhere from 7,000 to 41,500 mg/l.[4]

A recent study declared the technology being employed in this project as an "almost perfect wastewater treatment system for the tapioca industry in Vietnam".[5] The project will have positive effects on the local environment by improving air quality through the reduction of odor and cleaner emissions. Not only does the project prevent pollution; it also recovers

[1] http://library.wur.nl/wda/dissertations/dis4019.pdf (page16)

[2] http://library.wur.nl/wda/dissertations/dis4020.pdf (page 112)

[3] http://library.wur.nl/wda/dissertations/dis4019.pdf (page 5)

[4] http://library.wur.nl/wda/dissertations/dis4019.pdf (page 5)

[5] http://library.wur.nl/wda/dissertations/dis4019.pdf (page 144)

energy and protects the environment. The project will be installed with an extensive monitoring system and is designed to comply with all the local environmental regulations.

A.3. Project participants:

Name of Party involved (host) indicates a host Party	Private and/or public entity(ies) project participants (as applicable)	Kindly indicate if the party involved wishes to be considered as project participant (Yes/No)
Vietnam (host)	Cong ty TNHH mot thanh vien che bien nong san thuc pham Hieu Hung (Hieu Hung Agricultural Product Processing Company Limited)	No
Netherlands	AES Carbon Exchange Ltd.	No

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

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

A.4.1.1. Host Party(ies):

The Host Party for this project is **Vietnam**.

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

The project is located within the **Lao Cai Province.**

A.4.1.3. City/Town/Community etc:

The project site is shown in Figure 2 with specifics detailed in Table 1.

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

The project location is shown in Figure 2 and details are provided in Table 1. Short descriptions of sites are provided below:

Cong ty TNHH mot thanh vien che bien nong san thuc pham Hieu Hung has the following facility in Van Ban District, Lao Cai Province:

- Lao Cai Export Cassava Starch Processing Factory (VN0726WWS) is a starch processing facility which was built and began operating in 2005. The facility operates during both peak and off-peak seasons for cassava processing. During the peak season which runs from October through April, the facility processes fresh cassava root and produces dry cassava starch. During the off-peak season when fresh cassava is no longer available due to the constraints of the cassava growing season, the facility processes wet cassava starch remaining from the peak season production. On average, the facility currently produces 16,350 tonnes of dry starch and 10,000 tonnes of wet starch per year. The facility operates approximately 24 hours per day for 12 months (or 365 days) of the year.

The current average amount of wastewater produced per day ranges from 1000 to 2600 m^3 depending on the season. An open lagoon system without methane recovery consisting of sand traps, sedimentation tanks and 3 anaerobic lagoons is used to process the starch facility effluent before discharging to the Hong River. According to the common practice in Vietnam[6], all wastewater from the production processes is currently treated in the ponding system prior to its discharge into nearby waterways. At this facility, lagoon depth averages 5 meters but occasionally may vary due to sludge build-up. As a result, the lagoons are subject to sludge removal as needed. Upon removal, the sludge is land applied.

The drying system in use during the starch production process currently is powered by coal. The fuel used to power the drying system will be displaced by biogas as a result of this project activity.

The producer plans to increase production by 19 percent each year for the next three years to reach a production of 45,000 tonnes of starch per year. (This does not exceed the facility's currently approved capacity). At this rate, the average amount of wastewater produced per day is approximately 2,466 m^3 . The capacity of wastewater treatment system was designed to accommodate the wastewater produced when the facility operates at maximum capacity. According to third party sampling reports provided to the DOE, the wastewater treatment system is already proven to be capable of handling more than the anticipated daily volume of wastewater.

Figure 1 – Country map

[6] http://library.wur.nl/wda/dissertations/dis4019.pdf (page 11)

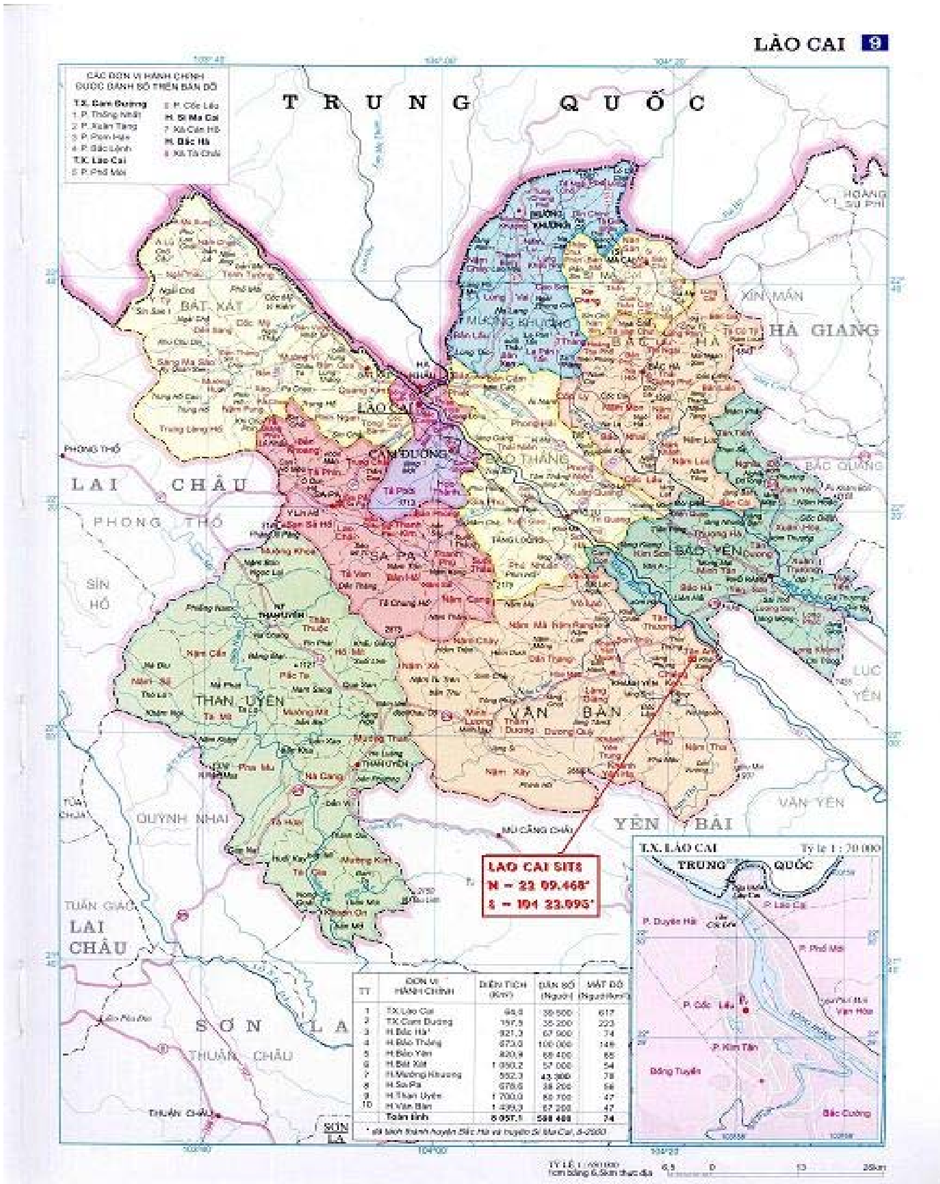

Figure 2 – Location of the project site

Table 1 – Detailed physical location / identification of project site

Site Name (Site ID)	Address	Town/State	Contact	Phone	GPS
Lao Cai Export Cassava Starch Processing Factory (VN0726WWS)	Tan Son Village, Tan An Commune	Van Ban District, Lao Cai Province	Tran Sy Hung	+84 913 219 816	N22º 09' 28" E104º 22' 05"

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

The project activity described in this document is a two-stage wastewater treatment system.
Stage I (methane recovery) is classified as a Type III, Other Project Activities, Category III.H., Ver. 9, *Methane recovery in wastewater treatment*.[7] This stage of the proposed project activity will recover methane from biogenic organic matter in wastewaters according to option (vi) of the methodology by introducing a sequential stage of wastewater treatment with methane recovery to the existing wastewater treatment system without methane recovery. Stage II (biogas utilization) is classified as a Type 1, Renewable Energy Projects, Category I.C., Ver. 13, *Thermal energy for the user with or without electricity*[8]. This stage will utilize the biogas recovered by the first stage, replacing the use of fossil fuel, to provide power for drying system which is used on-site.

Stage I (Methane Recovery)

The technology to be implemented by the project activity is an industrial tank system with a type of Upflow Anaerobic Sludge Blanket (UASB) system. Developed in the late 1970s, UASB is an internationally recognized anaerobic treatment technology for high strength organic wastewater from such operations as food processing.

In the UASB system, wastewater rises through an expanded bed of anaerobic active methanogenic sludge (or "sludge blanket") and an internal device at the top of the reactor, which results in a separation of the mixed liquid into clarified wastewater, biogas, and sludge. The absence of any mechanical agitation allows a natural selection towards heavy granules of active methanogenic sludge. Recirculation of the effluent does take place to ensure sufficient mixing within the sludge blanket and sufficient upflow velocity.

The high sedimentation velocity of biological granules formed in the system prevents the loss of methanogenic sludge granules. This leads to longer sludge retention time and improved operational efficiency of the system. The amount of sludge generated or accumulated will not change due to the project activity. Accumulated sludge may be removed as required from the bottom of the system after the first year of operation. Maintenance procedures have been developed to ensure proper handling and disposition of the sludge. The final disposition of sludge will not vary from the baseline scenario.

Through the utilization of this advanced technology, the project will be able to achieve at least 95% removal of COD according to manufacturer specifications. The type of UASB system in this project activity is a 3-phase separator which has a flow rate design capacity of up to 150 m^3/hour (up to 25,000 mg/liter COD). The resulting effluent from the UASB system will have only 2 to 5% of the COD load that was present before the implementation of the project activity. The effluent from the UASB anaerobic treatment will be further treated in the existing open lagoons which will be transformed into well-managed aerobic lagoons. The project will involve the distribution of the post-UASB effluent to multiple entry points of the existing open lagoon systems to avoid localized anaerobic conditions.

Stage II (Biogas Utilization)

Biogas generated by the anaerobic digestion system will be used as an energy source by the facility. The manufacturer estimates that each cubic meter of biogas consists of approximately 70% methane and has a calorific value of 5,999 kcal. Extracted biogas will be forwarded directly to the existing on-site drying system. The existing drying system consists of burners which heat thermal oil. This generates hot air which is used to dry wet starch in drying columns. There are currently two operational burners at this facility which use coal. The project activity will result in the coal burners being converted to use biogas

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[7] http://cdm.unfccc.int/UserManagement/FileStorage/CDMWF_AM_743QMM1YKHH15AK2AZAVAIJHRGD5R7

[8] http://cdm.unfccc.int/UserManagement/FileStorage/CDMWF_AM_YL0327DQSKVFXYQREWRT3VNR58402G

To combust the excess biogas, an enclosed type of ground flare with fully automatic operation, including temperature measurement, will be installed.. Flaring is fully automatic: starting when the biogas reaches an established high pressure setting and stopping when biogas pressure drops to an established low pressure setting. Prior to transport of the biogas to the burner, condensates are removed from the biogas in a demister. A biogas blower then directs the biogas to the drying system. The biogas distribution system consists of HDPE and stainless steel piping for the biogas flow and the biogas blowers to transport the gas. This system also includes all instrumentation required to monitor flow, pressure, temperature, and gas analysis.

Biogas will be accurately metered using a thermal mass flow meter that has two sensing elements: a velocity sensor and a temperature sensor that automatically corrects for changes in gas temperature. The transducer electronics heat the velocity sensor to a constant temperature differential greater than the gas temperature and measure the cooling effect of the gas flow. The meter runs on DC power and includes a UPS or battery back-up system to provide for the possibility of power outages. This meter type offers distinct advantages over standard flow meters including direct mass flow sensing for temperature and pressure compensation, high accuracy and repeatability for low-pressure gas flow measurement applications, outstanding rangeability, lower flow blockage and pressure drop than conventional meters, and no moving parts. The meter measures the mass flow and automatically converts to normalized volumetric output (NCMA). The biogas flow meter is normalized to 0 degrees Celsius at 1 ATM and calibrated in NCMH units by the manufacturer. Standard density conversion factors are established by the manufacturer.

Technology and know-how transfer:

The project developer is implementing a multi-faceted approach to ensure the project, including technology transfer, proceeds smoothly. This approach includes careful specification and design of a complete technology solution, identification and qualification of appropriate technology/services providers, supervision of the project installation, staff training, ongoing monitoring (by the project developer) and developing/implementing a complete Monitoring Plan. As part of this process, the project developer has specified a technology solution that will be self-sustaining (i.e., highly reliable, standardized maintenance, and reduced operation intervention when properly maintained). The materials and labour used in the base project activity are sourced from the host country whenever economically and technically feasible. When not feasible, the materials and labour will be sourced from Annex 1 countries.

By working closely with the facility staff on an ongoing basis, the project developer will ensure that all installed equipment is properly operated and maintained, and will carefully monitor the data collection and recording process. Moreover, by working with the facility staff over an extended period of time, the project developer will ensure that the facility staff acquires appropriate expertise and resources to operate the system on an ongoing/continuous basis.

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

Estimated emission reduction over the chosen crediting period	
Year	**Estimation of annual emission reductions in tonnes of CO2e**
Year1: 2009 - 2010	30,753
Year2: 2010 - 2011	36,566
Year3: 2011 - 2012	43,470
Year4: 2012 - 2013	51,671
Year5: 2013 - 2014	51,671
Year6: 2014 - 2015	51,671
Year7: 2015 - 2016	51,671
Total estimated reductions (tonnes of CO2e)	317,474
Total number of crediting years	7
Annual average of estimated reductions over the crediting period (tCO2e)	45,353

Note: Any minor differences in the above table are due to rounding in Microsoft Excel.

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

No public funding is being provided for this project.

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

Based on the *Compendium of guidance on the debundling for SSC project activities (EB36, Annex 27)*[9] this project is not debundled according to the following definition:

"*A proposed small-scale project activity shall be deemed to be a debundled component of a large project activity if there is a registered small-scale CDM project activity or an application to register another small-scale CDM project activity:*
(a) With the same project participants;
(b) In the same project category and technology/measure; and
(c) Registered within the previous 2 years; and
(d) Whose project boundary is within 1 km of the project boundary of the proposed small-scale activity at the closest point."

Note: The project participants have other AMS III.H, v.9 starch projects currently in the registration process but they are all **greater than 1 km apart from each other**.

[9] http://cdm.unfccc.int/Reference/Guidclarif/ssc/methSSC_guid17_v01.pdf

SECTION B. Application of a baseline and monitoring methodology

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

Stage I (methane recovery) of this project activity applies the UNFCCC-approved small scale methodology AMS III.H., Ver. 9, *Methane recovery in wastewater treatment*.[10] The methane recovery portion of the project will not exceed 60 kt CO_2eq from all type III components of the project activity annually.

Stage II (biogas utilization) of this project activity applies UNFCCC-approved small scale methodology AMS I.C, Ver. 13, *Thermal energy for the user with or without electricity.*[11] The thermal energy production capacity of this portion of the project activity will not exceed 45MW.

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

Stage I (methane recovery) of the proposed project activity will recover methane from biogenic organic matter in wastewaters according to option (vi) of the methodology:

> *Introduction of a sequential stage of wastewater treatment with methane recovery and combustion, with or without sludge treatment, to an existing wastewater treatment system without methane recovery (e.g. introduction of treatment in an anaerobic reactor with methane recovery as a sequential treatment step for the wastewater that is presently being treated in an anaerobic lagoon without methane recovery).* [12].

This project introduces methane recovery and combustion to an existing open air anaerobic lagoon system for wastewater treatment. The simplified baseline methodology is applicable to this project activity because without the proposed project activity, methane from the existing anaerobic treatment system would continue to be emitted into the atmosphere. Based on historical starch facility processing rates and baseline estimates, the estimated emission reductions of the project activity will not exceed 60 kt CO_2e from all type III components of the project activity in any year of the crediting period as shown in Section A.4.3.
Stage II (biogas utilization) of the project activity is applicable according to paragraphs 1 and 2 of AMS I.C., Ver. 13:[13]

- *Paragraph 1 states, in part: This category comprises renewable energy technologies that supply individual households or users with thermal energy that displaces fossil fuels.*

- *Paragraph 2 states: "Where thermal generation capacity is specified by the manufacturer, it shall be less than 45 MW."*

Stage II consists of a renewable energy technology (biogas utilization) that supplies the starch processing facility with thermal energy, displacing fossil fuels currently used in the drying system. The biogas will be used for thermal energy generation and excess biogas may be flared (refer to section A.4.2. for details). The total installed capacity of the drying system included in the project activity is under 4 MW and does not exceed 45 MW in accordance with the methodology.

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[10] http://cdm.unfccc.int/UserManagement/FileStorage/CDMWF_AM_743QMM1YKHH15AK2AZAVAIJHRGD5R7

[11] http://cdm.unfccc.int/UserManagement/FileStorage/CDMWF_AM_YL0327DQSKVFXYQREWRT3VNR58402G

[12] http://cdm.unfccc.int/UserManagement/FileStorage/CDMWF_AM_743QMM1YKHH15AK2AZAVAIJHRGD5R7

[13] http://cdm.unfccc.int/UserManagement/FileStorage/CDMWF_AM_YL0327DQSKVFXYQREWRT3VNR58402G

B.3. Description of the project boundary:

As stated in the AMS III-H methodology, the project boundary "is the physical, geographical site where the wastewater and sludge treatment takes place". This definition is applicable to Stage I of the project activity. In addition, as stated in the AMS I.C. methodology, the project boundary is delineated by "the physical, geographical site of the renewable energy generation." This definition applies to Stage II of the project activity.

Sources influenced by the project are included in the project boundary while sources not influenced by the project are excluded. For this project, the combined boundary includes the physical, geographical site of the waste treatment system, which includes all lagoons described in Section A.4.1.4., the tank digesters, the biogas recovery system, and the existing drying system which will now be powered by biogas. If any equipment is added due to the project activity, any power or fuel consumed by that equipment will be monitored / conservatively estimated for project activity emissions Sludge treatment is not affected by the implementation of the project activity, therefore, sludge will be disposed of in the same manner as it was prior to the project activity (land application).

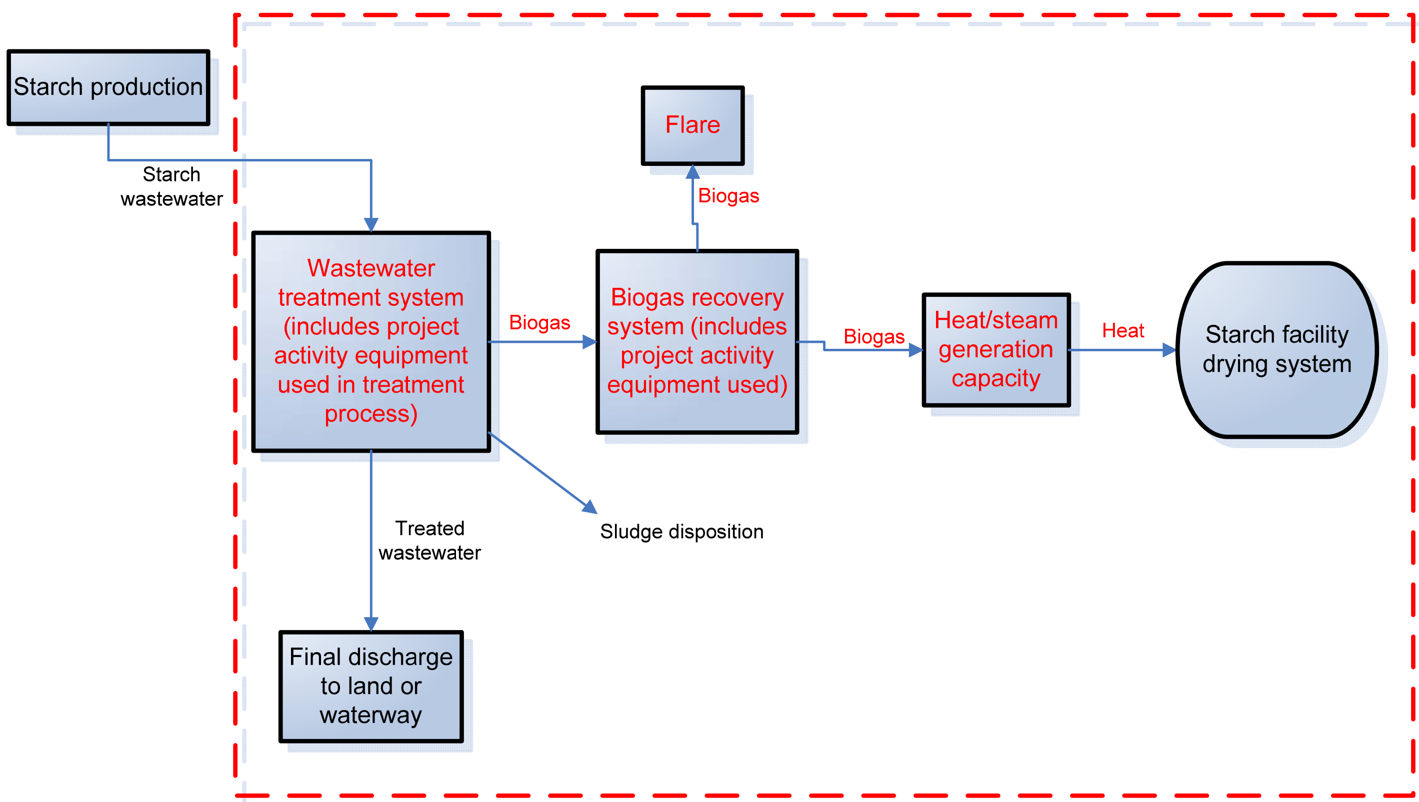

Figure 3 – Project Boundary

B.4. Description of baseline and its development:

The baseline for Stage I (methane recovery) and Stage II (biogas utilization) of this project activity is described in the following paragraphs.

Stage I (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 9, *Methane recovery in wastewater treatment.* According to this methodology, "*the baseline scenario will be one of the following situations:*"

Baseline scenario situations of AMS-III.H./Version 09[14]	*Applicability*
(i) The existing aerobic wastewater or sludge treatment system, in the case of substitution of one or both of these systems for anaerobic ones with methane recovery and combustion.	Not applicable: the existing wastewater treatment system has no methane recovery and combustion.
(ii) The existing sludge disposal system, in the case of introduction of anaerobic sludge treatment system with methane recovery and combustion to an existing wastewater treatment plant.	Not applicable: No sludge treatment system is being introduced
(iii) The existing sludge treatment system without methane recovery and combustion.	Not applicable: No sludge treatment system is being introduced.
(iv) The existing anaerobic wastewater treatment system without methane recovery and combustion.	Not applicable: the project introduces a sequential anaerobic wastewater treatment system with methane recovery.
(v) The untreated wastewater being discharged into sea, river, lake, stagnant sewer or flowing sewer, in the case of introducing the anaerobic treatment to an untreated wastewater stream.	Not applicable: the wastewater is treated by existing lagoons.
(vi) The existing anaerobic wastewater treatment system without methane recovery for the case of introduction of a sequential anaerobic wastewater treatment system with methane recovery.	Applicable

As demonstrated above, the baseline scenario applicable to this project is in accordance with paragraph 23, option *vi* of the methodology.

Wastewater treatment systems based on lagoons are the common practice among almost all tapioca / starch processing facilities in Vietnam[15]. As described in Section A.4.1.4, this starch facility currently uses a ponding system (without methane recovery) to treat wastewater prior to its discharge into nearby waterways. Therefore, the baseline scenario is the continuation of the present wastewater treatment system and the release of methane into the atmosphere.

Stage II (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. 13, *Thermal energy for the user with or without electricity.* [16]

The baseline scenario in this project meets the requirements of paragraphs 1 and 2 of AMS I.C., Ver. 13:[17]

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[14] http://cdm.unfccc.int/UserManagement/FileStorage/CDMWF_AM_743QMM1YKHH15AK2AZAVAIJHRGD5R7

[15] http://library.wur.nl/wda/dissertations/dis4019.pdf (page31,138 and 142)

[16] http://cdm.unfccc.int/UserManagement/FileStorage/CDMWF_AM_YL0327DQSKVFXYQREWRT3VNR58402G

[17] http://cdm.unfccc.int/UserManagement/FileStorage/CDMWF_AM_YL0327DQSKVFXYQREWRT3VNR58402G

- *Paragraph 1 states, in part: This category comprises renewable energy technologies that supply individual households or users with thermal energy that displaces fossil fuels.*

- *Paragraph 2 states: "Where thermal generation capacity is specified by the manufacturer, it shall be less than 45 MW."*

The baseline is determined in accordance with paragraphs 6, 10, and 13 of AMS I.C., Ver. 13. [18] Details are provided in Section B.6 and Annex 3.

As described in Section A.4.1.4, this starch facility currently uses a drying system on-site which is powered by fossil fuels (coal) for operation. Stage II of the project will utilize the biogas generated by the first stage, replacing the use of fossil fuel, to provide thermal energy for the drying system. The total installed capacity of the drying system included in the project activity is under 4 MW and does not exceed 45 MW in accordance with the methodology.

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

Anthropogenic GHGs, including methane, are released into the atmosphere via decomposition of the starch processing facility effluent. Currently, this biogas is not collected, destroyed, or reused. The proposed project activity intends to improve current wastewater management practices by implementing a two-stage process. These changes will result in the mitigation of anthropogenic GHG emissions, specifically the recovery of methane, by controlling the lagoon system's decomposition processes; collecting and combusting the biogas; and utilizing the biogas to replace the use of fossil fuels to power the existing drying system at the facility.

There are no existing, pending, or planned national regulatory requirements that govern GHG emissions from agro-industry operations (specifically, starch processing activities) as outlined in this PDD. The project participants have solicited information regarding this issue during numerous conversations with local and state government officials and through legal representation and have determined there is no regulatory impetus for producers to upgrade current wastewater treatment systems beyond the commonly used lagoon systems.

In accordance with *Attachment A to Appendix B* of *the Simplified Modalities and Procedures for Small-Scale CDM Project Activities*[19],and according to the *Non-binding best practice examples to demonstrate additionality for SSC project activities (EB35, Annex 34),*[20] "project participants shall provide an explanation to show that the project activity would not have occurred anyway due to at least one of the following barriers":

- *Investment barrier:* a financially more viable alternative to the project activity would have led to higher emissions;
- *Access-to-finance barrier*: the project activity could not access appropriate capital without consideration of the CDM revenues;
- *Technological barrier:* a less technologically advanced alternative to the project activity involves lower risks due to the performance uncertainty or low market share of the new technology adopted for the project activity and so would have led to higher emissions;

[18] http://cdm.unfccc.int/UserManagement/FileStorage/CDMWF_AM_YL0327DQSKVFXYQREWRT3VNR58402G

[19] http://cdm.unfccc.int/methodologies/SSCmethodologies/AppB_SSC_AttachmentA.pdf

[20] http://cdm.unfccc.int/Reference/Guidclarif/methSSC_guid15_v01.pdf

- *Barrier due to prevailing practice*: prevailing practice or existing regulatory or policy requirements would have led to implementation of a technology with higher emissions;
- *Other barriers* such as institutional barriers or limited information, managerial resources, organizational capacity, or capacity to absorb new technologies.

The most relevant barriers which have prevented this project activity from being implemented without the assistance of CDM are as follows:

Investment barrier

In accordance with the *Non-binding best practice examples to demonstrate additionality for SSC project activities (EB35, Annex 34).*[21] "a simple cost analysis (where CDM is the only revenue stream…)" is applied to demonstrate that a "a financially more viable alternative to the project activity would have led to higher emissions".

In the starch processing industry, the installation of waste treatment systems is an expense which provides little, if any, economic benefit.[22] Currently, the facility utilizes an open lagoon anaerobic wastewater treatment system which complies with the current discharge standard. The current system is the most economically attractive solution for the facility considering the low capital and operating costs involved. The existing waste treatment systems are significantly lower in capital and operating costs than anaerobic digestion technology.[23] Though costs vary according to the capacity of the facility and other factors, initial costs to install a wastewater treatment system can run in the tens of thousands of US dollars or more[24]. Facility owners or project developers have no reason to alter the existing wastewater treatment practice without the existence of CDM. Continuation of the existing open lagoon wastewater treatment system(s) requires no additional investment, therefore, it represents a financially more viable option which would lead to higher GHG emissions.

This proposed wastewater treatment approach is considered one of the more advanced systems in the world. Producers in few countries have implemented this type of technology on a widespread basis because of the high costs of associated materials and ongoing maintenance. Though costs vary according to the capacity of the facility and other factors, initial costs to install a wastewater treatment system can run in the tens of thousands of US dollars or more[25] AES Carbon Exchange Ltd is the owner of the project equipment. Implementation of the project activity requires a significant investment in capital and operating costs for AES Carbon Exchange Ltd. The capital investment is approximately $2,059,146 USD. Operating and maintenance costs are projected to be approximately $114,697 USD per year. The future CERs generated by this project are the only potential revenues for the project developer in this project. Any revenues or cost savings for electricity or heat generation will remain with the starch facility (as specifically stated in the LERPA between AES Carbon Exchange Ltd. and the facility owner). Only with CDM will the project activity be implemented and will GHG emissions be reduced. Without the assistance of CDM, the high development costs would have prevented AES Carbon Exchange Ltd. from pursuing project implementation and the current system, which results in higher GHG emissions, would continue to be used.

***Barriers due to prevailing practice*:** The current open air anaerobic lagoon system of wastewater treatment is considered the standard operating practice in starch processing facilities in Vietnam[26]. Despite a growing awareness of the negative

[21] http://cdm.unfccc.int/Reference/Guidclarif/methSSC_guid15_v01.pdf

[22] http://library.wur.nl/wda/dissertations/dis3406.pdf (pages 15, 228 and 229)

[23] http://library.wur.nl/wda/dissertations/dis3406.pdf (page 15, 228 and 229)

[24] http://library.wur.nl/wda/dissertations/dis4020.pdf (pages 118 and 126)

[25] http://library.wur.nl/wda/dissertations/dis4020.pdf (pages 118 and 126)

[26] http://library.wur.nl/wda/dissertations/dis3406.pdf (page 7,15,25 and 122)

impact on the environment of the current practice, the implementation of cleaner technology does not seem to have any urgency for starch facility owners. In addition, producers are hesitant to alter their current practices due to concerns that changes may take too long to implement or may affect the quality of their products.

While past practices cannot predict future events, it is worth noting that the site included in this project activity has been in existence for a number of years, during which time the prevailing wastewater management practice has been a system of open lagoons. No regulatory requirement for facilities to alter their current practices is in existence. Also, there are currently no incentives such as tax exemptions or reductions for implementing anaerobic bioreactor technology for wastewater treatment.[27] Currently, there is only one existing project in Vietnam (Quang Ngai APFCO Tapioca starch wastewater biogas extraction and utilization project, Quang Ngai Province, Socialist Republic of Vietnam[28]) which utilizes the UASB technology. That project is also being done with the assistance of CDM. Without the assistance of CDM, facilities have no reason to and are not likely to change current wastewater treatment practices due to the investment and technology barriers described above.

B.6. Emission reductions:

B.6.1. Explanation of methodological choices:

Baseline Emissions

The baseline emission calculations for Stage I (methane recovery) and Stage II (biogas utilization) of this project activity is described in the following paragraphs.

Stage I (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 9, *Methane recovery in wastewater treatment.* The baseline scenario applicable to this project is in accordance with paragraph 23, option *vi* of the methodology:

vi. *The existing anaerobic wastewater treatment system without methane recovery for the case of introduction of a sequential anaerobic wastewater treatment system with methane recovery*[29]

For option *vi,* the methodology requires baseline emissions be calculated as per the formula below, with MCF lower values from Table III.H.1 to be used.

Equation 1: Total baseline emissions[30]

$$BE_{y,stage1} = Q_{y,ww} * \sum(COD_{y,removed,i} * B_{o,ww} * MCF_{ww,treatment,i} * GWP\_CH_4)$$

Where:

[27] http://library.wur.nl/wda/dissertations/dis3406.pdf (page 15,126 and 128)

[28] http://cdm.unfccc.int/Projects/Validation/DB/XUDTRSHJ938ETV94P7KB3K8G839SGQ/view.html

[29] http://cdm.unfccc.int/UserManagement/FileStorage/CDMWF_AM_743QMM1YKHH15AK2AZAVAIJHRGD5R7 (page10/18)

[30] Adapted from UNFCCC methodology AMS-III.H (Methane recovery in wastewater treatment), V.9, http://cdm.unfccc.int/UserManagement/FileStorage/CDMWF_AM_743QMM1YKHH15AK2AZAVAIJHRGD5R7

$Q_{y,ww}$	Volume of wastewater treated in the year "y" (m^3)
$COD_{y,removed,i}$	Chemical oxygen demand removed by the anaerobic wastewater treatment systems "i" in the baseline situation in the year "y" to which the sequential anaerobic treatment step is being introduced (tonnes/ m^3)
$B_{o,ww}$	Methane producing capacity of the wastewater
$MCF_{ww,\ treatment,i}$	Methane correction factor for the existing anaerobic wastewater treatment systems "i" to which the sequential anaerobic treatment step is being introduced *(MCF lower value in Table III.H.1)*
GWP_CH_4	Global warming potential of methane

<u>Stage II (biogas utilization)</u>

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. 13, *Thermal energy for the user with or without electricity.* [31]

The baseline scenario in this project meets the requirements of paragraph 6 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.*

Accordingly, the methodology requires baseline emissions be calculated as per the formula below:

<u>Equation 2: Baseline emission for steam/heat produced using fossil fuels</u>[32]

$$BE_{y,stageII} = HG_y * EF_{CO2}{}^{33} / \eta_{th}$$

Where:

$BE_{y,stageII}$	the baseline emissions from steam/heat displaced by the project activity during the year y in tCO_2e.
HG_y	the net quantity of steam/heat supplied by the project activity during the year y in TJ.
EF_{CO2}	the CO_2 emission factor per unit of energy of the fuel that would have been used in the baseline plant in (tCO_2 / TJ), obtained from reliable local or national data if available, otherwise, IPCC default emission factors are used.
η_{th}	the efficiency of the plant using fossil fuel that would have been used in the absence of the project activity.

In accordance with AMS I.C., Ver. 13, Paragraph 13 (c), η_{th} is fixed ex-ante at "maximum efficiency of 100%".

$\boldsymbol{BE_{y,stageII}}$ details are provided in Annex 3.

<u>Project Activity Emissions</u>

[31] http://cdm.unfccc.int/UserManagement/FileStorage/CDMWF_AM_YL0327DQSKVFXYQREWRT3VNR58402G

[32] Adapted from UNFCCC methodology AMS I.C (Thermal energy for the user with or without electricity), V.13 http://cdm.unfccc.int/UserManagement/FileStorage/CDMWF_AM_YL0327DQSKVFXYQREWRT3VNR58402G

[33] http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/2_Volume2/V2_1_Ch1_Introduction.pdf . Fixed ex-ante.

The project activity emission calculations for Stage I (methane recovery) are described in the following paragraphs. Project activity emission calculations for Stage II (biogas utilization) of this project activity are not required by AMS I.C, Ver. 13[34].

Stage I (methane recovery)

As defined by the AMS III.H methodology, project activity emissions consist of:

(i) *CO_2 emissions on account of power used by the project activity facilities. Emission factors for grid electricity or diesel fuel use as the case may be shall be calculated as described in category AMS I.D.;*
(ii) *Methane emissions on account of inefficiency of the wastewater treatment and presence of degradable organic carbon in treated wastewater;*
(iii) *Methane emissions from the decay of the final sludge generated by the treatment systems;*
(iv) *Methane fugitive emissions on account of inefficiencies in capture and flare systems;*
(v) *Methane emissions resulting from dissolved methane in the treated wastewater effluent.*
(vi) *Where relevant, emissions due to the upgrading and compression of biogas (cases covered under paragraph 2 (b) and 2 (c)).*
(vii) *Where relevant, emissions due to physical leakage from the dedicated piped network for transport of upgraded biogas to the end users (cases covered under paragraph 2 (c ii)).*

In this case, items (iii), (vi), and (vii) are not applicable to the project activity emissions for the following reasons:

- Item (iii) may be neglected since the methodology states in paragraph 12 where $\mathbf{PE_{y,s,final}}$, "*If the sludge is controlled combusted, disposed in a landfill with methane recovery, or used for soil application, this term can be neglected, and the final disposal of the sludge shall be monitored during the crediting period.*" Therefore, $\mathbf{PE_{y,s,final}}$ can be neglected since sludge disposition in this project is soil application.
- Item (vi) may be neglected since this only applies to "*(cases covered under paragraph 2 (b) and 2 (c)*)". Since those cases are not applicable to this project, $\mathbf{PE_{y,upgrading}}$ can be neglected.
- Item (vii) may be neglected since this only applies to "*(cases covered under paragraph 2 (c ii)*)". Since that case is not applicable to this project, $\mathbf{PE_{y,leakage,\ pipeline}}$ can be neglected.

For stage I of this project activity (methane recovery), estimated project emissions are determined as follows:

Equation 3: Total project activity emissions[35]

$$PE_y = PE_{y,power} + PE_{y,ww,treated} + PE_{y,fugitive} + PE_{y,dissolved}$$

Where:

PE_y	Project activity emissions in the year "y" (tCO_2e)
$PE_{y,power}$	Emissions from electricity or diesel consumption in the year "y"
$PE_{y,ww,treated}$	Emissions from degradable organic carbon in treated wastewater in the year "y"

[34] http://cdm.unfccc.int/UserManagement/FileStorage/CDMWF_AM_YL0327DQSKVFXYQREWRT3VNR58402G

[35] Adapted from UNFCCC methodology AMS-III.H (Methane recovery in wastewater treatment), V.9, http://cdm.unfccc.int/UserManagement/FileStorage/CDMWF_AM_743QMM1YKHH15AK2AZAVAIJHRGD5R7

$PE_{y,fugitive}$	Emissions from methane release in capture and utilization/combustion/flare systems in the year "y"
$PE_{y,dissolved}$	Emissions from dissolved methane in treated wastewater in year "y". Project emissions from this source are only considered for project activities involving measures described in cases (i), (v) and (vi) of paragraph 1

The following equations (Equations 4 through 9) are used to determine the values applied in Equation 3.

Equation 4: Emissions from electricity and/or fossil fuel consumption

According to the methodology, paragraph 13 states: "*Project activity emissions from electricity consumption are determined as per the procedures described in AMS I.D. The energy consumption of all equipment/devices installed by the project activity, inter alia facilities for upgrade and compression, filling of bottles, distribution and the final end use of biogas shall be included. For project activity emissions from fossil fuel consumption the emission factor for the fossil fuel shall be used (tCO_2/tonne). Local values are to be used, if local values are difficult to obtain, IPCC default values may be used. If recovered methane is used to power auxiliary equipment of the project it should be taken into account accordingly, using zero as its emission factor.*"

Project emissions from electricity consumption are conservatively calculated based upon the total kilowatt hours (kWh) consumed by project activity equipment. *For the purposes of PDD estimation only, electricity consumption is conservatively based upon the full rated capacity (kWh) of the project activity equipment, plus 10% to account for distribution losses, for 24 hours per day, 365 days per year (total 8760 hours per year).* The project emissions due to the electricity consumption of project activity equipment are therefore determined by multiplying the total kilowatt hours (kWh) consumed by project activity equipment (**$kWh_{project}$**) by the emission factor for the grid (**EF_{grid}**). The following formula is used to convert the data to tCO_2e: [36]

$$PE_{y,power} = (kWh_{project} * EF_{grid}) / 1000$$

Where:

$PE_{y,power}$	*Project emissions due to electricity consumption of equipment (tCO_2e/yr)*
$kWh_{project}$	*Power consumed by project activity equipment*
EF_{grid}	*Country specific grid electricity emission factor*

$kWh_{project}$ and **$PE_{y,power}$** details are provided in Annex 3. The EF is determined as explained in Annex 3 and is fixed ex-ante.

Equation 5: Emissions from degradable organic carbon in treated wastewater[37]

$$PE_{y,ww,treated} = Q_{y,ww} * GWP\_CH_4 * B_{o,ww} * COD_{y,ww,treated} * MCF_{ww,final}$$

Where:

$PE_{y,ww,treated}$	Emissions from degradable organic carbon in treated wastewater in the year "y"

[36] http://www.energy-toolbox.vic.gov.au/understanding_your_energy_bill/emission_estimation_methodologies/electricity_emission_estimation_methodologies.html

[37] Adapted from UNFCCC methodology AMS-III.H (Methane recovery in wastewater treatment), V.9, http://cdm.unfccc.int/UserManagement/FileStorage/CDMWF_AM_743QMM1YKHH15AK2AZAVAIJHRGD5R7

$Q_{y,ww}$	Volume of wastewater treated in the year "y" (m^3)
GWP_CH_4	Global warming potential of methane
$B_{o,ww}$	Methane producing capacity of the wastewater
$COD_{y, ww, treated}$	Chemical oxygen demand of the final treated wastewater discharged into sea, river or lake in the year "y" (tonnes/m^3)
$MCF_{ww, final}$	Methane correction factor based on type of treatment and discharge pathway of the wastewater (fraction) *(MCF higher value in Table III.H.1)*

Equation 6. Emissions from methane release in capture and utilization/combustion/flare systems

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

Where:

$PE_{y,fugitive}$	Emissions from methane release in capture and utilization/combustion/flare systems in the year "y" (tCO_2e)
$PE_{y,fugitive,ww}$	Fugitive emissions through capture and utilization/combustion/flare inefficiencies in the anaerobic wastewater treatment in the year "y" (tCO_2e)
$PE_{y,fugitive,s}$	Fugitive emissions through capture and utilization/combustion/flare inefficiencies in the anaerobic sludge treatment in the year "y" (tCO_2e)

In the project activity, fugitive emissions through capture and utilization/combustion/flare inefficiencies in the anaerobic sludge treatment ($PE_{y,fugitive,s}$) are not calculated since sludge is not subject to any methane capture and flare system.

Therefore, total fugitive emissions ($PE_{y,fugitive}$) consists solely of fugitive emissions through capture and utilization/combustion/flare inefficiencies in the anaerobic wastewater treatment ($PE_{y,fugitive,ww}$).

Equation 7: Fugitive emissions through capture and utilization/combustion/flare inefficiencies in the anaerobic wastewater treatment[38]

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

Where:

$PE_{y,fugitive,ww}$	Fugitive emissions through capture and utilization/combustion/flare inefficiencies in the anaerobic wastewater treatment in the year "y" (tCO_2e)
CFE_{ww}	Capture and utilization/combustion/flare efficiency of the methane recovery and combustion/utilization equipment in the wastewater treatment
$MEP_{y,ww,treatment}$	Methane emission potential of the wastewater treatment plant in the year "y" (tonnes)
GWP_CH_4	Global warming potential of methane

[38] Adapted from UNFCCC methodology AMS-III.H (Methane recovery in wastewater treatment), V.9, http://cdm.unfccc.int/UserManagement/FileStorage/CDMWF_AM_743QMM1YKHH15AK2AZAVAIJHRGD5R7

Equation 8: Methane emission potential of the wastewater treatment plant[39]

$$MEP_{y,ww,treatment} = Q_{y,ww} * B_{o,ww} * \sum_j COD_{y,removed,j} * MCF_{ww,j}$$

Where:

$MEP_{y,ww,treatment}$	Methane emission potential of the wastewater treatment plant in the year y, tonnes
$Q_{y,ww}$	Volume of wastewater treated in the year "y" (m^3)
$B_{o,ww}$	Methane producing capacity of the wastewater
$COD_{y,removed,j}$	Chemical oxygen demand removed by the treatment system "j" of the project activity equipped with methane recovery in the year "y" (tonnes/ m^3)
$MCF_{ww,j}$	Methane correction factor for the wastewater treatment system "j" equipped with methane recovery and combustion/flare/utilization equipment *(MCF higher value in Table III.H.1)*

Equation 9: Emissions from dissolved methane in treated wastewater[40]

$$PE_{y,dissolved} = Q_{y,ww} * [CH_4]_{y,ww,treated} * GWP\_CH_4$$

Where:

$PE_{y,dissolved}$	Emissions from dissolved methane in treated wastewater in year "y". Project emissions from this source are only considered for project activities involving measures described in cases (i), (v) and (vi) of paragraph 1
$[CH_4]_{y,ww,treated}$	Dissolved methane content in the treated wastewater (tonnes/m^3). In aerobic wastewater treatment default value is zero, in anaerobic treatment it can be measured, or a default value of $10e^{-4}$ tonnes/m^3 can be used.
GWP_CH_4	Global warming potential of methane

Stage II (biogas utilization)

As stated in section B.4, the baseline is determined in accordance with paragraphs 6, 10, and 13 of AMS I.C., Ver. 13. [41] Since the baseline emissions (due to the use of fossil fuel) are fully replaced by the use of biogas from Stage I, no project emissions are applicable.

Leakage

Stage I (methane recovery): In accordance with AMS III.H, Ver. 9, leakage calculations are not required since the technology being employed in this project is not transferred from or to another activity.

[39] Adapted from UNFCCC methodology AMS-III.H (Methane recovery in wastewater treatment), V.9, http://cdm.unfccc.int/UserManagement/FileStorage/CDMWF_AM_743QMM1YKHH15AK2AZAVAIJHRGD5R7

[40] Adapted from UNFCCC methodology AMS-III.H (Methane recovery in wastewater treatment), V.9, http://cdm.unfccc.int/UserManagement/FileStorage/CDMWF_AM_743QMM1YKHH15AK2AZAVAIJHRGD5R7

[41] http://cdm.unfccc.int/UserManagement/FileStorage/CDMWF_AM_YL0327DQSKVFXYQREWRT3VNR58402G

Stage II (biogas utilization): In accordance with AMS I.C, Ver. 13, leakage calculations are not required since the technology being employed in this project is not transferred from or to another activity.

Emission reductions

Stage I (methane recovery):
Equation 10: Estimated emission reductions[42]

For the purposes of estimation, emission reductions are calculated as the difference between the baseline emission and the sum of the project emission and leakage. In accordance with the methodology, actual calculation of emission reductions during the crediting period will be "based on the amount of methane recovered and fuelled or flared, that is monitored ex-post".

$$ER_y = BE_y - (PE_y + Leakage_y)$$

Where:

ER_y	Emission reductions (tCO_2e/year)
BE_y	Baseline emissions (tCO_2e/year)
PE_y	Project emissions (tCO_2e/year)
$Leakage_y$	Leakage emissions (tCO_2e/year)

Stage II (biogas utilization)

For stage II of this project activity (biogas utilization), estimated emission reductions are equal to the baseline emissions calculated using Equation 2.

Total emission reductions

The overall estimated emission reductions are determined by summing the emission reductions from Stage I (ER_y) and the baseline emissions displaced by the project activity from Stage II ($BE_{y,stageII}$) .

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

Accurate data collection is essential. The starch processing facility maintains extensive production and processing records to manage operations and to maximize productivity and profitability. As an engineering service provider, AES Engineering Vietnam Ltd uses some data collected from this system. AES Engineering Vietnam Ltd has a rigorous QA/QC system that ensures data security and data integrity. Spot audits of data collection activities will be conducted on a regular basis. Project activity data related uncertainties will be reduced by applying sound data collection quality assurance and quality control procedures.

Parameters applicable to Stage I (methane recovery)

Data / Parameter:	**GWP_CH_4**
Data unit:	
Description:	Global Warming Potential of Methane

[42] Adapted from UNFCCC methodology AMS-III.H (Methane recovery in wastewater treatment), V.9, http://cdm.unfccc.int/UserManagement/FileStorage/CDMWF_AM_743QMM1YKHH15AK2AZAVAIJHRGD5R7

Source of data used:	Refer to AMS III-H, V.9 methodology
Value applied:	21
Justification of the choice of data or description of measurement methods and procedures actually applied:	
Comments:	

Data / Parameter:	**$B_{o,ww}$**
Data unit:	kg CH_4 / kg COD
Description:	Methane producing capacity of the wastewater
Source of data used:	IPCC default value for domestic wastewater as cited in AMS III H, V.9 methodology
Value applied:	0.21
Justification of the choice of data or description of measurement methods and procedures actually applied:	In accordance with the parameter definition in AMS III H, v.9
Comments:	

Data / Parameter:	**$MCF_{ww,treatment,i}$**
Data unit:	Fraction
Description:	Methane correction factor for the existing anaerobic wastewater treatment systems "i" to which the sequential anaerobic treatment step is being introduced
Source of data used:	IPCC default (lower) value from Table III.H.1 in AMS III H, V.9 methodology
Value applied:	0.8
Justification of the choice of data or description of measurement methods and procedures actually applied:	The current type of wastewater treatment and discharge pathway or system to which this project will be applied from Table III.H.1 is *Anaerobic deep lagoon (depth more than 2 metres).*
Comments:	

Data / Parameter:	**$MCF_{ww,j}$**
Data unit:	Fraction
Description:	Methane correction factor for the wastewater treatment system equipped with methane recovery and combustion/flare/utilization equipment
Source of data used:	IPCC default (higher) value from Table III.H.1 in AMS III H, V.9 methodology
Value applied:	1.0
Justification of the choice of data or description of measurement methods and procedures actually applied:	The current type of wastewater treatment and discharge pathway or system to which this project will be applied from Table III.H.1 is *Anaerobic deep lagoon (depth more than 2 metres)*
Comments:	

Data / Parameter:	**$MCF_{ww,final}$**

Data unit:	Fraction
Description:	Methane correction factor based on type of treatment and discharge pathway of the wastewater
Source of data used:	IPCC default (higher) value from Table III.H.1 in AMS III H, V.9 methodology
Value applied:	0.1
Justification of the choice of data or description of measurement methods and procedures actually applied:	The type of treatment and discharge pathway of the treated wastewater from Table III.H.1 is equivalent to *Aerobic treatment, well managed.* Please refer to Annex 3 for additional information.
Comments:	

Data / Parameter:	**$[CH_4]_{y,ww,treated}$**
Data unit:	$Tonnes/m^3$
Description:	Dissolved methane content in the treated wastewater
Source of data used:	Default value specified in AMS III H., V.9 methodology
Value applied:	0.0001
Justification of the choice of data or description of measurement methods and procedures actually applied:	Paragraph 17 of the methodology states, in part: *"In aerobic wastewater treatment default value is zero, in anaerobic treatment it can be measured, or a default value of $10e^{-4}$ tonnes/m^3 can be used".* Accordingly, the default value for anaerobic treatment is selected.
Comments:	

Data / Parameter:	**$COD_{y,removed,i}$**
Data unit:	$Tonnes/m^3$
Description:	Chemical oxygen demand removed by the anaerobic wastewater treatment systems "i" in the baseline situation in the year "y" to which the sequential anaerobic treatment step is being introduced
Source of data used:	Site Data
Value applied:	See Annex 3
Justification of the choice of data or description of measurement methods and procedures actually applied:	
Comments:	

Data / Parameter:	**EF_{grid}**
Data unit:	tCO_2e / mWh
Description:	Country specific grid electricity emission factor
Source of data used:	CDM Baseline Construction for Vietnam National Electricity Grid[43]
Value applied:	0.5801
Justification of the choice of data or description of measurement methods and procedures actually applied:	Per AMS IIIH, v.9, paragraph 13, "determined as per the procedures described in AMS I.D". In accordance with AMS I.D, v.13, paragraph 9 (a), the emission factor was calculated and published using the most recently available data from Vietnamese government agencies. Details are provided in Annex 3.

[43] http://opus.zbw-kiel.de/volltexte/2004/2304/pdf/295.pdf

Comments:	

Data / Parameter:	$\mathbf{D_{CH4,y}}$
Data unit:	Tonnes/m^3
Description:	Density of methane
Source of data used:	As defined in methodology ACM0001, v.9.1[44]
Value applied:	0.0007168
Justification of the choice of data or description of measurement methods and procedures actually applied:	The biogas flow meter is normalized to 0 degrees Celsius at 1 ATM and calibrated in NCMH units by the manufacturer. Standard density conversion factors are established by the manufacturer.
Comments:	

Parameters applicable to Stage II (biogas utilization)

Data / Parameter:	$\mathbf{NCV_{methane}}$
Data unit:	TJ/m^3
Description:	Net calorific value of methane
Source of data used:	2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 2, Table 1.2[45]
Value applied:	50.4
Justification of the choice of data or description of measurement methods and procedures actually applied:	
Comments:	This value is determined ex-ante and will be applicable during verification.

Data / Parameter:	$\mathbf{EF_{CO2}}$
Data unit:	tCO_2 / TJ
Description:	CO_2 emission factor per unit of energy of the fuel that would have been used in the baseline plant
Source of data used:	2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 2, Table 2.2[46]
Value applied:	See Annex 3
Justification of the choice of data or description of measurement methods and procedures actually applied:	
Comments:	

Data / Parameter:	η_{th}
Data unit:	Percentage
Description:	Efficiency of the plant using fossil fuel that would have been used in the

[44] http://cdm.unfccc.int/UserManagement/FileStorage/R5FE555DMDJ49EH3JHZUGV83GWX8LP

[45] http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/2_Volume2/V2_2_Ch2_Stationary_Combustion.pdf

[46] http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/2_Volume2/V2_2_Ch2_Stationary_Combustion.pdf

	absence of the project activity
Source of data used:	Refer to AMS I C., V.13 methodology
Value applied:	100%
Justification of the choice of data or description of measurement methods and procedures actually applied:	To remain conservative, the maximum efficiency of 100% (paragraph 13 option (c)) has been selected.
Comments:	

B.6.3 Ex-ante calculation of emission reductions:

<u>Stage I (methane recovery)</u>

<u>Stage I Baseline Emissions</u>

Baseline emissions for Stage I (methane recovery) are calculated using Equation 1 in Section B.6.1.

Baseline emissions for Stage I of the project activity are:

YenBinh2	III H.			
Year	2009-2010	2010-2011	2011-2012	2012-2016
Baseline emission from wastewater treatment in tonnes CO_2e/yr (BEy)	32,510	38,618	45,874	54,493

YenBinh2								III H.
Year	1	2	3	4	5	6	7	Total
Expected Growth%	0%	19%	19%	19%	0%	0%	0%	
Baseline Emissions, (Waste Water) (tCO2e)	32,510	38,618	45,874	54,493	54,493	54,493	54,493	334,973

<u>Stage I: Project Activity Emissions</u>

Project emissions for Stage I (methane recovery) are calculated using Equations 3 through 9 in Section B.6.1.

Project activity emissions for Stage I of the project activity are:

YenBinh2	III H.			
Year	2009-2010	2010-2011	2011-2012	2012-2016
Emissions through electricity or diesel consumption ($PE_{y,power}$)	182	182	182	182
Emissions through degradable organic carbon in treated wastewater ($PE_{y,ww,treated}$)	607	720	856	1,017
Emissions through anaerobic decay of the final sludge produced ($PE_{y,s,final}$)	0	0	0	0
Emissions through methane release in capture and flare systems ($PE_{y,fugitive}$)	4,437	5,270	6,261	7,437
Emissions from dissolved methane in treated wastewater ($PE_{y,dissolved}$)	1,128	1,339	1,591	1,890
Total annual project emissions (PEy)	6,352	7,512	8,889	10,525

YenBinh2								III H.
Year	1	2	3	4	5	6	7	**Total**
Expected Growth %	0%	19%	19%	18%	0%	0%	0%	
Project Emissions (tCO_2e)	6,352	7,512	8,889	10,525	10,525	10,525	10,525	64,853

Since the technology used does not consist of equipment from another activity nor is the existing equipment transferred to another activity, leakage does not need to be considered according to AMS III.H, Ver.9.

Stage I: Estimated emission reductions

Estimated emission reductions for Stage I (methane recovery) are calculated using Equation 10 in Section B.6.1.

YenBinh2								III H.
Year	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**Total**
Expected Growth%	0%	19%	19%	19%	0%	0%	0%	
Baseline Emissions, (Waste Water) (tCO2e)	32,510	38,618	45,874	54,493	54,493	54,493	54,493	334,973
Project Emissions (tCO2e)	6,352	7,512	8,889	10,525	10,525	10,525	10,525	64,853
Estimated Emission Reductions (tCO2e)	26,158	31,106	36,985	43,968	43,968	43,968	43,968	270,120

Stage II (biogas utilization)

Stage II: Baseline emissions

YenBinh2	I C.			
The net quantity of steam/heat supplied by the project activity during the year y in TJ (HGy)	48.58	57.71	68.55	81.43
The CO2 emission factor based on the fuel type used in the baseline in kgCO2e/TJ (EFCO2)	94,600	94,600	94,600	94,600
The efficiency of the boiler using fossil fuel (or cogen if both electricity and heat are produced) that would have been used in the absence of the project activity (ηth / ηcogen)	100%	100%	100%	100%
Total annual baseline emissions in tonnes of CO2e (BEy)	4,596	5,459	6,485	7,703

YenBinh2								I C.
Year	1	2	3	4	5	6	7	Total
Expected Growth%	0%	19%	19%	19%	0%	0%	0%	
Baseline Emissions, (Fuel Switch) (tCO2e)	4,596	5,459	6,485	7,703	7,703	7,703	7,703	47,354

Stage II: Project activity emissions

Project activity emission calculations for Stage II (biogas utilization) of this project activity are not required by AMS I.C, Ver. 13[47]

Since the technology used does not consist of equipment from another activity nor is the existing equipment transferred to another activity, leakage does not need to be considered according to AMS I.C, Ver. 13.

Stage II: Estimated emission reductions

For stage II of this project activity (biogas utilization), estimated emission reductions are equal to the baseline emissions calculated using Equation 2.

YenBinh2								I C.
Year	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**Total**
Expected Growth%	0%	17%	17%	17%	0%	0%	0%	
Baseline Emissions, (Fuel Switch) (tCO2e)	4,596	5,459	6,485	7,703	7,703	7,703	7,703	47,354
Project Emissions (tCO2e)	0	0	0	0	0	0	0	0
Estimated Emission Reductions (tCO2e)	4,596	5,459	6,485	7,703	7,703	7,703	7,703	47,354

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

[47] http://cdm.unfccc.int/UserManagement/FileStorage/CDMWF_AM_YL0327DQSKVFXYQREWRT3VNR58402G

Stage I: Estimated emission reductions (AMS III-H)

Year	Estimation of project activity emissions (tCO_2e)	Estimation of baseline emissions (tCO_2e)	Estimation of leakage (tCO_2e)	Estimation of overall emission reductions (tCO_2e)
Year2: 2010 - 2011	6,352	32,510	0	26,158
Year3: 2011 - 2012	7,512	38,618	0	31,106
Year4: 2012 - 2013	8,889	45,874	0	36,985
Year5: 2013 - 2014	10,525	54,493	0	43,968
Year6: 2014 - 2015	10,525	54,493	0	43,968
Year7: 2015 - 2016	10,525	54,493	0	43,968
Total (tonnes CO2e)	10,525	54,493	0	43,968
Total (tonnes CO_2e)	64,853	334,973	0	270,120

Stage II: Estimated emission reductions (AMS I-C)

Year	Estimation of project activity emissions (tCO_2e)	Estimation of baseline emissions (tCO_2e)	Estimation of leakage (tCO_2e)	Estimation of overall emission reductions (tCO_2e)
Year2: 2010 - 2011	0	4,596	0	4,596
Year3: 2011 - 2012	0	5,459	0	5,459
Year4: 2012 - 2013	0	6,485	0	6,485
Year5: 2013 - 2014	0	7,703	0	7,703
Year6: 2014 - 2015	0	7,703	0	7,703
Year7: 2015 - 2016	0	7,703	0	7,703
Total (tonnes CO2e)	0	7,703	0	7,703
Total (tonnes CO_2e)	0	47,354	0	47,354

Total Emission Reductions

Year	Estimation of project activity emissions (tCO_2e)	Estimation of baseline emissions (tCO_2e)	Estimation of leakage (tCO_2e)	Estimation of overall emission reductions (tCO_2e)
Year1: 2009 - 2010	6,352	37,106	0	30,753
Year2: 2010 - 2011	7,512	44,077	0	36,566
Year3: 2011 - 2012	8,889	52,359	0	43,470
Year4: 2012 - 2013	10,525	62,196	0	51,671
Year5: 2013 - 2014	10,525	62,196	0	51,671
Year6: 2014 - 2015	10,525	62,196	0	51,671
Year7: 2015 - 2016	10,525	62,196	0	51,671
Total (tonnes CO_2e)	64,853	382,327	0	317,474

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

B.7.1 Data and parameters monitored:

As an engineering service provider, AES Engineering Vietnam Ltd has developed a unique set of data management tools to efficiently capture and report data throughout the project lifecycle. On-site assessment, supplier production data exchange, task tracking, and post-implementation auditing tools have been developed to ensure accurate, consistent, and complete data gathering and project implementation. Tools have also been created to monitor the creation of high quality, permanent ERs using IPCC formulae. By implementing all of these tools, AES Engineering Vietnam Ltd enables transparent data collection and verification.

All equipment selected for this project meets international industry certification standards. The equipment (i.e. biogas flow meters, gas, flare/combustion equipment) will be calibrated and maintained in accordance with manufacturer specifications to ensure operation continues at design efficiency and accuracy. Equipment specifications have been provided to the DOE.

Monitoring parameters applicable to Stage I (methane recovery)

Data / Parameter:	$Q_{y,ww}$
Data unit:	m^3
Description:	Volume of the wastewater treated in the year "y"
Source of data to be used:	Continuous flow meter
Value of data	To be monitored
Description of measurement methods and procedures to be applied:	Monitored continuously and recorded daily. The electro-magnetic continuous flow meter uses a magnetic field which is applied to the metering tube, which results in a potential difference proportional to the flow velocity perpendicular to the flux lines.
QA/QC procedures to be applied:	AES Engineering Vietnam Ltd employs an internal QA audit process that ensures monitoring activities are conducted in accordance with the monitoring plan and verifies the accuracy of data reported. The flow meter will be operated and calibrated according to manufacturer's specifications (but no less than every 3 years). A calibration/service log will be maintained for the flow meter.
Any comment:	Data will be archived electronically and kept for the duration of the project + 2 years.

Data / Parameter:	$COD_{y,ww,untreated}$
Data unit:	Tonnes/m^3
Description:	Chemical oxygen demand of the wastewater entering the anaerobic treatment/reactor system in the year "y"
Source of data to be used:	Sampling Analysis
Value of data	To be monitored
Description of measurement methods and procedures to be applied:	Measured and recorded at least quarterly via third party sampling and analysis.
QA/QC procedures to be applied:	COD analysis of wastewater samples will be conducted by a third party in accordance with equipment manufacturer's specifications and will include blank and calibration standards. All equipment will be operated and calibrated according to manufacturer's specifications (but no less than every 3 years).
Any comment:	Data will be archived electronically and kept for the duration of the project + 2 years.

Data / Parameter:	**$COD_{y,ww,treated}$**
Data unit:	Tonnes/m^3
Description:	Chemical oxygen demand of the final treated wastewater discharged into the sea, river or lake in the year "y"
Source of data to be used:	Sampling Analysis
Value of data	To be monitored
Description of measurement methods and procedures to be applied:	Measured and recorded at least quarterly via third party sampling and analysis.
QA/QC procedures to be applied:	COD analysis of wastewater samples will be conducted by a third party in accordance with equipment manufacturer's specifications and will include blank and calibration standards. All equipment will be operated and calibrated according to manufacturer's specifications (but no less than every 3 years).
Any comment:	Data will be archived electronically and kept for the duration of the project + 2 years.

Data / Parameter:	**$COD_{y,removed}$**
Data unit:	Tonnes/m^3
Description:	Chemical oxygen demand that is the difference between the inflow COD and the outflow COD in the year "y"
Source of data to be used:	Calculated based upon sampling analysis
Value of data	To be monitored
Description of measurement methods and procedures to be applied:	In accordance with AMS III-H, v.9, paragraphs 34 and 35, this is determined by subtracting $COD_{y,ww,treated}$ from $COD_{y,ww,untreated.}$ Recorded at least quarterly
QA/QC procedures to be applied:	COD analysis of wastewater samples will be conducted by a third party in accordance with equipment manufacturer's specifications and will include blank and calibration standards. All equipment will be operated and calibrated according to manufacturer's specifications (but no less than every 3 years).
Any comment:	Data will be archived electronically and kept for the duration of the project + 2 years.

Data / Parameter:	**BGP_{Flare}**
Data unit:	Nm^3
Description:	Amount of biogas recovered and directed to flare for combustion
Source of data to be used:	Continuous flow meter (refer to Section A.4.2 for equipment description)
Value of data	To be monitored
Description of measurement methods and procedures to be applied:	Measured continuously and recorded quarterly (dry basis).
QA/QC procedures to be applied:	AES Engineering Vietnam Ltd employs an internal QA audit process that ensures monitoring activities are conducted in accordance with the monitoring plan and verifies the accuracy of data reported. The flow meter will be operated and calibrated according to manufacturer's specifications (but no less than every 3 years). A calibration/service log will be maintained for the flow

	meter.
Any comment:	Data will be archived electronically or on paper and kept for the duration of the project + 2 years.

Data / Parameter:	**MC_{biogas}**
Data unit:	Percentage (volume)
Description:	Methane content of biogas recovered and directed to the flare for combustion
Source of data to be used:	Gas analyzer
Value of data	To be monitored
Description of measurement methods and procedures to be applied:	Measured and recorded at least quarterly. (dry basis) A sufficient number of measurements will be made to meet a 95% confidence level, using the lower bound as the following clarification describes; AM_CLA_0095 states: "*In case the captured gas is used to produce energy or a* ***default value for flare efficiency*** *is adopted, the Meth Panel recommends allowing the option of conducting periodical measurements with a minimum of quarterly measurements per year. The lower bound of the 95% confidence interval obtained from the periodical measurements should be used to estimate baseline methane emissions to ensure conservativeness."*
QA/QC procedures to be applied:	Use and calibration of the gas analyzer will be conducted in accordance with manufacturer's standards (but no less than every 3 years). A calibration/service log will be maintained for each gas analyzer.
Any comment:	Data will be archived electronically or on paper and kept for the duration of the project + 2 years.

Data / Parameter:	**CFE_{ww}**
Data unit:	Percentage
Description:	Efficiency of the flaring process
Source of data to be used:	Automated flaring system (refer to Section A.4.2 for equipment description)
Value of data	0.90*
Description of measurement methods and procedures to be applied:	Flares shall be operated in accordance with manufacturer specifications. **Flare exhaust temperature** will be recorded electronically more frequently than hourly via the thermocouple(s) that is (are) part of the automated flaring system. (Refer to Section A.4.2. for equipment description). (See parameters BGP_{flare} and BGP_{RE} for biogas flow rate). * Refer to AMS III H, V.9 methodology (paragraph 38, option a):, *"If option (a) is chosen continuous check of compliance with the manufacturers specification of the flare device (temperature, biogas flow rate) should be done. If in any specific hour any of the parameters is out of the range of specifications 50% of default value should be used for this specific hour. For open flare 50% default value should be used, as it is not possible in this case to monitor the efficiency. If at any given time the temperature of the flare is below 500ºC, 0% default value should be used for this period.*
QA/QC procedures to be applied:	All flare monitoring/combustion equipment will be operated and calibrated according to manufacturer's specifications (but no less than every 3 years). Flare exhaust temperature and biogas flow data will be compiled and analyzed using software. A calibration/service log will be maintained for the flare monitoring/combustion equipment.

Any comment:	Electronic data will be stored for the duration of the project + 2 years.

Data / Parameter:	**$kWh_{project}$**
Data unit:	kWh
Description:	Electricity consumed by project activity equipment
Source of data to be used:	Project developer
Value of data	To be monitored
Description of measurement methods and procedures to be applied:	Continuously monitored and recorded by electricity meters.
QA/QC procedures to be applied:	The meter(s) will be operated and calibrated according to manufacturer's specifications (but no less than every 3 years). A calibration/service log will be maintained for each meter.
Any comment:	Data will be archived electronically or on paper and kept for the duration of the project + 2 years.

Data / Parameter:	**Fossil fuel**
Data unit:	Liters
Description:	Fossil fuel consumption
Source of data to be used:	Facility records.
Value of data	To be monitored
Description of measurement methods and procedures to be applied:	Facility records will be obtained on a quarterly basis to monitor the amount of fossil fuel used by the diesel generators.
QA/QC procedures to be applied:	AES Engineering Vietnam Ltd employs an internal QA audit process that ensures monitoring activities are conducted in accordance with the monitoring plan and verifies the accuracy of data reported.
Any comment:	Data will be archived electronically or on paper and kept for the duration of the project + 2 years.

Data / Parameter:	**$S_{f, end use}$**
Data unit:	
Description:	End use of final sludge
Source of data to be used:	Facility records
Value of data	To be monitored
Description of measurement methods and procedures to be applied:	Verified and recorded as sludge disposition is required. Sludge is sun-dried aerobically and land applied.
QA/QC procedures to be applied:	End use of sludge will be monitored and inspected on-site (visually) with verification by facility personnel.
Any comment:	Data will be archived electronically or on paper and kept for the duration of the project + 2 years.

Monitoring parameters applicable to Stage II (biogas utilization)

Data / Parameter:	**BGP_{dryer}**
Data unit:	Nm^3
Description:	Amount of biogas recovered and directed to the renewable energy unit for combustion
Source of data to be used:	Continuous flow meter (refer to Section A.4.2 for equipment description)
Value of data	To be monitored
Description of measurement methods and procedures to be applied:	Measured continuously and recorded quarterly (dry basis).
QA/QC procedures to be applied:	AES Engineering Vietnam Ltd employs an internal QA audit process that ensures monitoring activities are conducted in accordance with the monitoring plan and verifies the accuracy of data reported. The flow meter will be operated and calibrated according to manufacturer's specifications (but no less than every 3 years). A calibration/service log will be maintained for the flow meter.
Any comment:	Data will be archived electronically or on paper and kept for the duration of the project + 2 years.

Data / Parameter:	**MC_{dryer}**
Data unit:	Percentage (volume)
Description:	Methane content of biogas sent to dryer system for combustion
Source of data to be used:	Gas analyzer
Value of data	To be monitored
Description of measurement methods and procedures to be applied:	Measured and recorded at least quarterly. (dry basis) A sufficient number of measurements will be made to meet a 95% confidence level, using the lower bound as the following clarification describes; AM_CLA_0095 states: "*In case the captured gas is used to produce energy or a **default value for flare efficiency** is adopted, the Meth Panel recommends allowing the option of conducting periodical measurements with a minimum of quarterly measurements per year. The lower bound of the 95% confidence interval obtained from the periodical measurements should be used to estimate baseline methane emissions to ensure conservativeness.*"
QA/QC procedures to be applied:	Use and calibration of the gas analyzer will be conducted in accordance with manufacturer's standards. A calibration/service log will be maintained for each gas analyzer.
Any comment:	Data will be archived electronically or on paper and kept for the duration of the project + 2 years.

Data / Parameter:	**Q_x**
Data unit:	Kg/hr
Description:	Quantity of air/thermal oil heated by burner x
Source of data to be used:	Facility records
Value of data	To be monitored
Description of measurement methods and procedures to be	Air: Facility records will be obtained to determine the manufacturer specification of the capacity of the fan installed. Thermal oil: Facility records will be obtained to determine the manufacturer

applied:	specification of the capacity of the circulating pump. This parameter will be recorded for each burner in the drying system. Recorded at least quarterly.
QA/QC procedures to be applied:	AES Engineering Vietnam Ltd employs an internal QA audit process that ensures monitoring activities are conducted in accordance with the monitoring plan and verifies the accuracy of data reported.
Any comment:	Data will be archived electronically or on paper and kept for the duration of the project + 2 years.

Data / Parameter:	$\mathbf{C_{p.air/oil}}$
Data unit:	kJ/kg K
Description:	Specific heat content of air/thermal oil
Source of data to be used:	Air: http://www.engineeringtoolbox.com/air-properties-d_156.html Thermal oil: Facility records
Value of data	To be monitored
Description of measurement methods and procedures to be applied:	Air: The specific heat content is determined in conjunction with the temperature parameters. Thermal oil: The specific heat content is in accordance with the OEM data sheet for the type of thermal oil used. This parameter will be recorded for each burner in the drying system. Recorded at least quarterly.
QA/QC procedures to be applied:	AES Engineering Vietnam Ltd employs an internal QA audit process that ensures monitoring activities are conducted in accordance with the monitoring plan and verifies the accuracy of data reported.
Any comment:	Data will be archived electronically or on paper and kept for the duration of the project + 2 years.

Data / Parameter:	$\mathbf{t_{x,operate}}$
Data unit:	Hour
Description:	Hours of operation
Source of data to be used:	Facility records
Value of data	To be monitored
Description of measurement methods and procedures to be applied:	This parameter will be recorded for each burner in the drying system. Recorded at least quarterly.
QA/QC procedures to be applied:	AES Engineering Vietnam Ltd employs an internal QA audit process that ensures monitoring activities are conducted in accordance with the monitoring plan and verifies the accuracy of data reported.
Any comment:	Data will be archived electronically or on paper and kept for the duration of the project + 2 years.

Data / Parameter:	$\mathbf{T_{x,in}}$
Data unit:	^{o}C
Description:	Temperature of air/thermal oil at the inlet to burner X of the drying system
Source of data to be used:	Thermal gauge or equivalent
Value of data	To be monitored
Description of measurement methods	This parameter will be recorded for each burner in the drying system. Recorded at least quarterly.

and procedures to be applied:	
QA/QC procedures to be applied:	AES Engineering Vietnam Ltd employs an internal QA audit process that ensures monitoring activities are conducted in accordance with the monitoring plan and verifies the accuracy of data reported. All equipment will be operated and calibrated according to manufacturer's specifications (but no less than every 3 years).
Any comment:	Data will be archived electronically or on paper and kept for the duration of the project + 2 years.

Data / Parameter:	**$T_{x,out}$**
Data unit:	^{o}C
Description:	Temperature of air/thermal oil heated by burner X of the drying system
Source of data to be used:	Thermal gauge or equivalent
Value of data	To be monitored
Description of measurement methods and procedures to be applied:	This parameter will be recorded for each burner in the drying system. Recorded at least quarterly.
QA/QC procedures to be applied:	AES Engineering Vietnam Ltd employs an internal QA audit process that ensures monitoring activities are conducted in accordance with the monitoring plan and verifies the accuracy of data reported. All equipment will be operated and calibrated according to manufacturer's specifications (but no less than every 3 years).
Any comment:	Data will be archived electronically or on paper and kept for the duration of the project + 2 years.

Data / Parameter:	**$PE_{ff,dryer}$**
Data unit:	tCO_2e
Description:	Emissions from fossil fuel consumption in the drying system in the year "*y*"
Source of data to be used:	Facility records
Value of data	To be monitored
Description of measurement methods and procedures to be applied:	Verified and recorded as applicable. If any fossil fuel is consumed, this will be monitored in accordance with AMS I.C, v.13, paragraph 21.
QA/QC procedures to be applied:	AES Engineering Vietnam Ltd employs an internal QA audit process that ensures monitoring activities are conducted in accordance with the monitoring plan and verifies the accuracy of data reported.
Any comment:	Data will be archived electronically or on paper and kept for the duration of the project + 2 years.

Calculation of emission reductions during the crediting period

Stage 1 (Methane Recovery)

In accordance with the AMS III.H methodology, this type of project (technology option (vi)) requires that *"the calculation of emission reductions shall be based on the amount of methane recovered and fuelled or flared, that is monitored ex-post. Also for these cases, the project emissions and leakage will be deducted from the emission reductions* *calculated from the methane recovered and combusted, except where it can be demonstrated that the technology implemented does not increase the amount of methane produced per unit of COD removed (COD removed is the difference between the inflow COD ($COD_{y,ww,untreated}$) and outflow COD ($COD_{y,ww,treated}$)), compared with the technology used in the baseline.[48]"*

Accordingly, emission reductions (**ER**) during the crediting period will simply be based upon the methane recovered and fueled or flared (**MD_y**) minus any project emissions due to electricity consumption of project equipment (**$PE_{y,power}$**). In addition, as stated in section B.6.1, leakage calculations are not required since the technology being employed in this project is not transferred from or to another activity.

During the crediting period, it will be demonstrated *"that the technology implemented does not increase the amount of methane produced per unit of COD removed… compared with the technology used in the baseline".* Methane produced per unit of COD removed for the baseline technology is determined by dividing the estimated methane produced by the COD removed for the uncovered anaerobic lagoons (using data available at validation). The monitored parameters listed above will demonstrate there is no increase in the amount of methane produced per unit of COD removed. Methane produced per unit of COD removed for the project technology is determined by dividing **MD_y** by **$COD_{y,removed}$.**

The amount of methane recovered or fuelled/flared will be calculated and converted into tonnes of CO_2e according to the following equation.

Equation 11. Methane recovered and fuelled or flared ex-post

$$MD_y = [(BGP_{flare} * MC_{biogas}) + (BGP_{dryer} * MC_{dryer})] * D_{CH4} * CFE_{ww} * GWP\_CH_4$$

Where:

MD_y	Amount of methane destroyed in year "y" (tonnes)
$BGP_{flare,}$	Amount of biogas recovered and directed to flare for combustion (Nm^3)
MC_{biogas}	Methane content of biogas recovered and directed to flare for combustion during the year "y" (%)
$BGP_{dryer,}$	Amount of biogas recovered and directed to the renewable energy unit for combustion (Nm^3)
MC_{dryer}	Methane content of biogas sent to dryer system for combustion during the year "y" (%)
D_{CH4}	Density[49] of Methane at normal conditions (tCH_4/m^3CH_4)
CFE_{ww}	Efficiency of flaring/combustion process (%)
GWP_CH_4	Global warming potential of methane

Equation 12. Calculation of project emissions from electricity and/or fossil fuel consumption

$PE_{y,power}$ is determined using Equation 4 from Section B.6.1 (shown below):

$$PE_{y,power} = (kWh_{project} * EF_{grid}{}^{50}) / 1000$$

Stage II (Biogas Utilization)

In accordance with the AMS I.C version 13, option (a) from paragraph 18 is selected for monitoring:

[48] UNFCCC methodology AMS-III.H (Methane recovery in wastewater treatment), V.9, http://cdm.unfccc.int/UserManagement/FileStorage/CDMWF_AM_743QMM1YKHH15AK2AZAVAIJHRGD5R7

[49] Normalized to 0 degrees Celsius at 1 ATM and calibrated in NCMH units by the manufacturer. Standard density conversion factors are established by the manufacturer.

[50] Value is determined ex-ante and is applicable during verification. Please refer to Annex 3.

(a) *Metering the energy produced by a sample of the systems where the simplified baseline is based on the energy produced multiplied by an emission coefficient.*

Fossil fuels are not expected to be used in the drying system following the implementation of the project activity. In the event that fossil fuels are necessary for start-up of the drying system, this will be monitored in accordance with AMS I.C, version 13, paragraphs 21 and 23 as follows[51]:

> *21. If fossil fuel is used, the thermal energy or the electricity generation metered should be adjusted to deduct thermal energy or electricity generation from fossil fuels using the specific fuel consumption and the quantity of fossil fuel consumed.*
>
> *23. The amount of thermal energy or electricity generated using biomass fuels calculated as per paragraph 21 shall be compared with the amount of thermal energy or electricity generated calculated using specific fuel consumption and amount of each type of biomass fuel used. The lower of the two values should be used to calculate emission reductions.*

Since the simplified baseline is based on the displacement of fossil fuel with biogas, the thermal energy component of this project does not rely on direct measurements of heat or steam. Ex-post emission reductions for this component are based on the quantity of biogas that is recovered and sent to the dryer system for combustion. In this project, $\mathbf{HG_y}$ represents the energy produced due to the biogas displacement of fossil fuels. During the crediting period, this is determined as follows:

<u>Equation 13. Energy produced due to the biogas displacement of fossil fuels</u>

$$HG_y = HG_{in} * \eta_{th,project}$$

<u>Where:</u>

HG_{in}	*Energy input (TJ)*
$\eta_{th,project}$	*Efficiency of the dryer system now using biogas in the project activity (%)*

The efficiency of the dryer system now using biogas in the project activity ($\eta_{th,project}$) is determined by dividing the net energy output (HG_{out}) by the energy input (HG_{in}).

$$\eta_{th,project} = HG_{out} / HG_{in}$$

<u>Where:</u>

HG_{out}	*Net energy output (TJ)*
HG_{in}	*Energy input (TJ)*

Energy input is determined as follows:

$$HG_{in}{}^{52} = BGP_{dryer} * MC_{dryer} * NCV_{methane}{}^{53} * D_{CH4}$$

<u>Where:</u>

BGP_{dryer}	*Amount of biogas sent to the dryer system for combustion (Nm^3)*
MC_{dryer}	*Methane content of biogas sent to the dryer system for combustion (%)*
$NCV_{methane}$	*Net calorific value of methane (TJ/m^3)*

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[51] http://cdm.unfccc.int/UserManagement/FileStorage/CDMWF_AM_YL0327DQSKVFXYQREWRT3VNR58402G

[52] Equation from registered project 1483. http://cdm.unfccc.int/UserManagement/FileStorage/WLE23PONZSKREHTU4ZQLAX8DX6IWIO

[53] 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 2, Table 1.2 http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/2_Volume2/V2_1_Ch1_Introduction.pdf

D_{CH4} *Density*[54] *of Methane at normal conditions* (tCH_4/m^3CH_4)

Energy output is determined based upon the standard thermodynamics formula for specific heat capacity[55]:

$$HG_{out} = Q_x * C_{p,air/oil} * (T_{x,out} - T_{x,in}) * t_{x,operate}$$

Where:

Q_x *Quantity of air/thermal oil heated by burner x (kg/hr)*
$C_{p.air/oil}$ *Specific heat content of air/thermal oil (kJ/kg K)*
$T_{x,out}$ *Temperature of air/thermal oil heated by burner X of the drying system* (^oC)
$T_{x,in}$ *Temperature of air/thermal oil at the inlet to burner X of the drying system* (^oC)
$t_{x,operate}$ *Hours of operation*

Finally, HG_{out} (kJ) is converted to TJ by dividing by one trillion.[56]

Equation 14. Total ex-post emission reductions

$$ER = (MD_y - PE_{y,power}) + (HG_y - PE_{ff,dryer})$$

B.7.2 Description of the monitoring plan:

A monitoring plan has been developed to ensure that accurate and relevant measurements and observations are made to document starch facility production metrics, project biogas production and equipment operation, including possible sources of sludge, emissions and leakage. This plan reflects good monitoring practice appropriate to this type of project activity and meets the requirements of the *Simplified modalities and procedures for small-scale clean development mechanism project activities.*[57] Local or in-country personnel are responsible for the collection of all monitoring data. This data is quality checked and then transmitted to the engineering service provider, AES Engineering Vietnam Ltd, for secure electronic storage. All data is maintained for a minimum of 2 years beyond the duration of the project.

AES Engineering Vietnam Ltd has established a dedicated regional O&M staff to perform activities including, but not limited to, monitoring and collection of parameters, quality audits, personnel training, starch facility staff training, and equipment inspections. A separate operations and maintenance manual (OMM Manual) and detailed procedures have been developed to ensure equipment functions in accordance with required specifications and calibrations. The OMM manual and procedures provide specific guidance to individuals that collect and/or process data. AES Engineering Vietnam Ltd staff will perform audits of operations personnel on a regular basis to ensure integrity in the data collection and archiving.

An on-site training program will include hands-on proficiency training, question and answer sessions, and an evaluation. Training will be conducted prior to operational start-up. Training topics will include, but are not limited to, CDM project overview, system overview, subsystem specific modules, data collection and quality control, instrument function, malfunction diagnostics, fault reporting and escalation, and facility personnel orientation. Safety and security are elements that will be emphasized in each functional area. Follow-up training will be provided on an as-needed basis.

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[54] Fixed ex-ante.

[55] http://www.engineeringtoolbox.com/specific-heat-capacity-d_339.html

[56] http://en.wikipedia.org/wiki/Joule

[57] http://cdm.unfccc.int/Reference/COPMOP/08a01.pdf#page=43

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

The final draft of the application of the methodology was completed on 03/06/2009.

The baseline has been prepared by AES Climate Solutions. AES Climate Solutions should not be considered a project participant.

SECTION C. Duration of the project activity / crediting period

C.1 Duration of the project activity:

C.1.1. Starting date of the project activity:

The starting date for this activity is 09/09/2009 (engineering purchase order date).

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

The expected life of this project is 21y – 0m

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

The project activity will use a **renewable** crediting period

C.2.1. Renewable crediting period

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

The starting date of the first crediting period is 01/12/2009 or the project registration date (if it occurs after the planned credit period start date).

C.2.1.2. Length of the first crediting period:

The length of the first crediting period is **7y**.

C.2.2. Fixed crediting period:

C.2.2.1. Starting date:

Not applicable

C.2.2.2. Length:

Not applicable

SECTION D. Environmental impacts

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

All projects implemented in Vietnam must apply the environmental standards issued by the government and the Ministry of Natural Resources and Environment (MONRE) according to the following laws, decrees, and guidance:

- *No. 52-2005-QH11 Law on the Protection of the Environment*[58]
- *Decree No. 80-2006-ND-CP providing detailed regulations for implementation of the Law on Environment Protection dated 9 August 2006*[59]
- *Decree No. 21/2008/ND-CP dated 28 Feb.2008 on the amendment of Decree No 80-2006-ND-CP on implementation of Law on Environment Protection*
- *Circular No. 08/2006/TT-BTNMT Guiding strategic environmental assessment, Environmental impact assessment and commitment to protect environment dated 8 September 2006*

The facility conducted an Environmental Impact Assessment in 2006 for the existing wastewater treatment system. The EIA report, dated 21 August 2006, was appraised and approved by the government ministry responsible at that time.

Since the project activity consists of improvements to the existing technology for wastewater management, a supplement to the original EIA is being prepared which will include a description of the improved technology and the environmental benefits expected to occur. This is in accordance with Decree No. 80-2006-ND-CP, Article 13 states in part:

A supplementary environmental impact assessment report must be prepared in the following circumstances:

(a) If there is a change in the location, scale, design output or technology of the project;

Comments from representatives of the local citizenry are being solicited as part of this process.

The revised EIA report has been approved by Provincial People's Committee and Department of Natural Resources and Environment in December 2008. A copy has been made available to the DOE.

Environment:

There are no significant negative environmental impacts resulting from the proposed project activity.

Beyond the principal benefit of mitigating GHG emissions (the primary focus of the proposed project); the proposed activity will also result in positive environmental co-benefits. The technology described in Section A.4.2 results in several improvements to the existing wastewater treatment system. In summary, the wastewater is treated in closed system from which leakage to the groundwater is zero. There are no significant impacts to water resources during operation as wastewater effluent and influent will be strictly controlled to meet Vietnamese discharge requirements.

[58] http://www.dpi.hochiminhcity.gov.vn/invest/html/Law-on-Environment.html

[59] http://www.dpi.hochiminhcity.gov.vn/invest/html/ND80-2006-NDCP.html

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

No action required as there are no significant negative environmental impacts.

SECTION E. Stakeholders' comments

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

AES Climate Solutions invited stakeholders to meetings to explain both the UNFCCC CDM process and the proposed project activity. Invitation letters were sent to stakeholders at the provincial, district, and local levels. A full list of attendees and the meeting minutes are available on request.

These meetings were held on the following dates and locations:

- 27 May 2008 with members of the Department of Natural Resources and Environment of Lao Cai Province.
- 10 June 2008 and the Department of Planning and Investment of Lao Cai Province. Also present were representatives of Department of Agriculture and Rural Development of Lao Cai Province and Department of Industry and Trade of Lao Cai Province.

AES Climate Solutions representatives gave a presentation addressing the following topics:

- the purpose of the meeting
- an overview of global warming and the Kyoto Protocol
- UNFCCC CDM processes
- project participants, processes and responsibilities
- equipment used for evaluation and audits
- the information management system
- a project example
- benefits of the project (environmental and economic)
- where to obtain further information
- the company's business role in Vietnam for reducing carbon emissions

E.2. Summary of the comments received:

After the presentations, attendees were afforded the opportunity to ask questions regarding the proposed project activities.

Overall, the comments from the attendees at the stakeholders' meeting were positive and supportive of the project. Le Quoc Viet, Official of the Department of Industry and Trade of Lao Cai, stated that the project should be implemented province-wide including other plants. Nguyen Huu Duc, Deputy Director of the Department of Natural Resources and Environment of Lao Cai Province, stated that he totally agrees with the implementation of the project.

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

No action required.

Annex 1

CONTACT INFORMATION ON PARTICIPANTS IN THE PROJECT ACTIVITY

Project Participant	
Organization:	Cong ty TNHH mot thanh vien che bien nong san thuc pham Hieu Hung (Hieu Hung Agricultural Product Processing Company Limited)
Street/P.O.Box:	Tan Son village, Tan An Commune
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City:	Van Ban District
State/Region:	Lao Cai Province
Postfix/ZIP:	
Country:	Vietnam
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E-Mail:	
URL:	
Represented by:	Lao Cai Export Cassava Starch Processing Factory
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Salutation:	Mr.
Last Name:	Hung
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Project Participant	
Organization:	AES Carbon Exchange Ltd.
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Represented by:	
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Annex 2

INFORMATION REGARDING PUBLIC FUNDING

No public funding is being provided for this project.

Annex 3

BASELINE INFORMATION

Stage I Data available at validation (not presented in Section B.6.2)

Description	Variable	Value	Unit	Source
Annual starch production		2009-2010: 26,847 2010-2011: 31,891 2011-2012: 37,882 2012-2016: 45,000	Tonnes	Average based on 2006 and 2007 facility records and projected production increase.
Effluent conversion factor		20	m^3 / tonnes	*Integrated Treatment of Tapioca Processing Industrial Wastewater Based on Environmental Bio-Technology*[60]
Volume of wastewater treated in the year "y"	$Q_{y,ww}$	2009-2010: 536,931 2010-2011: 637,813 2011-2012: 757,649 2012-2016: 900,000	m^3	Average calculated based on facility records - Determined by multiplying the starch production by the effluent conversion factor
Inflow Chemical oxygen demand	$COD_{y,ww,untreated}$	0.019724	Tonnes /m^3*	Average of the samplings conducted and analyzed by an independent laboratory. Defined as wastewater entering the anaerobic lagoon system.
Chemical oxygen demand of the final treated wastewater discharged into sea, river or lake in the year "y"	$COD_{y,ww,treated}$	0.002562	tonnes/ m^3 *	Average of the samplings conducted and analyzed by an independent laboratory
Chemical oxygen demand removed by the treatment system "j" of the project activity equipped with methane recovery in the year "y"	$COD_{y,removed,j}$	0.018737	tonnes/ m^3 *	Average of the samplings conducted and analyzed by an independent laboratory. Inflow COD is the wastewater entering the anaerobic lagoons and outflow COD is the wastewater leaving the digester.
Chemical oxygen demand removed by the anaerobic wastewater treatment system "i" in the baseline situation in the year "y" to which the sequential anaerobic treatment step is being introduced	$COD_{y,removed,i}$	0.017162	tonnes/ m^3 *	Average of the samplings conducted and analyzed by an independent laboratory. Inflow COD is the wastewater entering the anaerobic wastewater treatment system and outflow COD is the "final treated wastewater discharged into sea, river, or lake".
Annual Total electricity consumption for the project activity	$kWh_{project}$	312,881	kWh / year	*For ex-ante PDD estimation only* : Kilowatt hours (kWh) consumed by project activity equipment plus 10% for distribution loss. To remain conservative, equipment is assumed to be in operation 24 hours per day, 365 days per year. See equipment listed below.** *Monitored ex-post.*
Country Emission Factor for Grid Connected Electricity	EF_{grid}	0.5801	tonnes CO_2e /	CDM Baseline Construction for Vietnam National Electricity Grid[61]. Please refer to

[60] http://library.wur.nl/wda/dissertations/dis4019.pdf (p.24)

[61] http://opus.zbw-kiel.de/volltexte/2004/2304/pdf/295.pdf

			MWh	"Country Specific Grid Emission Factor Determination" below.
Emissions from electricity or diesel consumption in the year "y"	$PE_{y, power}$	182	tCO_2e	See explanation in Section B.6.1 Equation 4
End use of final sludge	$S_{f, enduse}$	Sludge is land applied		Facility records. *If sludge is land applied,* $PE_{y,s,final} = 0$ *&* $MEP_{y,s,treatment} = 0$

*COD values were measured and recorded in mg/l. The values were converted to tonnes/m^3 as follows:

$$\text{mg/L} / 1{,}000{,}000 = \text{tonnes/m}^3$$

Note on $MCF_{ww,final}$: Following treatment in the anaerobic tank digester system, the resulting COD (calculated BOD) load of the digester effluent to the pond system is 0.032 kg/m3/day. This is much less than the 0.1 standard value listed in the World Bank report.[62] The $MCF_{ww,final}$ of 0.1 is applied in order to remain conservative even though the actual value is less due to the significantly reduced COD load.

**Project activity equipment list (*for ex-ante PDD estimation only)*:

	Submerged Mixer	B 105 Mixer	Influent Pump	Methane Reactor Feed	Caustic soda metering pump	Screen extractor
kW,i (kW)	7.5	1.5	11	11	0.37	1.1
Hours,i (hrs)	24	24	24	24	24	24
Days,i (days)	365	365	365	365	365	365
	1	1	1	1	1	1
kWh,y (kWh / year)	65,700.0	13,140.0	96,360.0	96,360.0	3,241.2	9,636.0

Total electricity consumed by project equipment (kWh)	284,437
Additional 10% for distribution loss	28,444
Total electricity for project emissions (kWh)	**312,881**

Stage II Data available at validation (not presented in Section B.6.2)

Description	Variable	Value	Unit	Source
Net quantity of steam/heat supplied by the project activity during the year y	HG_y	2009-2010: 48.58 2010-2011: 57.71 2011-2012: 68.55 2012-2016: 81.43	TJ/year	Determined from the amount of biogas being combusted by the renewable energy device and the energy content of the biogas
Annual fuel consumption		2009-2010: 1,723 2010-2011: 2,046 2011-2012: 2,431 2012-2016: 2,888	Tonnes / year	Facility records and expected production increase.
Net calorific value for fuel (coal)	NCV_{fuel}	28.2	TJ/Gg	2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 2, Table 1.2[63]

[62] http://www-wds.worldbank.org/external/default/WDSContentServer/WDSP/IB/2002/08/27/000178830_98101904165457/Rendered/PDF/multi0page.pdf

[63] http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/2_Volume2/V2_1_Ch1_Introduction.pdf

Net calorific value of methane	$NCV_{methane}$	50.4	TJ/Gg	2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 2, Table 1.2[64]
Emission factor per unit of energy of the fuel that would have been used in the baseline plant (coal)	EF_{coal}	94.6	t CO_2e / TJ	2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 2, Table 2.2[65]

Country Specific Grid Emission Factor Determination

In accordance with AMS III-H, v.9, paragraph 13, project emissions must be determined in accordance with the procedures described in AMS I-D. Paragraph 9 (a) of AMS I-D, v.13[66] states:

> *"For all other systems, the baseline is the kWh produced by the renewable generating unit multiplied by an emission coefficient (measured in kg CO2e/kWh) calculated in a transparent and conservative manner as:*
> *(a) A combined margin (CM), consisting of the combination of operating margin (OM) and build margin (BM) according to the procedures prescribed in the 'Tool to calculate the emission factor for an electricity system'."*

The "*Tool to calculate the emission factor for an electricity system", v.1.1*[67] is applied through a six step process:

STEP 1. Identify the relevant electric power system.
STEP 2. Select an operating margin (OM) method.
STEP 3. Calculate the operating margin emission factor according to the selected method.
STEP 4. Identify the cohort of power units to be included in the build margin (BM).
STEP 5. Calculate the build margin emission factor.
STEP 6. Calculate the combined margin (CM) emissions factor.

Step 1: Identify the relevant electric power system:

The Vietnamese national electricity grid is the relevant electric power system. Details are presented in the publication titled "CDM Baseline Construction for Vietnam National Electricity Grid"[68]. All data is from the following sources:

- Electricity of Vietnam (2002): V-Master plan of Electricity Expansion (2001 – 2010)
- Ministry of Natural Resources and Environment, Vietnam (2003): Vietnam National Strategy Study on Clean Development Mechanism,
- Program of National Project Energy Development – 2001 – 2005

Step 2: Select an operating margin (OM) method

According to the "*Tool to calculate the emission factor for an electricity system, Version 01.1*"[69], there are four different approaches that can be used in order to calculate the OM emission factor.

[64] http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/2_Volume2/V2_1_Ch1_Introduction.pdf
[65] http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/2_Volume2/V2_1_Ch1_Introduction.pdf
[66] http://cdm.unfccc.int/UserManagement/FileStorage/CDMWF_AM_PHPV5WESACMBTJ2YY54GAJYSIEI3HD
[67] http://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-07-v1.1.pdf
[68] http://opus.zbw-kiel.de/volltexte/2004/2304/pdf/295.pdf
[69] http://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-07-v1.1.pdf

(a) Simple OM, or
(b) Simple adjusted OM, or
(c) Dispatch data analysis OM, or
(d) Average OM.

The simple OM emission factor is calculated as the generation-weighted average CO_2 emissions per unit net electricity generation (tCO2/MWh) of all generating power plants serving the system, not including low-cost / must-run power plants / units. The most recent 5 years data on electricity generation by fuel type is shown as follows[70]:

	Hydro		Coal		Gas		Other		Total
Year	GWh	%	GWh	%	GWh	%	GWh	%	GWh
2004	17,883	38.53%	6,435	13.86%	21,440	46.19%	655	1.41%	46,413
2005	18,451	34.53%	8,408	15.73%	25,291	47.33%	1,289	2.41%	53,439
2006	19,502	32.50%	8,813	14.70%	29,180	48.70%	2,439	4.10%	59,934
2007	21,602	32.10%	11,692	17.40%	30,438	45.20%	3,583	5.30%	67,315
2008	24,139	32.10%	14,958	19.90%	35,894	47.70%	280	0.40%	75,271

According to the data available, the simple OM method is used for OM emission factor calculation for this project activity. It is calculated "*Based on data on the total net electricity generation of all power plants serving the system and the fuel types and total fuel consumption of the project electricity system (Option C)*" [71] as "*Option C should only be used if the necessary data for option A and option B is not available and can only be used if only nuclear and renewable power generation are considered as low-cost / must-run power sources and if the quantity of electricity supplied to the grid by these sources is known.*". The data that is available is from Vietnam's official sources (listed in Step 1).

For the simple OM, the simple adjusted OM and the average OM, the emissions factor can be calculated using either of the two following data vintages:

- *Ex ante option: A 3-year generation-weighted average, based on the most recent data available at the time of submission of the CDM-PDD to the DOE for validation, without requirement to monitor and recalculate the emissions factor during the crediting period, or*

- *Ex post option: The year in which the project activity displaces grid electricity, requiring the emissions factor to be updated annually during monitoring. If the data required to calculate the emission factor for year y is usually only available later than six months after the end of year y, alternatively the emission factor of the previous year (y-1) may be used. If the data is usually only available 18 months after the end of year y, the emission factor of the year proceeding the previous year (y-2) may be used. The same data vintage (y, y-1 or y-2) should be used throughout all crediting periods.*

For this PDD, the *ex ante* option has been chosen.

Step 3: Calculate the operating margin emission factor according to the selected method

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[70] http://opus.zbw-kiel.de/volltexte/2004/2304/pdf/295.pdf , p.15

[71] http://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-07-v1.1.pdf , p.5

Where Option C is used, the simple OM emission factor is calculated based on the net electricity supplied to the grid by all power plants serving the system, not including low-cost / must-run power plants / units, and based on the fuel type(s) and total fuel consumption of the project electricity system, as follows[72]:

$$EF_{grid,OMsimple,y} = \frac{\sum_i FC_{i,y} \times NCV_{i,y} \times EF_{CO2,i,y}}{EG_y} \quad (5)$$

Where:

$EF_{grid,OMsimple,y}$	Simple operating margin CO_2 emission factor in year y (tCO_2/MWh)
$FC_{i,y}$	Amount of fossil fuel type *i* consumed in the project electricity system in year *y* (mass or volume unit)
$NCV_{i,y}$	Net calorific value (energy content) of fossil fuel type *i* in year *y* (GJ / mass or volume unit)
$EF_{CO2,i,y}$	CO_2 emission factor of fossil fuel type *i* in year *y* (tCO_2/GJ)
EG_y	Net electricity generated and delivered to the grid by all power sources serving the system, not including low-cost / must-run power plants / units, in year *y* (MWh)
i	All fossil fuel types combusted in power sources in the project electricity system in year *y*
y	Either the three most recent years for which data is available at the time of submission of the CDM PDD to the DOE for validation (ex ante option) or the applicable year during monitoring (ex post option), following the guidance on data vintage in step 2

The OM emission factor was obtained for three years for which the most recent data were available. As illustrated in the following table, the “approximate operating margin” in the publication titled “CDM Baseline Construction for Vietnam National Electricity Grid”[73] “*is the weighted average emissions (in kg CO2eq./kWh) of all generating sources serving the system, excluding hydro, geothermal, wind, low-cost biomass, nuclear and solar generation;*”

Fuel type	Notes	Unit	2006	2007	2008
Coal (Anthracite)		GWh	8813	11692	14958
	5700 kcal/kg (Vietnam value)	kt	4129	5493	6946
	26.8 TC/TJ (2006 IPCC default carbon content Chapter 1, Table 1.4)	kt CO2	9498	12636	15978
Natural Gas		GWh	29180	30438	35894
	8500 kcal/m3 (Vietnam value)	Million m3	6418	6667	7934
	15.3 TC/TJ (2006 IPCC default carbon content Chapter 1, Table 1.4)	kt CO2	12697	13189	15696
Diesel Oil		GWh	155	152	153
	10200 kcal/kg (Vietnam value)	kt	45	45	45
	20.2 TC/TJ (2006 IPCC default carbon content Chapter 1, Table 1.4)	kt CO2	141	141	141
Fuel Oil		GWh	2284	3431	127
	9900 kcal/kg (Vietnam value)	kt	524	782	36
	21.1 TC/TJ (2006 IPCC default carbon content Chapter 1, Table 1.4)	kt CO2	1665	2485	114
Total CO2 emission from Vietnam Grid, kt CO2			**24001**	**28451**	**31929**
Total thermal output generated, GWh			**40432**	**45713**	**51132**
OM: Weighted Thermal Average, gCO2/kWh			594	622	624

[72] http://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-07-v1.1.pdf , p.6

[73] http://opus.zbw-kiel.de/volltexte/2004/2304/pdf/295.pdf

As in equation 2, the OM is the result of the sum of the CO2 emissions per year for each applicable fuel type divided by the total electricity generated and is shown in the following table[74]:

Year	$\Sigma FC_{i,y} * NCV_{i,y} * EF_{CO2,i,y}$ (tCO2)	EG_y (MWh)	*EF per year* (tCO2/MWh)	$EF_{grid,OMsimple,y}$ **(tCO2/MWh)**
2006	24,001,000	40,432,000	0.5936	**0.6135**
2007	28,451,000	45,713,000	0.6224	
2008	31,929,000	51,132,000	0.6244	

Step 4: Identify the cohort of power units to be included in the build margin (BM)

According to the "*Tool to calculate the emission factor for an electrical system, Version 01.1*[75]", a sample group of power units *m* used to calculate the build margin consists of either:

(a) The set of five power units that have been built most recently, or
(b) The set of power capacity additions in the electricity system that comprise 20% of the system generation (in MWh) and that have been built most recently.

The option should be chosen that comprises the larger annual generation. Power plants registered as CDM project activities should be excluded from the sample group m as long as the power plants in the sample group are not older than 10 years. Option (b) is applicable in this case.

In terms of vintage of data, project participants can choose between one of the following two options[76]:

- *Option 1. For the first crediting period, calculate the build margin emission factor ex-ante based on the most recent information available on units already built for sample group m at the time of CDM-PDD submission to the DOE for validation. For the second crediting period, the build margin emission factor should be updated based on the most recent information available on units already built at the time of submission of the request for renewal of the crediting period to the DOE. For the third crediting period, the build margin emission factor calculated for the second crediting period should be used. This option does not require monitoring the emission factor during the crediting period..*

- *Option 2. For the first crediting period, the build margin emission factor shall be updated annually, ex-post, including those units built up to the year of registration of the project activity or, if information up to the year of registration is not yet available, including those units built up to the latest year for which information is available. For the second crediting period, the build margin emissions factor shall be calculated ex-ante, as described in option 1 above. For the third crediting period, the build margin emission factor calculated for the second crediting period should be used.*

For this project, the BM emission factor is calculated ex-ante based on Option 1.

Step 5: Calculate the build margin emission factor

[74] http://opus.zbw-kiel.de/volltexte/2004/2304/pdf/295.pdf , p.15

[75] http://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-07-v1.1.pdf

[76] http://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-07-v1.1.pdf , p.13

The build margin emission factor is the generated-weighted average emission factor (tCO_2/MWh) of power units in sample group *m* during the most recent year *y* for which power generation data is available, calculated as follows[77]

$$EF_{grid,BM,y} = \frac{\sum_m EG_{m,y} . EF_{EL,m,y}}{\sum_m EG_{m,y}} \quad (12)$$

Where:

$EF_{grid,BM,y}$	Build margin CO_2 emission factor in year y (tCO_2/MWh)
$EG_{m,y}$	Net quantity of electricity generated and delivered to the grid by power unit m in year y (MWh)
$EF_{EL,m,y}$	CO_2 emission factor of power unit m in year y (tCO_2/MWh)
m	Power units included in the build margin
y	Most recent historical year for which power generation data is available.

The summary of the BM emission factor calculation is shown in the following table[78]:

y (year)	Last 20% plants		Build Margin (BM)		
	m Plant	MW	Sum of $EG_{m,y}$ (GWh)	Sum of $EG_{m,y}$ * $EF_{EL,m,y}$ (kt CO2)	$EF_{grid,BM,y}$ (tCO2/kWh)
2008	Ban La, hydropower	300	328	0	**0.5467713**
	PleiKrong, hydropower	110	175	0	
	Cua Dat, hydropower	97	165	0	
	Srepok 3, hydropower	90	198	0	
	Dai Ninh, hydropower	300	1,143	0	
	Nhon Trach, gas	600	3,512	1,389	
	Expansion Ninh Binh, coal	300	334	342	
	Quang Ninh, coal	600	1,878	1,922	
	Hai Phong, coal	600	3,512	3,595	
	A Vuong, hydropower	170	715	0	
	Tuyen Quang, hydropower	342	1,296	0	
	TOTAL	**3,509**	**13,256**	**7,248**	

Step 6: Calculating the combined margin (CM) emission factor

The combined margin emissions factor is calculated as follows[79]:

$$EF_{grid,CM,y} = w_{OM} . EF_{grid,OM,y} + w_{BM} . EF_{grid,BM,y} \quad (13)$$

Where:

$EF_{grid,BM,y}$	Build margin CO_2 emission factor in year *y* (tCO_2/MWh)
$EF_{grid,OM,y}$	Operating margin CO_2 emission factor in year *y* (tCO_2/MWh)
w_{OM}	Weighting of operating margin emissions factor (%)

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[77] http://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-07-v1.1.pdf , p.14

[78] http://opus.zbw-kiel.de/volltexte/2004/2304/pdf/295.pdf , p.18

[79] http://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-07-v1.1.pdf , p.14

w_{BM} Weighting of build margin emissions factor (%)

The following default values are used for w_{OM} and w_{BM}[80]

- w_{OM} = 0.5 and w_{BM} = 0.5 for the first crediting period
- w_{OM} = 0.25 and w_{BM} = 0.75 for the second and third crediting period.

Summary of OM, BM and CM emission factors[81]

$EF_{grid,OM,y}$ (tCO_2/MWh)	$EF_{grid,BM,y}$ (tCO_2/MWh)	$EF_{grid,CM,y}$ (tCO_2/MWh)
0.6135	0.5468	**0.5801**

[80] http://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-07-v1.1.pdf , p.14

[81] http://opus.zbw-kiel.de/volltexte/2004/2304/pdf/295.pdf

Annex 4

MONITORING INFORMATION

Stage I (Methane Recovery):

Monitoring activities will be conducted as specified by AMS III.H, Version 9: Methane recovery in wastewater treatment.[82] Please refer to Section B.7.2.

Stage II (Biogas Utilization):

Monitoring activities will be conducted as specified by AMS I.C, Version 13: Thermal energy for the user with or without electricity.[83] Please refer to Section B.7.2.

[82] UNFCCC methodology AMS-III.H (Methane recovery in wastewater treatment), V.9, http://cdm.unfccc.int/UserManagement/FileStorage/CDMWF_AM_743QMM1YKHH15AK2AZAVAIJHRGD5R7

[83] http://cdm.unfccc.int/UserManagement/FileStorage/CDMWF_AM_YL0327DQSKVFXYQREWRT3VNR58402G