Project design document form for CDM project activities

(Version 06.0)

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

PROJECT DESIGN DOCUMENT (PDD)	
Title of the project activity	TBEC LIG Biogas Project
Version number of the PDD	05.1
Completion date of the PDD	13/08/2015
Project participant(s)	TBEC (Lao) Sole Co., Ltd. Carbon Bridge Pte Ltd Swedish Energy Agency (*added, effective from 13/09/2013*)
Host Party	Lao People's Democratic Republic
Sectoral scope and selected methodology(ies), and where applicable, selected standardized baseline(s)	*Sectoral Scope* 13: Waste handling and disposal *Methodology* ACM0014: Mitigation of greenhouse gas emissions from treatment of industrial wastewater
Estimated amount of annual average GHG emission reductions	37,120 tCO_2e

SECTION A. Description of project activity

A.1. Purpose and general description of project activity

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The TBEC LIG Biogas Project involves the construction of an anaerobic wastewater treatment facility at the Lao-Indochina Group Company's (LIG) tapioca starch factory in Vientiane, Lao PDR. The factory processes cassava to produce starch powder. The existing practice for wastewater treatment at the factory involves the use of 12 open lagoons which release methane-rich biogas directly to the atmosphere. The project will install a covered lagoon bio-reactor (CLBR), designed to capture the gases produced from the digestion of organic matter in the wastewater stream of the starch factory. The captured biogas will be combusted to produce heat for use in the starch production process and any excess biogas will be combusted in a flare. The treated wastewater discharged from the CLBR will flow to the existing open lagoons.

The purpose of the project is to:

- Capture biogas for use as fuel in the LIG factory thereby displacing the existing coal fuel supply
- Reduce odour from the existing open lagoons through installation of a CLBR biogas system
- Reduce greenhouse gas emissions and create Certified Emission Reductions (CERs)

The baseline scenario is the scenario existing prior to the start of implementation of the project activity:

- The continued treatment of the wastewater in deep anaerobic lagoons, which currently emit CH_4 to the atmosphere
- The continue usage of fossil fuel for the starch-dryer, which currently emits CO_2 to the atmosphere

The above baseline scenario has been identified in accordance with the consolidated methodology ACM0014 for mitigation of greenhouse gas emissions from treatment of industrial wastewater. In the project scenario, methane biogas will be captured in the CLBR and used to fuel a starch dryer in the LIG factory, thus reducing emissions of this potent greenhouse gas. The biogas fuel will replace coal, a non-renewable fossil fuel. The Project Activity will claim emission reductions from both the avoidance of methane emissions from anaerobic lagoons and displacement of fossil fuel for the starch-dryer.

<u>Contribution to Sustainable Development</u>

1. Environment and Natural Resources
    - The project will improve the local and global environment, by improving wastewater treatment in the LIG starch factory result in reducing odour and greenhouse gas emissions, therefore reduce air pollution. The project will introduce a sequential stage of water treatment. The water discharged from the CLBR will then be treated in the existing open lagoons system. The project will not have a significant effect on soil, biodiversity, mineral, forest and water resources, in the project area.

2. Social
    - The project will create more than 10 employment opportunities associated with operation of the plant. During the project construction there will be up to 30 additional jobs created. A thorough local stakeholder consultation has been undertaken and all relevant stakeholders were invited including local villagers, government representatives, women and the elderly. Presentations were given to the stakeholders to enable them to understand the project and provide feedback on the environmental and social impacts (see Section E). All stakeholders were provided with an opportunity to ask questions and raise their concerns. The project will share benefits with the local stakeholders by identifying and funding a community project. The project will comply with Lao's labour laws and ensure workers are provided with reasonable working conditions.

3. Economic
   - The jobs created by the project will improve local human capacity and diversity of employment opportunities by training project managers, lab technicians and operators. The project will produce biogas which will be used as fuel in the starch factory, reducing the dependence on fossil fuels. The project will source material and supply within Lao if available which will stimulate the local Lao economy.

4. Technology
   - TBEC has signed a long term Build, Own, Operate and Transfer (BOOT) contract with the Lao-Indochina Group Company's (LIG) Starch factory to build a biogas plant. TBEC, a company of Thailand, will manage the construction and operation of the biogas plant and have extensive experience in the design, operation and maintenance of biogas systems. TBEC have hired Waste Solutions Ltd., a New Zealand firm, to provide technical consultancy on the design of the system. Therefore, the project will result in technology transfer from overseas. This is an important feature since the use of CLBR biogas systems to treat wastewater from tapioca factory is new to Lao PDR. It will be the first time that a biogas system of this scale will be commercially operated in Laos. The local staff will be trained to ensure they have adequate skills to meet the requirements of the job.

A.2. Location of project activity

A.2.1. Host Party

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Lao PDR

A.2.2. Region/State/Province etc.

>>
Vientiane Capital

A.2.3. City/Town/Community etc.

>>
Pak Ngum District

A.2.4. Physical/Geographical location

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TBEC LIG Biogas project locate at km 47 of the 13 South Road, Ban Naxone, Pak Ngum District, Vientiane Capital, Lao PDR. The precise co-ordinates of LIG are at 18.0780ºN and 102.9702ºE

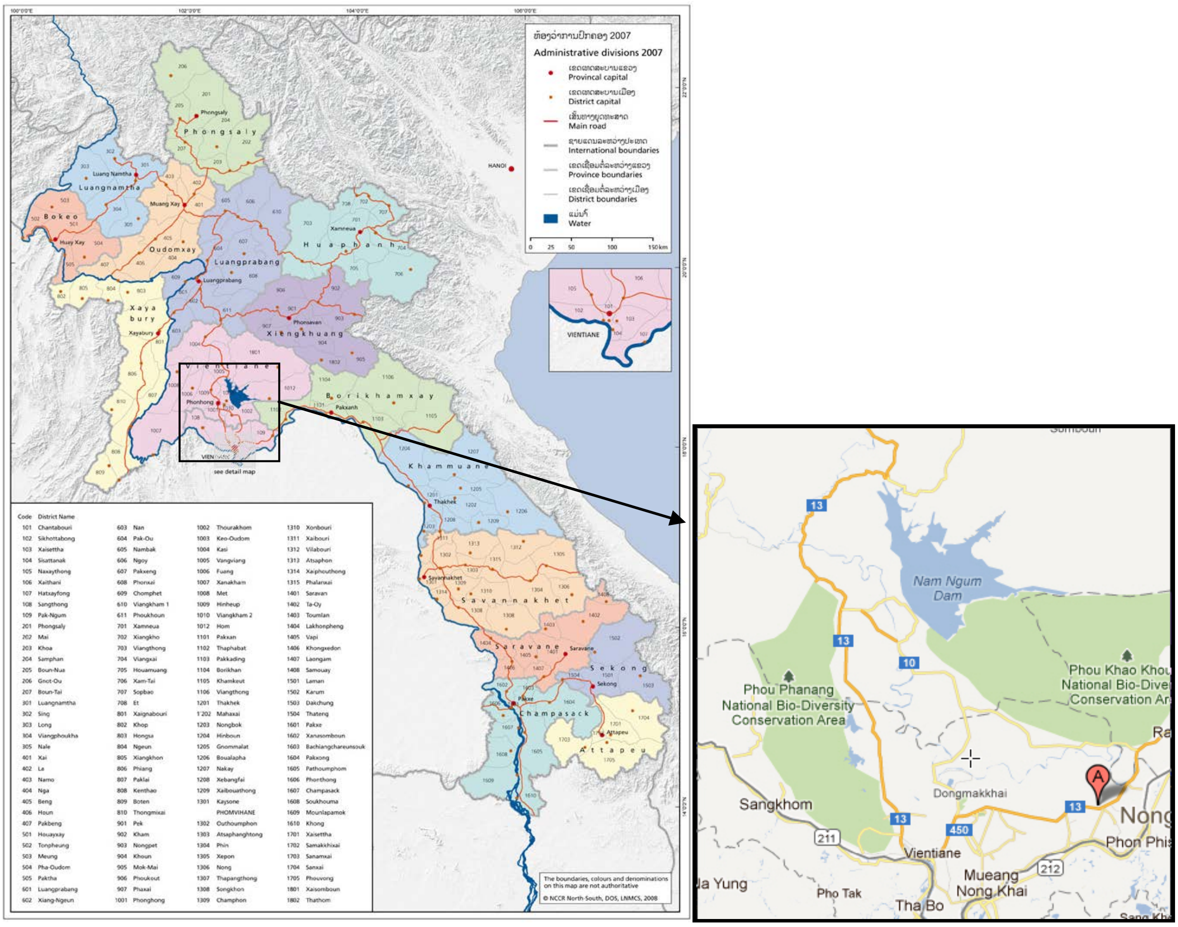

Figure A.2.4.1.a: Location of the LIG starch factory

A.3. Technologies and/or measures

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The Project Activity will employ CLBR technology, which comprises a uniquely designed lagoon process with a wastewater receiving system, mixers, baffles, a reactor with thick HDPE cover, wastewater recirculation systems, biogas collection/distribution equipment and biogas processing/cleaning equipment. The CLBR will contain the organic rich effluent water in an anaerobic lagoon to optimise the contact with anaerobic bacteria to convert the organic matter into biogas. The CLBR system processes the biogas which involves a scrubber to remove hydrogen sulphide before pipes transport biogas to tapioca starch factory. In case of any excess build up of biogas the surplus gas will be flared.

The technology and the project process is summarised as follows:

- Effluent collection and reticulation – the waste water from the factory will be pumped into a mixing tank.
- Feed distribution – from the mixing tank the wastewater will be pumped into the CLBR.
- CLBR process – the CLBR is a lagoon with a series of inlet pipes, baffles, gas extraction pipes and a thick cover of HDPE sheeting. In the CLBR the wastewater follows a series of processes and baffle walls that maximize mixing and contact with the anaerobic bacteria to promote the release of biogas.
- Sediment Retention and Effluent Discharge – the CLBR system includes integrated sediment processing. Prior to discharge of effluent wastewater sediment is settled and retained in the CLBR. The treated waste leaving the treatment system boundary is then pumped to existing water treatment lagoons.

- Sludge, which consists of active bacteria, perished bacteria, and cell debris from the waste water will be collected in the bottom of the CLBR, and will be re-circulated back to the CLBR inlet as slurry. It is not anticipated that the CLBR will need to be de-sludged during the life of the project.
- Gas extraction and pumping – the gas will be extracted in a large diameter pipe where it will be stripped of condensation, dust, H_2S and compressed to be sent to the starch factory.
- The biogas will be combusted in dual fuel burners capable of combusting biogas and heavy fuel oil. The primary fuel in the burner will be the biogas, however where there is insufficient biogas, heavy fuel oil will be combusted. Initially one dual fuel burner will be installed, and an additional burner will be installed if the throughput of the factory increases.
- Any excess biogas that is not combusted in the burner will be combusted in a closed flare.

The Technical Specifications for the dual fuel burner is as follows:

Dual Fuel Burner Specifications	
Manufacturer	Weishaupt
Model Number	RGMS70/2-A
Capacity	9450kW

Table A.3.1: Burner Specifications

The CLBR biogas technology has been developed by Waste Solutions Ltd (WSL) who has over 15 years of experience with anaerobic digestion projects. The technology has been applied at other CDM biogas projects where the technology has been demonstrated to be safe. This includes the TBEC CDM projects at Tha Chang, Kitroongrang, Jirapattana and Chou Khun Agro sites. The CLBR's HDPE cover may be easily drawn down to the liquid surface and covered by water in the event of serious adverse weather. Thus the cover is not at risk to wind conditions and a procedure is in place to manage unusual storm events such as flooding.

A.4. Parties and project participants

Party involved (host) indicates host Party	Private and/or public entity(ies) project participants (as applicable)	Indicate if the Party involved wishes to be considered as project participant (Yes/No)
Lao People's Democratic Republic (host)	TBEC (Lao) Sole Co., Ltd Carbon Bridge Pte Ltd	No
Sweden	Swedish Energy Agency	No

The Swedish Energy Agency has been added as project participant since 13/09/2013. Please see Annex 1 for detailed contact information.

A.5. Public funding of project activity

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No public funding from Annex 1 Parties will be used for the project activity.

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

B.1. Reference of methodology and standardized baseline

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The following approved baseline and monitoring methodologies have been applied to the project:

- ACM0014 "Mitigation of greenhouse gas emissions from treatment of industrial wastewater" (Version 04.1.0, EB58)

- "Tool to determine project emissions from flaring gases containing methane" (Version 01, EB28 Report, Annex 13)

- "Tool to calculate baseline, project and/or leakage emissions from electricity consumption" Version 1, EB39, Annex 7

- "Tool to calculate the emission factor for an electricity system" - Version 2.2.1, EB63, Annex 19

- "Tool to determine the baseline efficiency of thermal or electric energy generation systems" – Version 1, EB48, Annex 12

Identification of the baseline scenario and assessment of additionality has been performed using:

- "Tool for the demonstration and assessment of additionality" (Version 06.1, EB 69 Report, Annex 20)

Also referring to:

- Guidelines on the Assessment of Investment Analysis Version 05 EB 62 Report, Annex 5

Further details of these approved baseline and monitoring methodologies can be found at the UNFCCC CDM website at http://cdm.unfccc.int/methodologies/PAmethodologies/approved.html

B.2. Applicability of methodology and standardized baseline

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ACM0014 is applicable to project activities that aim at reducing methane emissions from industrial wastewater treatment. Of the two scenarios described in Table 1 of ACM0014, the project activity is applicable to scenario 1.

Scenario	Description of the Baseline Situation	Description of the Project Activity
1	The wastewater is not treated, but directed to open lagoons that have clearly anaerobic conditions. In cases where solid materials are separated before directing the wastewater to the open lagoons, the solid materials have a different treatment than the wastewater. *The wastewater from the LIG factory is directed to open lagoons that have clearly anaerobic conditions. Rootcake, a solid material, is separated in an open pond, where the wastewater is*	The wastewater is treated in a new anaerobic digester. In cases where solid materials are separated from the wastewater (both in the project and baseline scenarios), they will be treated separately and not treated with the new anaerobic digester employed for treatment of liquid effluents. The biogas extracted from the anaerobic digester and, if applicable, biogas generated from the treatment of solid materials, is flared and used to generate electricity and/or heat. The residual from the anaerobic digester, after treatment, is directed to open lagoons . *The wastewater is treated in a new anaerobic digester. The solid waste rootcake separated*

	directed back to the open lagoons and the solid rootcake retained and used as fertiliser.	*in the baseline will not be treated in the new anaerobic digester in the Project Scenario. The biogas extracted from the anaerobic digester will be used to generate heat and any excess is flared. The residual from the anaerobic digester, after treatment, is directed to open lagoons.*

Table B.2.a: Scenario applicable to the methodology

<u>Description of the baseline situation:</u>

The baseline scenario is the same as the scenario existing prior to the start of the implementation of the project activity. The LIG factory currently discharges wastewater from the starch factory to open lagoons without any pre-treatment. These lagoons have a total surface area more than 100,000m^2 and total volume more than 800,000 m^3. This lagoon volume, with a hydraulic retention time of over 400days, is significantly larger than necessary for the current throughput and is designed to cater for increase in throughput at the factory over time. All the lagoons have a depth greater than 2m and are therefore clearly anaerobic. The lagoons depths range between 5 to 8 meters. The outlet of the final pond is directed to the river through the local water course. Details of all the lagoons at the LIG site are summarised in Annex 3.

The onsite coal fired boiler at the LIG starch factory produces the steam requirements for the starch drying process in the baseline scenario.

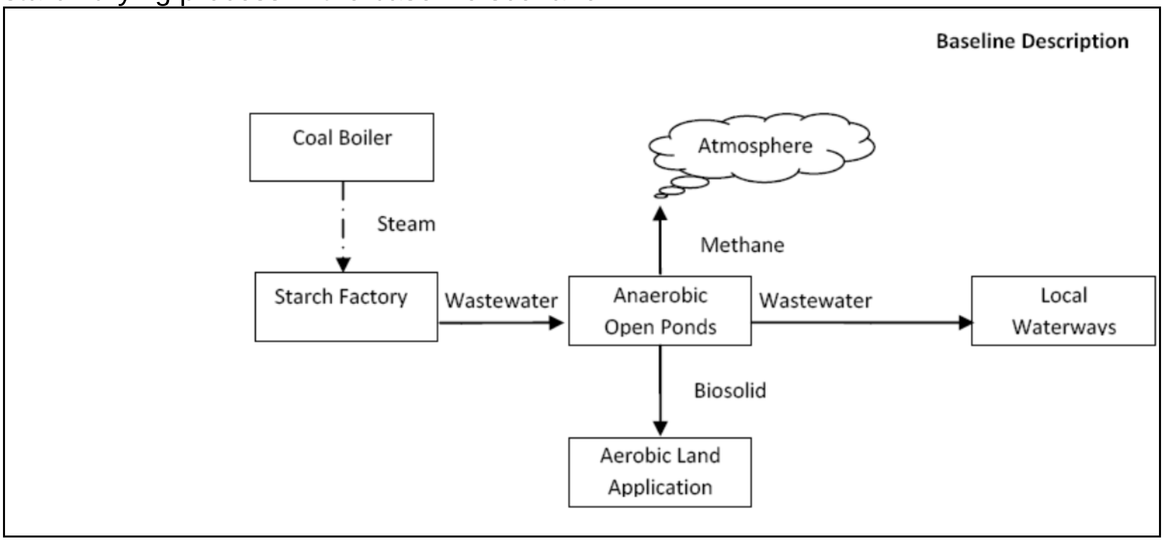

Figure B.2.b: Situation prior to start of the project activity

<u>Description of the project activity:</u>

The project activity involves the construction of a new anaerobic digester (CLBR) to treat the factory wastewater. Wastewater from the starch factory will be treated in the CLBR which will have a retention time greater than 30 days. Approximately 3,024,000 Nm^3/year of biogas will be captured in the digester each year and piped to a dual fuel biogas boiler to dry starch in the factory. Excess biogas will be combusted in a closed flare. The residual wastewater from the CLBR will be directed to the existing open lagoons.

A new dual fuel boiler, capable of combusting biogas and heavy fuel oil, will be installed to combusted the biogas and supply heat to the starch factory. Biogas will be the primary fuel source, however when there is insufficient biogas, heavy fuel oil will be combusted. The existing onsite coal boiler will remain on site as a backup in case any problems with the new dual fuel boiler.

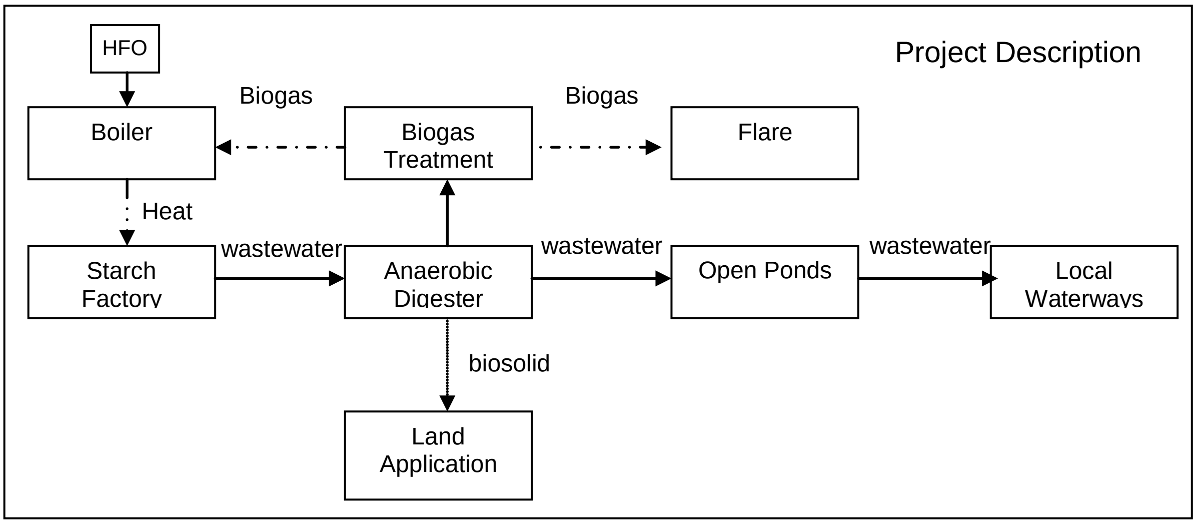

Figure B.2.c: Description of situation after implementation of the project

A description of the situation prior to and after the project activity is provided in figure A.4.a and A.4.b respectively.

The project also complies with all other relevant applicability criteria as follows:

- The average depth of the open lagoons or sludge pits in the baseline scenario is at least 1 m.
  The depth of individual lagoons varies between 8m and 5m, therefore the average depth of the open lagoons is more than 1m. The detail of lagoons size is in Annex 3.

- Heat and electricity requirements per unit input of the water treatment facility remain largely unchanged in the baseline scenario and the project activity;
  In the baseline situation wastewater is directed to open lagoons for treatment . The project activity biogas system will not alter the design of the existing open lagoons and therefore the heat and electricity requirements remain unchanged.

- Data requirements as laid out in this methodology are fulfilled.
  All necessary data requirements of the methodology are met as described in section B.6.2 and section B.7.

- The residence time of the organic matter in the open lagoon system should be at least 30 days;
  The residence time of the organic matter in the open lagoon system is greater than 30 days.

- Local regulations do not prevent discharge of wastewater in open lagoons.
  Discharge of wastewater in open lagoons is not prevented by Lao regulation and it is standard practice for the industry.

- Inclusion of solid materials in the project activity is only applicable where: (i) Such solid materials are generated by the industrial facility producing the wastewater, and (ii) The solid materials would be generated both in the project and in the baseline scenario.
  Solid materials are generated in the starch production and therefore would be generated both in the project and in the baseline scenario.

B.3. Project boundary

Source		GHGs	Included?	Justification/Explanation
Baseline scenario	Wastewater treatment process	CO_2	Excluded	CO_2 emissions from the decomposition of organic waste are not accounted for
		CH_4	Included	The major source of emissions in the baseline from open lagoons
		N_2O	Excluded	Excluded for simplification. This is conservative.
	Electricity consumption	CO_2	Excluded	Excluded for simplification. This is conservative.
		CH_4	Excluded	Excluded for simplification. This is conservative.
		N_2O	Excluded	Excluded for simplification. This is conservative.
	Electricity generation	CO_2	Excluded	The project does not displace electricity.
		CH_4	Excluded	Excluded for simplification. This is conservative.
		N_2O	Excluded	Excluded for simplification. This is conservative.
	Thermal energy generation	CO_2	Included	The project activity will displace the existing coal boiler.
		CH_4	Excluded	Excluded for simplification. This is conservative.
		N_2O	Excluded	Excluded for simplification. This is conservative.
Project scenario	Wastewater treatment process	CO_2	Excluded	CO_2 emissions from the decomposition of organic waste are not accounted for.
		CH_4	Included	The treatment of wastewater under the project activity includes the following emissions: (i) Methane emissions from the lagoons (ii) Physical leakage of methane from the digester system (iii) Methane emissions from flaring
		N_2O	Excluded	In the case of projects that involve the land application of sludge, but not applicable to this project.
	On-site electricity use	CO_2	Included	Emissions from electricity used for the operation of the biogas plant will be deducted as project emissions.
		CH_4	Excluded	Excluded for simplification. This emissions source is assumed to be very small.
		N_2O	Excluded	Excluded for simplification. This emissions source is assumed to be very small.
	On-site fossil fuel consumption	CO_2	Excluded	The project activity does not use fossil fuels.
		CH_4	Excluded	The project activity does not use fossil fuels
		N_2O	Excluded	The project activity does not use fossil fuels

B.4. Establishment and description of baseline scenario

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ACM0014v4.1 outlines the procedure for identification of the most plausible baseline scenario through the following four steps.

Step 1: Identification of alternative scenarios
Step 2: Eliminate alternatives that are not complying with applicable laws and regulations
Step 3: Eliminate alternatives that face prohibitive barriers
Step 4: Compare economic attractiveness of remaining alternative

Step 1: Identification of alternative scenarios
Plausible alternative scenarios for the treatment of wastewater may include the following:

W1. The use of open lagoons for the treatment of the wastewater;
W2. Direct release of wastewaters to a nearby water body;
W3. Aerobic wastewater treatment facilities (e.g., activated sludge or filter bed type treatment);
W4. Anaerobic digester with methane recovery and flaring;
W5. Anaerobic digester with methane recovery and utilization for electricity or heat generation.
W6: Wastewater is directed to land application without dewatering;
W7: Wastewater is dewatered and directed to land application/used as fuel in energy applications.

Scenario W3 and W7 involves the installation of aerobic treatment equipment (i.e. aerators) or dewatering processes for the treatment of wastewater at a site where open lagoons are already operational. Whilst these scenarios involves costs associated with equipment installation and ongoing electricity consumption costs, there are no revenues or cost savings to be gained from installing an aerobic treatment system. Therefore, these scenarios are not considered to be a plausible alternative.

Similarly, scenario W4 involves significant investment costs associated with the installation of methane recovery and flaring equipment. Whilst this scenario involves costs associated with equipment installation and ongoing electricity consumption costs, there are no revenues or cost savings to be gained. Therefore, this scenario is not considered to be a plausible alternative.

Therefore the list of plausible alternatives is as follows:

W1. The use of open lagoons for the treatment of the wastewater;
W2. Direct release of wastewaters to a nearby water body;
W5. Anaerobic digester with methane recovery and utilization for electricity or heat generation.
W6: Wastewater is directed to land application without dewatering;

The project activity includes heat generation with biogas from a new anaerobic digester, plausible alternative scenarios for the generation of heat is determined as the following:

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

Step 2: Eliminate alternatives that are not complying with applicable laws and regulations
Alternatives that are not in compliance with applicable legal and regulatory requirements must be eliminated.

Under Lao regulations, it is illegal to directly discharge wastewater into water bodies or elsewhere, as in The Law on Hygiene, Disease Prevention and Health Promotion, Article 19, which states that “It is forbidden to release waste, chemicals or waste water from factories, including other production sites, into water bodies or elsewhere without undergoing a treatment process”. Therefore alternative scenario W2, the direct release of wastewaters to a nearby water body, and

scenario W6, the directing wastewater to land (elsewhere) is not in compliance with the Lao regulations and therefore must be eliminated. There are no laws that forbid the use of fossil fuels in a boiler, renewable sources to produce heat energy or the use of fossil fuels in cogeneration power plants.

The use of open lagoons for the treatment of wastewater is in compliance with regulation, and it is not mandatory to use specific technologies such as biogas digesters. LIG Tapioca starch factory is in full compliance under these regulations and therefore faces no barrier for continuation of the existing practice which is alternative scenario W1. To date, there is no existing legislation that enforces anaerobic wastewater treatment with coupled biogas collection and utilization. Thus there is no legal barrier to alternative W5.

Therefore, alternative scenario W2 and W6 are scenarios that do not comply with applicable laws and regulations And W2 and W6 are eliminated and will not be considered further.

There are no laws or regulations that prohibit the use of fossil fuels in cogeneration system or in a boiler, or the use of renewable sources for heat generation.

Therefore the remaining alternatives after this step are W1, W5, H1, H2, H3.

Step 3: Eliminate alternatives that face prohibitive barriers

Scenarios that face prohibitive barriers should be eliminated by applying Step 3 of the “Tool for the demonstration and assessment of additionality”. This Tool also referencesthe “Guidelines for objective demonstration and assessment of barriers”, whereby Guideline 7 states that for projects in Least Developed Countries it is sufficient to transparently describe the relevant barriers. Technology Barriers of the Additionality Tool are applicable in this context. There is significant process risk associated with this type of project compared to the standard practice of open ponds and using fossil fuels for producing heat – fossil fuels are readily available in the commercial market and have been used at the factory since it started operating to provide the factories heat needs. In contrast, anaerobic digestion performance risks are significant because the process relies on a biological process that is not fully characterised - the biological process is at constant risk of changes in the chemical composition that can harm the anaerobic bacteria and biological activity and subsequently the waste management and energy production regimes. These harmful changes can be caused by a host of problems such as mismanagement of the CIGAR or mixing lagoon, improper recycling of the wastewater or the introduction of chemical agents, such as sulphur, into the system. As the system is a biological system the characteristics inside the anaerobic covered lagoon reactor, such as temperature and pH must be carefully controlled in order to achieve stability and sustain the methanogenic bacteria. When problems do arise they are often difficult to diagnose and it can take significant time to re-stabilise the biological system. In short, anaerobic reactors require constant, skilled, monitoring as they are susceptible to upsets, variation of flow and shock loading[1]. In order to avoid these problems and ensure comparable service compared to the use of coal for heat production, skilled and trained labour are necessary to operate and maintain the biological processes of the anaerobic digesters. As biogas plants are new to Laos, and as a Least Developed country with lower levels of industrial processes and therefore skilled labour, this presents a high risk of the anaerobic biological system to underperform and or malfunction. Therefore, scenarios W5 and H3 face prohibitive technology barriers and are eliminated.

[1] Deepak L. Joshi, High Rate Anaerobic Treatment of Industrial Wastewater in the Tropics, Thammasa Int. J. Sc. Tech.,Vol.3, No. I, January1998

At present there are no examples of the use of co-generation of heat using fossil fuels in a captive cogeneration power plant in Laos and therefore a new co-generation project would be the first of its kind in Laos. The existing practice for heat generation at the starch factory is the use of a coal fired boiler, therefore the installation of a co-generation plant is not considered realistic. Therefore, scenario H1 is eliminated.

In summary, all alternative scenarios are eliminated through the barrier analysis except W1, the use of open lagoons for the treatment of wastewater and H2, heat generation using fossil fuels.

Step 4: Compare economic attractiveness of remaining alternative
After elimination of alternatives that face prohibitive barriers, the only remaining alternatives are W1 and H2, and therefore Step 4 is not applicable.

As per ACM14v4.1, the methodology is applicable because it can be demonstrated that the baseline scenario corresponds to the scenario described in Table 1 and Scenario 1

B.5. Demonstration of additionality

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The project reduces anthropogenic emissions of GHG through the destruction of methane which is produced through the anaerobic decay of wastewater from the LIG starch factory. By combusting methane that would otherwise have been released to the atmosphere the project results in the reduction of emissions. The equipment used to capture and combust methane would not have been installed in the absence of the registered CDM project, as demonstrated below.

Demonstration of Prior consideration of CDM
In accordance with the guidance on the demonstration and assessment of prior consideration of CDM, project activities with a start date after 2 August 2008 must inform a Host Party DNA and the UNFCCC secretariat in writing of the commencement of the project activity and of the intention to seek CDM status. In accordance with this guidance, notification was sent to the UNFCCC in a letter dated 12/02/10. The prior consideration notification was also sent to the Lao DNA by email on the date of 12/02/10. This is well within 6 months after the start date of the project (29/09/10 as referenced in Section C).

ACM0014v4.1 requires that the additionality of the project be demonstrated and assessed using the latest version of the “Tool for the demonstration and assessment of additionality” v06.1. The tool defines a step-wise approach as follows:

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

Step 1. Identification of alternatives to the project activity consistent with current laws and regulations
According to the ‘Guidelines for Completing CDM PDDs Section B.4 and B.5 are complimentary and the same information need not be replicated in both sections. Therefore as Step 1 has already been completed, Step 2 is applied.

Step 2. Investment analysis
The investment analysis is performed to determine that the proposed project activity is not economically or financially feasible, without the revenue from the sale of certified emission reductions.

Sub-step 2a: Determine appropriate analysis method
The simple cost analysis is applied if the CDM project activity and the alternatives identified in Step 1 generate no financial or economic benefits other than CDM related income. Scenario W5 derives income from biogas sales; therefore the simple cost analysis method cannot be applied.

Sub-step 2b. Option III. Apply benchmark analysis.
Project IRR is considered an appropriate financial/economic indicator for the project activity. The benchmark to be applied is the weighted average cost of capital (WACC) as follows:

Parameter	Value	Source
Debt Percentage	50%	CDM Guidelines Default Value
Equity Percentage	50%	CDM Guidelines Default Value
Cost of Debt	24.00%	Commercial Lending Rate[2]
Cost of Equity	13.25%	CDM Guidelines Default Value
WACC = (debt percentage x cost of debt) + (equity percentage x cost of equity)		
WACC	**18.625%**	

Sub-step 2c. Calculation and comparison of financial indicators:
The investment analysis is based on the project details considered by the board when approving the investment in the project on the 16th May, 2010. Therefore, the inputs to the investment analysis are considered relevant to the timing of the investment decision. The input values for the Project IRR are as follows:

Description	Units	Value	Primary Source
Date of Board Decision	Date	16/05/2010	Board Minutes, 16/05/2010
Yearly Biogas Production	Nm^3/year	3,024,000	Technology Supplier
Methane Content of Biogas	%	60%	Technology Supplier
Percentage of Biogas Flared	%	6.5%	Verification Report via similar TBEC project
Tariff parameter HFO equivalent	MJ/litre	39.50	BOOT Agreement
Tariff parameter Methane content	MJ/m_3	35.90	BOOT Agreement
Base Biogas Tariff (per equivalent litre HFO)	Baht/litre	7	BOOT Agreement
Escalation of Tariff and CPI	%	4.03%	CPI increase in Laos from 2007/2008/2009 (World Bank Statistics)
Residual value of equipment	Baht	1	BOOT Agreement
Emission Reductions	tCO_2e	37,120	PDD
CER sale price	€	18.00	http://www.setatwork.eu/certificates.htm (Average Gold Standard CER Price =(21+15)/2)
Conversion Rate	€/THB	46.4	Bank of Thailand,

[2] International Monetary Fund, Financial Statistics of Lending Rate, October 2009

Equity Return	%	13.25%	FIN07: CDM Guidelines Default Value, "GUIDELINES ON THE ASSESSMENT OF INVESTMENT ANALYSIS version 05"
Total Investment Cost	x10^6 THB	125	Budget based on audited cost of other TBEC projects
Operation and Maintenance Annual Cost	x10^6 THB	16.5	Audited Accounting Records of O&M costs for other TBEC projects (average 2008 & 2009)
Operational Lifetime (Supply Period)	Years	15	BOOT Agreement

Project IRR
The project IRR calculated with and without CERs is as follows:

Project IRR without CERs	Negative
Project IRR with CERs	24.934%

The project IRR without CERs is below the benchmark and the project IRR with CERs is above the benchmark. Therefore the project is additional.

Sub-step 2d. Sensitivity analysis:
The sensitivity analysis is performed to demonstrate that the financial/economic attractiveness is robust to reasonable variations in the critical assumptions. Only variable that constitute more than 20% of either the total project costs or total project revenues should be subjected to reasonable variations and the variations are completed in the range of +10% and -10%. The relevant variables identified are: Total Investment Costs, Total Revenues and Total Operation and Maintenance Costs as follows:

- A reduction in Total Investment Costs by 10% will not increase the IRR passed the benchmark as the IRR remains negative. Therefore, the IRR is robust to changes in the Total Investment Costs.

- An increase in Total Revenues by 10% will not increase the IRR passed the benchmark as the IRR remains negative. It is reasonable the LIG tapioca factory may considerably increase it's throughput at the factory which would increase the biogas production and hence total revenues by more than 10%. However, in order for the IRR to exceed the benchmark, even if total revenues increase by 200%, the IRR does not exceed the benchmark. Therefore, the IRR is robust to changes in the Total Revenues.

- A reduction in Total Operation and Maintenance Costs by 10% will not increase the IRR passed the benchmark as the IRR remains negative. Therefore, the IRR is robust to changes in the Total Operation and Maintenance Costs.

Outcome of Step 2: After the sensitivity analysis it is concluded that the proposed CDM project activity is unlikely to be financially/economically attractive and Step 4 Common practice analysis is followed.

Step 4 – Common Practice Analysis
As per paragraph 6 of tool for "Demonstration and assessment of additionality" the project is in accordance with measure (c) methane destruction. The geographical area is defined as Laos, the entire host country as the default. Therefore the steps outlined in paragraph 47 are outlined below:

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

The service provided by the Project Activity is the treatment of wastewater at a tapioca starch factory.
The design capacity of the proposed project activity is the volume of wastewater treated in the anaerobic digester. The project activity design capacity is 652,200m^3/yr wastewater from the starch factory.
Therefore +/-50% of the design capacity range is 978,300m^3/yr – 326,100m^3/yr.

Step 2: In the applicable geographical area, identify all plants that deliver the same output or capacity, within the applicable output range calculated in Step 1, as the proposed project activity and have started commercial operation before the start date of the project. Note their number N_{all}. Registered CDM project activities and projects activities undergoing validation shall not be included in this step:
The Lao Department of Industry[3], provided information on all starch factories operating in Lao PDR, including wastewater capacity. None of the plants are within the applicable output range.
In accordance with step 2 above,

$$N_{all} = 0.$$

Step 3: Within plants identified in Step 2, identify those that apply technologies different that the technology applied in the proposed project activity. Note their number N_{diff}.

$$N_{diff} = 0.$$

Step 4: Calculate factor $F=1-N_{diff}/N_{all}$ representing the share of plants using technology similar to the technology used in the proposed project activity in all plants that deliver the same output or capacity as the proposed project activity.

$$F = 1$$

$$N_{all}-N_{diff} = 0$$

As F is equal to 1 and N_{all} – N_{diff} is equal to 0, the proposed project activity is not “common practice” and therefore the project is additional.

B.6. Emission reductions

B.6.1. Explanation of methodological choices

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The applicable methodology, ACM0014, is suitable for project activities aimed at reducing methane emissions from industrial wastewater treatment. Two scenarios are applicable to the methodology as described in the following table from ACM0014. Scenario 1 is applicable to the project activity as established in section B.2.

[3] WW Treatment Practices in Laos Lao Dept Industry Nov 2010

Scenario	Description of the baseline situation	Description of the project activity
1	The wastewater is not treated, but directed to open lagoons that have clearly anaerobic conditions. In cases where solid materials are separated before directing the wastewater to the open lagoons, the solid materials have a different treatment than the wastewater	The wastewater is treated in a new anaerobic digester. In cases where solid materials are separated from the wastewater (both in the project and baseline scenarios), they will be treated separately and not treated with the new anaerobic digester employed for treatment of liquid effluents. The biogas extracted from the anaerobic digester and, if applicable, biogas3 generated from the treatment of solid materials, is flared and/or used to generate electricity and/or heat. The residual from the anaerobic digester, after treatment, is directed to open lagoons or is treated under clearly aerobic conditions (e.g. dewatering and land application)

Table B.6.1.a: Scenarios applicable to ACM0014 version 4.1

The project involves the installation of a new anaerobic digester for the treatment of wastewater, which is scenario 1. The project does not involve sludge treatment in a new anaerobic digester from an existing wastewater treatment plant, which is scenario 2 in ACM0014. Therefore, all data and terms used in the calculation of baseline emissions from anaerobic treatment relate to the treatment of wastewater in a new anaerobic digester (Scenario 1) and not sludge (Scenario 2).

Emission reductions are calculated by subtracting the project emissions from the baseline emissions. The methodological choices used to determine the calculation methods for baseline and project emissions were applied as follows.

Baseline emissions

Baseline emissions are calculated as follows:

$BE_y = BE_{CH4,y} + BE_{EL,y} + BE_{HG,y,}$

Therefore, the baseline emissions are calculated in three steps as follows:

Step 1: Calculation of baseline emissions from anaerobic treatment of the wastewater or sludge ($BE_{CH4,y}$);
Step 2: Calculation of baseline emissions from generation and consumption of electricity ($BE_{EL,y}$).
Step 3: Calculation of baseline emissions from heat generation ($BE_{HG,y}$);

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

The methodology proposes two alternative methods for the estimation of methane emissions from open lagoons:
(a) The Methane Conversion Factor Method (described in Step 1a); and
(b) The Organic Removal Ratio Method (described in Step 1b).

The organic removal ratio method (option b) has been selected for calculating the baseline emissions in this PDD. This method was chosen because the data requirements of this method are more consistent with the available data for the project.

Step 1b: Organic removal ratio (ORR) method

Baseline methane emissions from anaerobic treatment of the wastewater in open lagoons are estimated based on a mass balance of the organic matter, as per equation (12) of ACM0014 as follows:

$$BE_{CH4,y} = GWP_{CH4} \text{ x } B_O \text{ x } (COD_{BL,y} - COD_{aerobic,BL} - COD_{OX,BL,y} - COD_{sedim,BL,y})$$

$BE_{CH4,y}$	=	Methane emissions from anaerobic treatment of the wastewater in open lagoons in the absence of the project activity in year y (tCO2e/yr)
GWP_{CH4}	=	Global Warming Potential of methane for the commitment period (tCO_2e/tCH_4)
B_O	=	Maximum methane producing capacity (tCH_4/tCOD)
$COD_{BL,y}$	=	Quantity of chemical oxygen demand that would be treated in open lagoons in the absence
	=	of the project activity in year y (t COD/yr)
$COD_{aerobic,BL}$	=	Annual quantity of COD that would degrade aerobically in the lagoon (t COD/yr)
$COD_{OX,BL,y}$	=	Annual quantity of COD that would be chemically oxidised through sulphate in the wastewater in year y (t COD/yr)
$COD_{sedim,BL,y}$	=	Amount of COD lost through sedimentation in lagoon (t COD/yr)

In principle, the baseline chemical oxygen demand (COD_{BL}) corresponds to the chemical oxygen demand that is treated under the project activity (COD_{PJ}), i.e. the wastewater treated in the CLBR would have otherwise been treated in the existing open lagoons. However, the effluent from the lagoons must be accounted for in the baseline scenario. This is achieved by adjusting COD_{BL} by the effluent adjustment factor (AD_{BL}) which represents the percentage of the total COD treated in the project that would have been treated in the open lagoons in the absence of the project. This is calculated as follows:

$$COD_{BL,y} = AD_{BL} \times COD_{PJ,y}$$

where,

$$COD_{PJ,y} = \Sigma F_{PJ,dig,m} \text{ x } w_{COD,dig,m}$$

where:

$COD_{BL,y}$	=	Quantity of COD treated in open lagoons in absence of the project, year y (tCOD/yr)
$COD_{PJ,y}$	=	Quantity of chemical oxygen demand that is treated in the anaerobic digesterdigester or under clearly aerobic conditions in the project activity in year y (t COD/yr)
AD_{BL}	=	Effluent adjustment factor expressing the % of COD degraded in open lagoons
$COD_{out,x}$	=	COD of the effluent in the period x (t COD)
$COD_{in,}$	=	COD directed to the open lagoons (t COD)
$F_{PJ,dig,m}$	=	Quantity of wastewater or sludge that is treated in the anaerobic digesterdigester in the project activity in month m (m^3/month)
$w_{COD,dig,m}$	=	Average COD in the wastewater or sludge that is treated in the anaerobic digesterdigester in the project activity in month m (t COD/ m^3)

For existing facilities where one year worth of data for COD_{in} and COD_{out} is not available, AD_{BL} is determined by conducting measurements of the COD inflow to and effluent from the lagoon system over a campaign of 10 days. The average COD_{in} and COD_{out} values from the measurement campaign shall be used in the above equation and the result shall be multiplied by 0.89 to account for the uncertainty range (of 30% to 50%) associated with this approach as compared to one-year historical data, as per the requirements of ACM0014.

Determination of $COD_{aerobic,BL}$

The annual quantity of COD that would degrade aerobically in the lagoon is calculated as per equation (13) of ACM0014 as follows:

$$COD_{aerobic,BL} = A \times f_{COD,aerobic}$$

where:

$COD_{aerobic,BL}$	=	Annual quantity of COD that would degrade aerobically in the lagoon (t COD/yr)
A	=	Surface of the lagoon (ha)
$f_{COD,aerobic}$	=	Quantity of COD degraded to CO2 under aerobic conditions per surface area of the lagoon (t COD / ha yr)

Determination of $COD_{OX,BL,y}$

Where the wastewater contains chemical substance that chemically oxidise organic matter in the wastewater, the reduction in chemical oxygen demand due to chemical oxidation is calculated as per equation (14) of ACM0014 as follows:

$$COD_{OX,BL,y} = F_{PJ,y} \times \Sigma w_{s,y} \times R_s \times 0.001$$

where:

$COD_{OX,BL,y}$	=	Annual quantity of chemical oxygen demand that would be chemically oxidised through sulphate in the wastewater in year y (t COD/yr)
$F_{PJ,y}$	=	Quantity of wastewater treated in the digestor in year y (m³/yr)
$w_{s,y}$	=	Average concentration of chemical oxidative substance s in the wastewater treated in the digestor in year y (kg/m³)
R_s	=	Specific reduction in COD by substance s (t COD / t substance)
s	=	Substances in the wastewater that can chemically oxidize organic matter

Sulfur is often utilized in the production process of the tapioca starch factory. The reduction in COD by chemical oxidation due to the presence of sulfur will be calculating using the above equation.

Determination of $COD_{sedim,BL}$

To determine $COD_{sedim,BL}$ the procedure in appendix 2 of methodology ACM0014 Version 04.1 is applied.

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

This step is not applicable because the existing open lagoon wastewater treatment system does not consume electricity; water flows through the system is by means of gravity flow. Also, the project activity will not use biogas from the new anaerobic digester to generate electricity. Therefore, baseline emissions from the generation and consumption of electricity are zero.

Step 3: Baseline emissions from the generation of heat

This step is applicable if the biogas captured from the new anaerobic digester is utilized in the project scenario for heat generation. As described in section B.4, scenario H2 is the baseline for the project. Fossil fuel combustion for the generation of heat in the baseline is displaced by biogas and baseline emissions are calculated as follows:

Baseline emissions from the generation of heat ($BE_{HG,y}$)

Where the biogas captured from the new anaerobic digester is utilised for heat generation which displaces heat previously generated by fossil fuel in boilers, the baseline emissions are calculated as follows:

$$BE_{HG,y} = \frac{HG_{PJ,y} \times EF_{CO2,FF,boiler}}{\eta_{BL,boiler}}$$

where,

$BE_{HG,y}$	=	CO_2 emissions associated with fossil fuel combustion for heating equipment that is displaced by the project in year y (tCO_2/yr)
$HG_{PJ,y}$	=	Net quantity of heat generated in year y with biogas ((
$EF_{CO2,FF,boiler}$	=	CO_2 emission factor of the fossil fuel type used in the boiler for heat generation in the absence of the project activity (tCO_2/GJ)
$\eta_{BL,boiler}$	=	Efficiency of the boiler that would be used for heat generation in the absence of the project activity

Project emissions

A number of potential project emissions are described in ACM0014 and their applicability is dependent on the relevant scenario described in table 1 of the methodology. All potential project emission sources are included on equation (19) of ACM0014 as follows:

$$PE_y = PE_{CH4,effluent,y} + PE_{CH4,digest,y} + PE_{flare,y} + PE_{sludge,LA,y} + PE_{ww,LA,y} + PE_{EC,y} + PE_{FC,y}$$

where,

PE_y	=	Project emissions in year y (tCO2e/yr)
$PE_{CH4,effluent,y}$	=	Project emissions from treatment of the wastewater effluent from the anaerobic digester in year y (tCO2e/yr)
$PE_{CH4,digest,y}$	=	Project emissions from physical leakage of methane from the anaerobic digester in year y (tCO2e/yr)
$PE_{flare,y}$	=	Project emissions from flaring of anaerobic digester biogas in year y (tCO2e/yr)
$PE_{sludge,LA,y}$	=	Project emissions from land application of sludge in year y (tCO2e/yr)
$PE_{EC,y}$	=	Project emissions from electricity consumption in year y (tCO2e/yr)
$PE_{FC,y}$	=	Project emissions from fossil fuel consumption in year y (tCO2e/yr)
$PE_{ww,LA,y}$	=	Project emissions from land application of wastewater in year y (tCO2e/yr)

The applicability of each potential emission source to the project activity is assessed as follows:

<u>(i) Methane emissions from the treatment of digester effluent in open lagoons</u>

The project activity involves the discharge of wastewater effluent from the anaerobic digester to open lagoons. Therefore methane emissions from the lagoons are attributable to the project activity. As for baseline emissions, the organic removal ratio method is used to calculate wastewater emissions. Equation (28) of ACM0014 is applied as follows:

$$PE_{CH4,effluent,y} = GWP_{CH4} \times B_O \times (COD_{PJ,effl,dig,y} - COD_{PJ,aerobic} - COD_{PJ,OX,y} - COD_{PJ,sedim,y} - COD_{PJ,effl,lag,y})$$

$PE_{CH4,effluent,y}$	=	Project emissions from treatment of the wastewater effluent from the anaerobic digester in year y (tCO2e/yr)
GWP_{CH4}	=	Global Warming Potential of methane for the commitment period (tCO_2e/tCH_4)
B_O	=	Maximum methane producing capacity (tCH_4/tCOD)
$COD_{PJ,effl,dig,y}$	=	Quantity of chemical oxygen demand in the effluent from the digester (t COD/yr)
$COD_{PJ,aerobic}$	=	Annual quantity of COD that would degrade aerobically in the lagoon under the project activity (t COD/yr)
$COD_{PJOX,y}$	=	Annual quantity of COD that is chemically oxidised through oxidising substances in the effluent from the digester in year y (t COD/yr)
$COD_{PJ,sedim,y}$	=	Amount of COD lost through sedimentation in the lagoon under the project activity (t COD/yr)
$COD_{PJ,effl,lag,y}$	=	Quantity of COD in the effluent of the open lagoon in which the effluent from the digester is treated in year y (t COD/yr)

$COD_{PJ,aerobic}$, $COD_{PJ,OX}$ and $COD_{PJ,sedim}$ are calculated as per the baseline emissions calculations. $COD_{PJ,effl,dig,y}$ and $COD_{PJ,effl,lag,y}$ are both calculated using equations (21) and (22) from the methodology as follows:

$$COD_{PJ,effl,dig,y} = \Sigma F_{PJ,effl,dig,m} \times w_{COD,effl,dig,m}$$

where,

$F_{PJ,effl,dig,m}$ = Quantity of effluent from the digester in month m (m^3/month)

$w_{COD,effl,dig,m}$ = Average COD in the effluent from the digester in month m (t COD / m^3)

$$COD_{PJ,effl,lag,y} = \Sigma F_{PJ,effl,lag,m} \times w_{COD,effl,lag,m}$$

where,

$F_{PJ,effl,lag,m}$ = Amount of effluent from the open lagoon in which the effluent from the digestor is treated in month m (m^3/month)

$w_{COD,effl,lag,m}$ = Average COD in the effluent from the open lagoon in which the effluent from the digestor is treated in month m (t COD / m^3)

<u>(ii) Physical leakage of methane from the digester system;</u>

The project involves the construction of a new anaerobic digester, therefore physical leakage of methane must be accounted for. The calculations are performed as per equation (30) of the ACM0014 as follows:

$$PE_{CH4,digest,y} = F_{biogas,y} \times FL_{biogas,digest} \times w_{CH4,digest} \times GWP_{CH4} \times 0.001$$

where,

$PE_{CH4,digest}$ = Project emissions from physical leakage of methane from the digester (tCO_2e/yr)

$F_{biogas,y}$ = Amount of biogas collected in the outlet of the new digester in year y (m^3/yr)

$FL_{biogas,digest}$ = Fraction of biogas that leaks from digester (m^3 biogas leaked / m^3 biogas produced)

$w_{CH4,digest}$ = Concentration of methane in the biogas in the outlet of the new digester (kg CH_4/m^3)

<u>(iii) Methane emissions from flaring;</u>

Excess methane from regular boiler operation and methane captured during maintenance activities will be flared; therefore emissions from flaring must be accounted for. Emissions from flaring will be calculated using the “Tool to determine project emissions from flaring gases containing methane” EB28, Annex 13.

Project methane emissions due to incomplete flaring

Methane emissions that occur due to incomplete flaring will be calculated as per the "Tool to determine project emissions from flaring gases containing methane" as follows:

An enclosed flare will be used to destroy any biogas not used in the biogas burner. In accordance with section II of the tool, option (a) will be used to determine the flare efficiency of the enclosed flare as follows:

(a) To use a 90% default value. Continuous monitoring of compliance with manufacturer’s specification of flare (temperature, flow rate of residual gas at the inlet of the flare) must be performed. If in a specific hour any of the parameters are out of the limit manufacturer’s specifications, a 50% default value for the flare efficiency should be used for the calculations for this specific hour.

If there is no record of the temperature of the exhaust gas of the flare or if the recorded temperature is less than 500 °C for any particular hour, it shall be assumed that during that hour the flare efficiency is zero. As such, manufacturer’s specification for the manufacturer’s

specifications for the operation of the flare and the required data and procedures to monitor these specifications are documented in section B.7.

The default value for flare efficiency will be used therefore steps 3 and 4 of the flare tool are not applicable. As a simplified approach, project participants may only measure the volumetric fraction of
methane and consider the difference to 100% as being nitrogen and the corresponding calculations on steps 1 and 2 are also not required. As such, the flare emissions are calculated with Steps 5-7 as follows:

The methane mass flow rate in the flare gas stream is calculated using Step 5 of the tool as follows:

$TM_{RG,h} = FV_{RG,h} \times fv_{CH4,RG,h} \times \rho_{CH4,n}$
where,
$TM_{RG,h}$ = Mass flow rate of methane in the residual gas in hour *h* (kg/h)
$FV_{RG,h}$ = Volumetric flow rate of the residual gas in dry basis at normal conditions in hour *h* (m^3/h)
$fv_{CH4,RG,h}$= Volumetric fraction of methane in the residual gas on dry basis in hour h (NB: this corresponds to $fv_{iRG,h}$ where *i* refers to methane)
$\rho_{CH4,n}$ = Density of methane at normal conditions (0.716 kg/m3)

As stated above, the default efficiency factor has been selected for the flare. In accordance with Step 6 of the tool, the determination of hourly flare efficiency depends on the operation of flare and the type of flare used. In the case where the default value for flare efficiency is applied to enclosed flares, the flare efficiency in hour *h* ($\eta_{flare,h}$) is:

- 0% if the temperature in the exhaust of the flare (T_{flare}) is below 500 °C for more than 20 minutes during the hour *h*.
- 50% if the temperature in the exhaust gas of the flare (T_{flare}) is above 500 °C for more than 40 minutes during the hour *h*, but manufacturer's specifications on proper operation of the flare are not met at any point in time during the hour *h*.
- 90% if the temperature in the exhaust gas of the flare (T_{flare}) is above 500 °C for more than 40 minutes during the hour *h* and the manufacturer's specifications on proper operation of the flare are met continuously during the hour *h*.

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

$PE_{flare,y} = \Sigma^{8760}_{h=1} TM_{RG,h} \times (1 - \eta_{flare,h}) \times GWP_{CH4} / 1000$
where,
$PE_{flare,y}$ = Project emissions from flaring of the residual gas stream in year *y* (tCO_2e)
$TM_{RG,h}$ = Mass flow rate of methane in the residual gas in hour *h* (kg/h)
$\eta_{flare,h}$ = Flare efficiency in hour *h*
GWP_{CH4} = Global Warming Potential of methane valid for the commitment period (tCO_2e/tCH_4)

(iv) Project emissions from land application of sludge

The project is designed to recycle sludge back through the system to ensure maximum removal of COD. Therefore, it is not anticipated that any sludge will be removed for land application. However, in the event that sludge must be removed due to maintenance or operational requirements, emissions will be calculated in accordance with equation 31 of ACM0014 as follows:

$$PE_{sludge,LA,y} = COD_{sludge,LA,y} \times B_o \times MCF_{sludge,LA} \times GWP_{CH4} + S_{LA,y} \times w_{N,sludge,y} \times EF_{N20,LA,sludge}$$

where:

$PE_{sludge,LA,y}$	=	Project emissions from land application of sludge in year y (tCO_2e/yr)
$COD_{sludge,LA,y}$	=	COD of sludge applied to land after the dewatering process in year y (tCOD/yr)
$MCF_{sludge,LA}$	=	Methane conversion factor for the application of sludge to lands
$S_{LA,y}$	=	Amount of sludge applied to land in year y (t/yr)
$w_{N,sludge,y}$	=	Mass fraction of nitrogen in the sludge applied to land in year y (t N/t sludge)
$EF_{N20,LA,sludge}$	=	N2O emission factor for nitrogen from sludge applied to land (t N2O/t N)
GWP_{N2O}	=	Global warming potential of nitrous dioxide (tCO_2e/tN_2O)

(v) Project emissions from land application of wastewater

This emission source is not applicable because the project activity wastewater is not dewatered and directed to land application. The treated wastewater from the project activity is directed to the existing open lagoons.

(vi) Project emissions from electricity consumption

The latest version of the “Tool to calculate baseline, project and/or leakage emissions from electricity consumption” Version 1, EB39, Annex 7 is applied to calculate project emissions via Scenario A whereby the source, j is the electricity grid according to the following

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

where $EF_{EL,j,y}$ is the emission factor for electricity generation sourced from the grid in year y (tCO_2/MWh) calculated following the “Tool to calculate the emission factor for an electricity system”, Version 2.2.1, EB63 provided in spreadsheet submitted for Validation; and the default value of 20% is applied for $TDL_{j,y}$

(vii) Project emissions from fossil fuel consumption and combustion of fossil fuels in the project

The project activity will install a dual fuel burner (biogas/HFO). Biogas will be the primary source of energy in the burner and HFO will only be used if there is insufficient biogas. However, any combustion of HFO will be outside the project boundary. Baseline emissions associated with the displaced fossil fuels is only calculated from the energy produced from the biogas (via monitoring the biogas volume and calorific value of the biogas) and no energy from the combusted fossil fuels in the dual fuel burner is claimed in the baseline – therefore any excess fossil fuel combustion remains the baseline and outside the project boundary.

Leakage

Leakage emissions are only calculated for Scenario 1 type projects that include the treatment of solid materials in the digester in the project activity, and the identified baseline scenario for the treatment of solid materials in the “Procedure for the identification of the most plausible baseline scenario” is SM2: The solid materials are used as animal fodder.

In the baseline scenario the solid materials are not used as animal fodder. Part of the solid material is sold to a third party for use as fertilizer, the remainder is treated on-site in a root cake pond. The liquid discharged from the pond is treated in the open ponds in the baseline scenario and in the digester during the project activity. Therefore, leakage emissions are excluded.

Emissions Reductions
Emission reductions for any given year of the crediting period are calculated by subtracting project emissions from baseline emissions.
$ER_y = BE_y - PE_y$

B.6.2. Data and parameters fixed ex ante

Data / Parameter	**COD $_{out,x}$**
Unit	tCOD/10 days
Description	Average COD of the effluent from open lagoons over the measurement period.
Source of data	COD from the open lagoons was determined over a measurement campaign of 10 days.
Value(s) applied	86.99
Choice of data or Measurement methods and procedures	One year of historical data was not available; therefore the COD effluent from the lagoons was measured over a reference period of 10 days. The measurements were undertaken during a reference period that is representative of the typical operating conditions for the plant and ambient conditions of the site. The resulting ratio of COD effluent to COD inflow for the lagoons was multiplied by a factor of 0.89 to account for the uncertainty associated with this approach compared to one-year of historical data.
Purpose of data	Calculation of project emissions
Additional comment	x = Representative historical reference period of ten days.

Data / Parameter	**COD $_{in,x}$**
Unit	tCOD/10 days
Description	Average COD directed to the open lagoons over the measurement period
Source of data	COD from the open lagoons was determined over a measurement campaign of 10 days.
Value(s) applied	5,369.12
Choice of data or Measurement methods and procedures	One year of historical data was not available; therefore the COD directed to the open lagoons was measured over a reference period of 10 days. The measurements were undertaken during a reference period that is representative of the typical operating conditions for the plant and ambient conditions of the site. The resulting ratio of COD effluent to COD inflow for the lagoons is multiplied by a factor of 0.89 to account for the uncertainty associated with this approach compared to one-year of historical data.
Purpose of data	Calculation of baseline emissions
Additional comment	x = Representative historical reference period of ten days.

Data / Parameter	**B_o**
Unit	tCH_4/tCOD
Description	Maximum methane producing capacity, expressing the maximum amount of CH_4 that can be produced from a given quantity of chemical oxygen demand (COD)

Source of data	2006 IPCC Guidelines
Value(s) applied	0.21
Choice of data or Measurement methods and procedures	No measurement procedures. The default IPCC value for B_o is 0.25 kg CH_4/kg COD. If the methodology is used for wastewater containing materials not akin to simple sugars, a CH4 emissions factor different from 0.21 tCH_4/tCOD has to be estimated and applied. This is considered to be conservative, as research showed that average removals are 0.238 kg CH4/kg COD (Jacob et al, 2006).
Purpose of data	Calculation of baseline and project emissions
Additional comment	0.21 tCH_4/tCOD is applied as a conservative assumption.

Data / Parameter	**A**
Unit	Unit of area (ha)
Description	Surface area of the lagoon.
Source of data	Official factory layout of lagoons based on initial lagoon design and updated due to changes in use over time.
Value(s) applied	11.9
Choice of data or Measurement methods and procedures	-
Purpose of data	Calculation of baseline and project emissions
Additional comment	There are 12 open lagoons (see Annex 3 for calculation of total area)

Data / Parameter	$\mathbf{f_{COD,aerobic}}$
Unit	t COD / ha yr
Description	Quantity of chemical oxygen demand degraded to CO_2 under aerobic conditions per surface area of the lagoon or sludge pit
Source of data	ACM0014 version 4.1
Value(s) applied	92.7 (= 254 kg COD/ha day)
Choice of data or Measurement methods and procedures	-
Purpose of data	Calculation of baseline and project emissions
Additional comment	Applicable to the organic removal ratio method

Data / Parameter	**D**
Unit	M
Description	depth of the lagoons
Source of data	Official Site Diagram
Value(s) applied	5-8m
Choice of data or Measurement methods and procedures	Based on factory open lagoons design. See Annex 3
Purpose of data	Calculation of project emissions
Additional comment	-

Data / Parameter	EC_{BL}
Unit	MWh/year
Description	Annual quantity of electricity that would be consumed in the absence of the project activity for the treatment of the wastewater (scenario 1)
Source of data	Historical Records
Value(s) applied	0
Choice of data or Measurement methods and procedures	There is no electrical equipment used to treat wastewater in the baseline. For conservativeness, the electricity consumption is assumed to be zero.
Purpose of data	Calculation of baseline emissions
Additional comment	-

Data / Parameter	$EF_{CO2,FF,boiler}$
Unit	tCO_2/GJ
Description	CO_2 emission factor of the fossil fuel type used in the boiler for heat generation in the absence of the project activity
Source of data	IPCC 2006 guidelines for National Greenhouse Gas Inventories for Stationary Combustion
Value(s) applied	0.0961
Choice of data or Measurement methods and procedures	Type of coal Sub-Bituminous Coal
Purpose of data	Calculation of baseline emissions
Additional comment	

Data / Parameter	$\eta_{BL,boiler}$
Unit	%
Description	Efficiency of the boiler that would be used for heat generation in the absence of the project activity
Source of data	"Tool to determine the baseline efficiency of thermal or electric energy generation systems"
Value(s) applied	0.85
Choice of data or Measurement methods and procedures	In accordance with Option F of the Tool, the default efficiency for a new coal fired boiler is applied. This is a conservative assumption.
Purpose of data	Calculation of baseline emissions
Additional comment	-

Data / Parameter	**$MCF_{sludge,LA.}$**
Unit	-
Description	Methane conversion factor for sludge used for land application
Source of data	ACM0014v4.1
Value(s) applied	0.05
Choice of data or Measurement methods and procedures	No measurement procedures according to ACM0014v4.1
Purpose of data	Calculation of project emissions
Additional comment	-

Data / Parameter	**GWP_{CH4}**
Unit	tCO_2e/tCH_4
Description	Global warming potential for CH_4
Source of data	IPCC
Value(s) applied	21 (*valid until 31/12/2012*), 25 (*use this value since 01/01/2013*)
Choice of data or Measurement methods and procedures	Default IPCC value applied.
Purpose of data	Calculation of baseline and project emissions
Additional comment	Shall be updated according to any future COP/MOP decisions

Data / Parameter	**Rs**
Unit	t COD / t sulphate
Description	Specific reduction in chemical oxygen demand by sulphate
Source of data	Wastewater Engineering: Treatment and Reuse by George Tchobanoglous, Franklin L. Burton, H. David Stensel, 4th Edn, page 994
Value(s) applied	0.89
Choice of data or Measurement methods and procedures	The most conservative default value from review of published literature as per ACM0014. The above reference quotes a consumption of COD by sulphate in anaerobic conditions of between 0.89 and 0.67 gm COD per gram sulphate.
Purpose of data	Calculation of baseline and project emissions
Additional comment	-

Data / Parameter	$FL_{biogas,digest}$
Unit	m³ biogas leaked/m³ biogas produced
Description	Fraction of biogas that leaks from the digester
Source of data	IPCC (2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 5, Chapter 4, Page 4.4)
Value(s) applied	0.05 m³ biogas leaked/m³ biogas produced
Choice of data or Measurement methods and procedures	Default value defined in ACM0014.
Purpose of data	Calculation of project emissions
Additional comment	-

Data / Parameter	$COD_{sedim,BL,y}$
Unit	t COD / year
Description	Amount of chemical oxygen demand lost through sedimentation in the existing lagoons
Source of data	Site measurements of sedimentation rate.
Value(s) applied	26.16
Choice of data or Measurement methods and procedures	Calculated from sedimentation test procedure as outlined in Annex of ACM14v4.1
Purpose of data	Calculation of baseline emissions
Additional comment	-

Data / Parameter	ρ_{CH4}
Unit	kg/m^3
Description	Density of methane at normal conditions
Source of data	“Tool to determine project emissions from flaring gases containing methane”
Value(s) applied	0.716
Choice of data or Measurement methods and procedures	The density of methane is defined as a constant on page 12 of the “Tool to determine project emissions from flaring gases containing methane”.
Purpose of data	Calculation of project emissions
Additional comment	-

Data / Parameter	**Flare efficiency**
Unit	%
Description	Flare efficiency of the an enclosed flare
Source of data	“Tool to determine project emissions from flaring gases containing methane”
Value(s) applied	90%
Choice of data or Measurement methods and procedures	The project has an enclosed flare, therefore the 90% default value from the “Tool to determine project emissions from flaring gases containing methane” is applied.
Purpose of data	Calculation of project emissions
Additional comment	-

Data / Parameter	$EF_{EL,j,y}$
Unit	tCO2/MWh
Description	Combined margin CO2 emission factor for grid connected power generation in year y calculated using the latest version of the “Tool to calculate the emission factor for an electricity system”
Source of data	Statistics Yearbook 2009 prepared by Lao Statistic-Planning Office; OM for electricity imports from Thailand Greenhouse Gas Management Organisation (TGO), the Designated National Authority (DNA) of Thailand.
Value(s) applied	0.042
Choice of data or Measurement methods and procedures	The combined margin CO2 emission factor is calculated as per “Tool to calculate the emission factor for an electricity system”
Purpose of data	Calculation of project emissions
Additional comment	Used to calculate Project Emissions. The GEF data vintage is ex-ante. Full details of the calculation is provided in spreadsheet submitted for Validation.

Data / Parameter	**TDLj,y**
Unit	-
Description	Average technical transmission and distribution losses for providing electricity to source *j*,
Source of data	Tool to calculate baseline, project and/or leakage emissions from electricity consumption,Version 01, EB39
Value(s) applied	20%
Choice of data or Measurement methods and procedures	Default value provided in Tool for project electricity consumption sources.
Purpose of data	Calculation of project emissions
Additional comment	-

B.6.3. Ex ante calculation of emission reductions

>>

The emission reduction calculations are performed as per ACM0014 version 04.1

Emission Reductions

There are no emissions through leakage estimated in the methodology, therefore the emission reductions are calculated as follows:

$ER_y = BE_y - PE_y$

Parameter	Description of Value Applied	Value	Units
BE_y	Calculated as per equation (1) of ACM0014,	44,255	tCO_2e/yr
PE_y	Calculated as per equation (19) of ACM0014	7,135	tCO_2e/yr
ER_y	Calculated as BE_y – PE_y	37,120	tCO_2e/yr

Baseline Emissions

Baseline emissions are calculated as follows:

$BE_y = BE_{CH4} + BE_{EL,y} + BE_{HG}$

Parameter	Description of Value Applied	Value	Units
$BE_{CH4,y}$	Calculated as per ORR method, equation (12) of ACM0014	32,570	tCO_2e/yr
$BE_{EL,y}$	Equal to zero as determined in Section B.6.1.	0	tCO_2e/yr
$BE_{HG,y}$	Calculated as per equation (18) of ACM0014	11,686	tCO_2e/yr
BE_y	Calculated as $BE_{CH4} + BE_{EL,y} + BE_{HG}$	44,255	tCO_2e/yr

Project Emissions

Project emissions are calculated as follows:

$PE_y = PE_{CH4,effluent} + PE_{CH4,digest} + PE_{flare} + PE_{sludge,LA} + PE_{FC,y} + PE_{EC,y}$

Parameter	Description of Value Applied	Value	Units
$PE_{CH4,effluent,y}$	Calculated with the ORR method, equation (28) of ACM0014	5,551	tCO_2e/yr
$PE_{CH4,digest,y}$	Calculated as per equation (30) of ACM0014	1,364	tCO_2e/yr
$PE_{flare,y}$	Estimated volumes of biogas sent to flare	177	tCO_2e/yr
$PE_{sludge,LA,y}$	Equal to zero as outlined in Section B.6.1.	0	tCO_2e/yr
$PE_{EC,y}$	Calculated as per Tool to calculate baseline, project and/or leakage emissions from electricity consumption outlined in Section B.6.1.	42	tCO_2e/yr
$PE_{FC,y}$	Equal to zero as outlined in Section B.6.1.	0	tCO_2e/yr
PE_y	Calculated as $PE_{CH4,effluent} + PE_{CH4,digest} + PE_{flare}$	7,135	tCO_2e/yr

Leakage

No leakage is estimated as TBEC LIG biogas project is not intend to use solid waste. The baseline scenario for solid waste will continue during the project activity.

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

Year	Baseline emissions (t CO_2e)	Project emissions (t CO_2e)	Leakage (t CO_2e)	Emission reductions (t CO_2e)
2012*	7,376	1,189	0	6,186
2013	44,255	7,135	0	37,120
2014	44,255	7,135	0	37,120
2015	44,255	7,135	0	37,120
2016	44,255	7,135	0	37,120
2017	44,255	7,135	0	37,120
2018	44,255	7,135	0	37,120
2019*	36,879	5,946	0	30,933
Total	309,785	49,945	**0**	259,839
Total number of crediting years	7 years			
Annual average over the crediting period	44,255	7,135	0	37,120

* reflects partial year of emission reductions. Final emission reductions are rounded down for each year.

B.7. Monitoring plan

B.7.1. Data and parameters to be monitored

Data / Parameter	$F_{PJ,dig,m}$
Unit	m^3 / month
Description	Quantity of wastewater that is treated in the anaerobic digester in the project activity in month m.
Source of data	Measured
Value(s) applied	54,350
Measurement methods and procedures	Continuously measure and record daily
Monitoring frequency	Parameter monitored continuously using flow meters. Aggregated annually for calculations.
QA/QC procedures	Flow meters will be calibrated prior to operation and a calibration certificate issued. The meters will be calibrated every three years or as specified by manufacturer, whichever is earliest. TBEC will own/operate the meter and be responsible for ensuring correct operation and for the periodic calibration.
Purpose of data	Calculation of baseline emissions
Additional comment	Aggregated annual values have been applied for ex-ante calculations. Conservative assumptions will be applied for any period where there is any malfunction

Data / Parameter	$W_{COD,dig,m}$
Unit	t COD/m^3
Description	Average chemical oxygen demand in the wastewater or sludge that is treated in the anaerobic digester or under clearly aerobic conditions in the project activity in month *m*
Source of data	Measured
Value(s) applied	0.0149
Measurement methods and procedures	Measured according to international standards, following TBEC protocol and procedures.
Monitoring frequency	Weekly sampling of the treated wastewater and tested on site at the TBEC laboratory using Hach meter. Weekly samples will be taken and used to calculate average monthly and annual values.
QA/QC procedures	The equipment will be calibrated prior to use and every 3 years or frequency as per supplier specifications, whichever earlier
Purpose of data	Calculation of baseline emissions
Additional comment	Conservative assumptions will be applied for any period where there is any malfunction

Data / Parameter	$W_{S,y}$
Unit	Kg/m^3
Description	Average concentration of chemical oxidative substance (sulphate) in the wastewater or sludge treated in the digester in year y
Source of data	Measured
Value(s) applied	0.027
Measurement methods and procedures	Measured according to international standards, following TBEC protocol and procedures.
Monitoring frequency	Measured weekly at least, calculate average monthly and annual values
QA/QC procedures	The measurement calibration will be done by external party on an annual basis.
Purpose of data	Calculation of baseline emissions
Additional comment	The result of the test will be reported in mg/l; however, the reported unit will be converted to Kg/m^3 by using general conversion factor. Conservative assumptions will be applied for any period where there is any malfunction

Data / Parameter	$HG_{PJ,y}$
Unit	GJ/year
Description	Net quantity of heat generated in year y with biogas from the new anaerobic digester
Source of data	Calculated from the measurement of the volume of biogas captured and used for heat generation ($F_{biogas,boiler,y}$) multiplied by the methane content of the gas ($fv_{CH4,RG,h}$), the calorific value of the biogas (CV) and the default efficiency of the boiler. (ex-ante value calculated by the energy demand from biogas required to dry starch)
Value(s) applied	103,358
Measurement methods and procedures	$F_{biogas,boiler,y}$ and $fv_{CH4,RG,h}$ monitored as per monitoring parameters in this Monitoring Plan. CV (Calorific Value of biogas) will be sampled and measured annually by an external laboratory.

Monitoring frequency	-
QA/QC procedures	The parameters used for $HG_{PJ,y}$ calculation will follow their QA/QC procedures mentioned in section B 7.1 (Ref: $F_{biogas,boiler,y}$ and $fv_{CH4, RG,h}$)
Purpose of data	Calculation of baseline emissions
Additional comment	Conservative assumptions will be applied for any period where there is any malfunction

Data / Parameter	$F_{PJ,effl,dig,m}$
Unit	m³ / month
Description	Quantity of effluent from the digester in month m
Source of data	Measured
Value(s) applied	54,350
Measurement methods and procedures	Continuously measure and record daily
Monitoring frequency	Parameter monitored continuously using standard flow meters. Aggregated annually for calculations.
QA/QC procedures	Flow meters will be calibrated prior to installation and a calibration certificate issued. The meters will be calibrated every three years or as specified by manufacturer, whichever is earliest. The meters will be checked monthly to ensure they are operating. TBEC will own/operate the meter and be responsible for ensuring correct operation and for the periodic calibration.
Purpose of data	Calculation of project emissions
Additional comment	Conservative assumptions will be applied for any period where there is any malfunction

Data / Parameter	$F_{PJ,effl,lag,m}$
Unit	m³ / month
Description	Quantity of effluent from the open lagoon in which the effluent from the digester is treated in month m.
Source of data	Measured
Value(s) applied	54,350
Measurement methods and procedures	Parameter monitored continuously using standard flow meters. Weekly record by shift leader/ process operator or senior/lab technician. Aggregated annually for calculations.
Monitoring frequency	Parameter monitored continuously using standard flow meters. Aggregated annually for calculations.
QA/QC procedures	Flow meters will be calibrated prior to installation and a calibration certificate issued. The meters will be calibrated every three years or as specified by manufacturer, whichever is earliest. The meters will be checked monthly to ensure they are operating. TBEC will own/operate the meter and be responsible for ensuring correct operation and for the periodic calibration.
Purpose of data	Calculation of project emissions
Additional comment	Conservative assumptions will be applied for any period where there is any malfunction

Data / Parameter	$w_{COD,effl,dig,m}$
Unit	t COD / m³
Description	Average chemical oxygen demand in the effluent from the digester in month m
Source of data	Measured by the TBEC Lab Technician in mg/L and unit converted to kg/m^3
Value(s) applied	0.003729
Measurement methods and procedures	Measured according to international standards, following TBEC protocol and procedures.
Monitoring frequency	Weekly sampling of the treated wastewater and tested on site at the TBEC laboratory using Hach meter. Weekly samples will be taken and used to calculate average monthly and annual values.
QA/QC procedures	The equipment will be calibrated prior to use and every 3 years or frequency as per supplier specifications, whichever earlier
Purpose of data	Calculation of project emissions
Additional comment	Conservative assumptions will be applied for any period where there is any malfunction

Data / Parameter	$w_{COD,effl,lag,m}$
Unit	t COD / m³
Description	Average chemical oxygen demand in the effluent from the lagoons in month m
Source of data	Measured
Value(s) applied	0.0000637
Measurement methods and procedures	Measured by the TBEC Lab Technician in mg/L and unit converted to kg/m^3
Monitoring frequency	Weekly sampling of the treated wastewater and tested on site at the TBEC laboratory using Hach meter. Weekly samples will be taken and used to calculate average monthly and annual values.
QA/QC procedures	The equipment will be calibrated prior to use and every 3 years or frequency as per supplier specifications, whichever earlier.
Purpose of data	Calculation of project emissions
Additional comment	Aggregated annual values have been applied for ex-ante calculations.

Data / Parameter	$W_{S,effl,y}$
Unit	Kg/m^3
Description	Average concentration of chemical oxidative substance (sulphate) in the effluent from the digester in year y
Source of data	Measured by TBEC by the lab Technician
Value(s) applied	0.027
Measurement methods and procedures	Measured according to international standards, following TBEC protocol and procedures.
Monitoring frequency	Measured fortnightly, calculate average monthly and annual values

QA/QC procedures	The sulphate will be measured in weekly basis by spectrophotometer. The measurement calibration will be done by external party on an annual basis.
Purpose of data	Calculation of project emissions
Additional comment	The result of the test will be reported in mg/l; however, the reported unit will be converted to Kg/m^3 by using general conversion factor. Conservative assumptions will be applied for any period where there is any malfunction

Data / Parameter	$S_{LA,y}$
Unit	m^3/month
Description	Quantity of sludge in liquid form applied to land in year y
Source of data	Measured
Value(s) applied	0
Measurement methods and procedures	Continuously measure by standard flow meter.
Monitoring frequency	Flow meters will be logged manually on a weekly basis to ensure monthly data is available. Aggregated annually for calculations.
QA/QC procedures	Flow meters will be calibrated prior to installation and a calibration certificate issued. The meters will be calibrated every three years or as specified by manufacturer, whichever is earliest. The meters will be checked monthly to ensure they are operating.
Purpose of data	Calculation of project emissions
Additional comment	Expected to be zero, but monitored continuously. Conservative assumptions will be applied for any period where there is any malfunction

Data / Parameter	$w_{CODsludge,LA,y}$
Unit	kg/m^3
Description	t COD / t sludge
Source of data	Measured
Value(s) applied	0
Measurement methods and procedures	Measured according to international standards, following TBEC protocol and procedures.
Monitoring frequency	Weekly sampling of the treated wastewater and tested on site at the TBEC laboratory using Hach meter. Weekly samples will be taken and used to calculate average monthly and annual values.
QA/QC procedures	The measurement calibration will be done by external party on an annual basis.
Purpose of data	Calculation of project emissions
Additional comment	Expected to be zero. However, the measurement will be performed when there is a sludge removal.

Data / Parameter	$W_{S,effl,y}$
Unit	Kg/m^3
Description	Average concentration of chemical oxidative substance (sulphate) in the effluent from the digester in year y
Source of data	Measured by TBEC by the lab Technician
Value(s) applied	0.027
Measurement methods and procedures	Measured according to international standards, following TBEC protocol and procedures.
Monitoring frequency	Measured fortnightly, calculate average monthly and annual values
QA/QC procedures	The sulphate will be measured in weekly basis by spectrophotometer. The measurement calibration will be done by external party on an annual basis.
Purpose of data	Calculation of project emissions
Additional comment	The result of the test will be reported in mg/l; however, the reported unit will be converted to Kg/m3 by using general conversion factor. Conservative assumptions will be applied for any period where there is any malfunction

Data / Parameter	$F_{biogas,y}$ ($F_{biogas,flare,y}$ + $F_{biogas,boiler,y}$)
Unit	Nm^3 / yr
Description	Amount of biogas collected in the outlet of the new digester in year y
Source of data	Measured with a flow meter and calculated by TBEC.
Value(s) applied	3,024,000 = (196,560 + 2,827,440)
Measurement methods and procedures	Parameter monitored continuously with a flowrate meter and aggregated annually for calculations. The digester system includes a plastic cover, pipes for biogas collection, a scrubber and dehumidifier. Biogas will be measured after the scrubber and dehumidifier has removed moisture to ensure accuracy of the measurements. Biogas will be summed from independent measurements of flow to the flare and the boiler to calculate total biogas collected in the new digester.
Monitoring frequency	Continuously measure using standard gas flow meter and aggregated annually for calculations.
QA/QC procedures	Flow meters will be calibrated prior to operation and a calibration certificate issued. The meters will be calibrated every three years or as specified by manufacturer, whichever is earliest. TBEC will own/operate the meter and be responsible for ensuring correct operation and for the periodic calibration.
Purpose of data	Calculation of project emissions
Additional comment	Applied to estimate emissions associated with physical leakage from the digester. Conservative assumptions will be applied for any period where there is any malfunction

Data / Parameter	$w_{CH4,biogas,y}$
Unit	kg CH_4/m^3
Description	Concentration of methane in the biogas in the outlet of the new digester.
Source of data	Measured with a gas analyser by TBEC.
Value(s) applied	0.43
Measurement methods and procedures	Measured continuously using a gas analyser. The digester system includes a plastic cover, pipes for biogas collection, a scrubber and dehumidifier. Biogas will be measured after the scrubber and dehumidifier has removed moisture to ensure accuracy of measurements. Biogas will be sampled in the same pipe-run as the flow meters such that there will not be any gas blowers or other mechanical flow devices between the sample point and the meters.
Monitoring frequency	Continuously measure using gas analyser.
QA/QC procedures	The gas analyser will be calibrated annually by using standard gas recommended by manufacture.
Purpose of data	Calculation of project emissions
Additional comment	Conservative assumptions will be applied for any period where there is any malfunction

Data / Parameter	$COD_{PJ,sedim,y}$
Unit	t COD / yr
Description	Amount of chemical oxygen demand lost through sedimentation in the lagoon or sludge pit under the project activity
Source of data	To be calculated from data collected in accordance with the sedimentation test procedure.
Value(s) applied	26.16
Measurement methods and procedures	Sampling procedures described in Appendix 2 of ACM0014 v4.1
Monitoring frequency	As per described in Appendix 2 of ACM0014 v4.1
QA/QC procedures	Sampling procedures described in Appendix 2 of ACM0014 v4.1
Purpose of data	Calculation of project emissions
Additional comment	Conservative assumptions will be applied for any period where there is any malfunction

Data / Parameter	$EC_{PJ,grid,y}$
Unit	MWh / year
Description	Electricity used to operate the Project Activity in year *y*
Source of data	Measured by meter in kWh and calculated to MWh TBEC by the shift leader/process operator
Value(s) applied	840 MWh/year
Measurement methods and procedures	Measured continuously using electricity meters. As a backup, the Shift leader/process operator will log the meter reading on paper every month and transfer the amount to the electronic spreadsheet.

Monitoring frequency	Continuously measure by electricity meter
QA/QC procedures	Meters will undergo maintenance and calibration according to appropriate national standards. EDL official records of net electricity sold will be used to cross check the data. Conservative assumptions will be applied for any period where there is any malfunction.
Purpose of data	Calculation of project emissions
Additional comment	The ex-ante estimate are calculated from estimated load of 116.65 kW operating continuously. Applied as per Tool to calculate baseline, project and/or leakage emissions from electricity consumption.

Data and Parameters to be Monitored in the "Tool to determine project emissions from flaring gases containing methane"

Data / Parameter	**$FV_{RG,h}$**
Unit	Nm^3/hr
Description	Biogas sent to flare (Volumetric flow rate of the residual gas in dry basis at normal conditions in the hour *h*)
Source of data	Measured with standard flow meter
Value(s) applied	Project emissions due to flaring have been calculated with an estimated percentage of biogas sent to flare of 6.5% of total biogas produced.
Measurement methods and procedures	Measured continuously and averaged hourly.
Monitoring frequency	Continuously measure using standard gas flow meter and aggregated annually for calculations.
QA/QC procedures	Flow meters will be calibrated prior to installation and a calibration certificate issued. The meters will be calibrated every three years or as specified by manufacturer, whichever is earliest. The meters will be checked monthly to ensure they are operating. TBEC will own/operate the meter and be responsible for ensuring correct operation and for the periodic calibration.
Purpose of data	Calculation of project emissions
Additional comment	Conservative assumptions will be applied for any period where there is any malfunction

Data / Parameter	**$fv_{CH4,RG,h}$ (same as $w_{CH4,biogas,y}$)**
Unit	mg/m^3
Description	Volumetric fraction of methane in the residual gas in the hour h
Source of data	Measured by TBEC with a gas analyser.
Value(s) applied	0.43
Measurement methods and procedures	Continuously using a gas analyser. Values to be averaged hourly. Measured on dry basis.
Monitoring frequency	Continuously measure using gas analyser.

QA/QC procedures	Analysers will be calibrated initially and on a regular basis. A zero check and a typical value check should be performed by comparison with a standard certified gas.
Purpose of data	Calculation of project emissions
Additional comment	Conservative assumptions will be applied for any period where there is any malfunction

Data / Parameter	T_{flare}
Unit	°C
Description	Temperature in the exhaust gas of the flare
Source of data	Measure the temperature of the exhaust gas stream
Value(s) applied	When temperature < 500°C; 0% for the flare efficiency When temperature > 500°C; either 50% or 90% depend on the flaring time and manufacturer's specification
Measurement methods and procedures	Continuously measure using thermocouple, type-N
Monitoring frequency	Continuously measure
QA/QC procedures	Replace every 10,000 operating hours or replace every year
Purpose of data	Calculation of project emissions
Additional comment	-

B.7.2. Sampling plan

>>
N/A

B.7.3. Other elements of monitoring plan

>>
The Monitoring Plan ensures that parameters for both project and baseline emissions are monitored according to the requirements of ACM0014 version 4.1

<u>Details of Data to be Monitored</u>
Section B.7.1 describes the data and parameters to be monitored. Data for each parameter will be monitored at a frequency described in the relevant table of section B.7.1. The main equipment used for monitoring is:

- Wastewater flow meters
- Biogas flow meters
- Gas analyser for measuring the methane content in biogas
- Flame detector Temperature sensor for flare monitoring
- Electricity meter
- COD laboratory test results.
- Sludge removal

Monitoring Procedure
Monitoring data will be recorded/downloaded monthly and stored electronically in a database. Any problems with the monitoring equipment will be noted in an operation and maintenance log and entered into the database. A quarterly monitoring report will be produced containing the monthly monitoring data files and details of any equipment faults and/or loss of data. The quarterly report will be submitted to the project participants for review and acceptance. All records will be retained for at least two years after the end of the crediting period during which the data was recorded.

All data will be stored in spreadsheets and backed up electronically on a separate computer. Copies of the collated data will be printed monthly as part of the monthly report. All data will be kept for at least 2 years following the end of the crediting period. Any lost data due to equipment failure will be reconstructed from former and subsequent series measurements up to 6 months after the equipment failed. This is considered reasonable as despite a quality control, maintenance and auditing system in place, instrument failure and delays in replacement may still occur. During this period, additional evidence will be used to demonstrate the continuing of factory operations to avoid suspicion that the data is indeed missing due to instrument failure and not cessation of the production process.

In case of back out period, the conservative assumption will be applied in all parameters mentioned in the PDD.

For further detail of the operational and management structure developed to implement the monitoring plan refer to Annex 4.

B.8. Date of completion of application of methodology and standardized baseline and contact information of responsible persons/ entities

>>
Application of the baseline study and monitoring methodology was performed by Carbon Bridge. Carbon Bridge is a project participant in the project.

Date of Completion of the baseline study and the monitoring methodology for the draft PDD: 07/09/2011

Responsible Entity: Carbon Bridge Pte Ltd

Full contact details are provided in Annex-I of the document

SECTION C. Duration and crediting period

C.1. Duration of project activity

C.1.1. Start date of project activity

>>
The starting date of the project was 29/09/10, the date the purchase order was signed to commence the excavation work for the project.

C.1.2. Expected operational lifetime of project activity

>>
Expected operational lifetime of the project activity is 21 years.

C.2. Crediting period of project activity

C.2.1. Type of crediting period

>>
Renewable

C.2.2. Start date of crediting period

>>
01 November 2012, or date of Registration.

C.2.3. Length of crediting period

>>
The length of the first crediting period is 7 years and 0 months.

SECTION D. Environmental impacts

D.1. Analysis of environmental impacts

>>
An Initial Environmental Evaluation (IEE) was conducted for the project, considering direct and indirect impacts on the environment, human use and quality of life values. No significant direct or indirect environmental impacts were identified compared to the business as usual operation of the factory.
The IEE summarized the key environmental impacts as follows:

(1) Impact on the topographical feature, geology, and soil resource
- The project construction activities such as land leveling may accelerate soil erosion and might wash top soil to water resources. To avoid the impact, TBEC LIG will avoid construction during rainy season and will use concrete in order to prevent the collapse and erosion along ditches and construction sites. The impact on soil resources is expected to be at a low level.
- During operation of the TBEC LIG project the impact in geology and soil resources is expected to be low. There may be changes in the topographical features of the site however the project will design drainage systems to ensure flood prevention.

(2) Impact on air quality
- During construction period;
  - Dust impacts are considered to be at acceptable level. Dust from construction activity larger than ten microns will not disperse further than 6-9 meters. During project construction water will be sprayed on the top soil to lessen dust dispersion. This is to mitigate the impact to staff at the site. The wheels of trucks will be cleaned when the leave the site to prevent trucks from dispersing soil.
  - Air pollution from the construction machinery is considered to be at an acceptable level. The IEE has shown that there will be low level of impact to the air quality of the surrounding area and the impact will occur in a short period of time.
- During operation period
  - Pollution from the exhaust pipe of the starch factory boiler will not exceed the international standard level. CLBR system biogas will be captured and monitored, therefore odor will be contained. The biogas will be scrubbed to remove H_2S which is the source of odor.

(3) Impact on noise pollution
- During construction period the project will mitigate the pollution by select the machines and equipment with lowest pitch and will be regularly maintain in good condition. The project will also limit the activity with loud noise to operate only in normal working hours and personal preventive equipment such as ear plugs and ear muff will be used.

(4) Impact on water quality
- During the construction the impact on water will be low. There will be not much wastewater from the construction apart from the toilets.
- During operating period, the project will improve the water quality. Wastewater quality from the biogas producing process will improve as the CLBR system will treat the wastewater from the factory. The project will not use ground water and the project will analyze the flow direction of the ground water to protect the contamination of the wastewater from the CLBR.

(5) The biological impact was documented as negligible because the land was within the confines of LIG tapioca factory.

D.2. Environmental impact assessment

>>

Referring to Regulation on Environment Assessment, 2002, in the Lao PDR, Science Technology and Environment Agency (STEA) which referred to the Law on Environmental Protection (EPL), No. 02-99/NZ, dated 3/4/99 and Prime Minister’s Decree on the establishment and function of the Science, Technology, and Environment Agency, No. 68/PM, dated 21/5/99, requires that the project need to conduct an initial Environment Examination (IEE).

The IEE was submitted to Water Resource and Environment Administration (WREA) and received the Environmental Certificate on 1/07/2010. There is no requirement from the host party to conduct Environment Impact Assessment (EIA).

The DNA also requires the project developer to submit a Sustainable Development Checklist assessing the project outcomes in terms of environment, social, economic and transfer of technology.

SECTION E. Local stakeholder consultation

E.1. Solicitation of comments from local stakeholders

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A local stakeholder consultation was conducted in line with the Gold Standard toolkit v.2.1. The consultations included an explanation of the project and a blind sustainable development exercise.

The Stakeholder Consultation was divided in two sessions. The first session was held at Wat Naxone, Ban Naxone, Pak Ngum District, Vientiane Capital, Lao PDR at 9am on 16th March 2010 near the project site. Many representatives of the local community were in attendance. The main participants are from local community. In total 174 stakeholders were recorded as follows:

- 127 local people, including village elders, youths, woman union representatives and village heads.
- 39 local policy makers and representatives of local authorities including District Governor Office, District Security Office, District Administrative Organization Committee, Ministry of Industry and Commerce
- 2 from local media
- 5 from TBEC LIG starch project CDM consultant
- 79 female stakeholders including women's union representatives, teachers and mothers accompanied by young children.

In order to ensure that the consultation process was also accessible to NGO representatives working in Vientiane Capital The second session was held at Conference Room, Ramayana Gallery Hotel (Dokmaideng Hotel),Lanexang Avenue, Ban Hatsady Chantabouly District, Vientiane Capital, Lao PDR at 10am on 17th March 2010. Participants consists of 2 international NGOs and 2 local NGOs.

The process to invite stakeholders was as follows:

- Public notices were placed in local newspaper, Vientiane Time (English) and Vientiane Mai (Laos)
- Key stakeholders were directly invited to attend the consultation meetings for the TBEC LIG Biogas project via a letter.
- As is customary in Laos, the village heads were invited in person and asked to extend the invitation to all the villagers.
- NGO representatives were invited directly for the meeting in Vientiane capital

E.2. Summary of comments received

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Stakeholders were invited to ask questions and raise any concerns about the proposed project. To overcome the reluctance of stakeholders to voice questions in front of the large group, TBEC staff assisted individual stakeholders by recording their questions on paper and submitting them to the Master of Ceremony who read the questions aloud. This was approach help facilitate a large number of questions/comments and overcame the reluctance of individuals to stand up and ask questions.

All the questions asked/answered during the consultation are summarised in section E.3 together with details of how TBEC LIG has taken the comments into account.

Stakeholders were provided with feedback forms upon arrival at the consultation venue. After completion of the presentations/discussions, stakeholders were asked to record their comments on the feedback forms.

Generally, the presentations by the project participants were well received and the stakeholders were well engaged in the consultation process. A total of 125 feedback forms were completed.

The feedback suggests that the presentations and explanations adequately conveyed sufficient project details to enable the stakeholders to understand the project and engage in the sustainability exercise. 24 stakeholders felt that the project presentations provided clear and adequate explanations of the project details while only one stakeholder felt that the explanations were not sufficiently clear. 114 stakeholders commented on aspects of the project which they liked and 51 stakeholders commented on aspects of the project which they disliked.

The main positive aspects of the project which participants noted were; reduction in smell from the factory (42 respondents), increase in the availability of jobs (21 respondents), sharing information about the project (8 respondents) and the use of biogas to displace other fossil fuel, i.e. coal, (6 respondents). The main negative aspects of the project which participants noted were; continued smell from the starch factory (31 respondents), wastewater discharge (7 respondents) and potential safety issues from the biogas (2 respondents). In addition, 12 respondents felt that the project would result in positive outcomes provided that it could be ensured that there would be no negative impacts on local people or animals.

E.3. Report on consideration of comments received

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All comments are taken into account as follows;

Q1: If this project happens, will it affect people and animals and will it explode?
A1: The question was answered during the stakeholder consultation meeting. TBEC explained that the design of the biogas system is purchased from a New Zealand company and the project is designed to minimise hazards to people associated with fire and explosion. Animals and livestock will be excluded from accessing the biogas plant to prevent injury occurring from the project equipment.

Q2 : What is the progress of the construction?
A2 : The question was answered during the stakeholder consultation meeting. At the time of the meeting, construction had not begun.

Q3 : How can we be confident that what the company has said will be actually done?
A3: The question was answered during the stakeholder consultation meeting. TBEC explained that the stakeholders would be invited to an open day to inspect the project outcomes after construction was finished.

Q4 : Will the fumes from the gas harm people and the environment?
A4 : The question was answered during the stakeholder consultation meeting. TBEC explained that the biogas will be combusted for fuel in the cassava factory and any excess biogas will be flared. When methane is combusted it is converted to CO_2, which naturally occurs in the atmosphere and will not harm people. This has a positive effect on the environment because the project will reduce the total amount of GHG’s emitted by the cassava factory.

Q5 : Please explain about the effects of biogas.
A5 : The question was answered during the stakeholder consultation meeting. TBEC explained that the biogas will be combusted for fuel in the cassava factory and any excess biogas will be flared. When methane is combusted it is converted to CO_2, which naturally occurs in the atmosphere and will not harm people. This has a positive effect on the environment because the project will reduce the total amount of GHG’s emitted by the cassava factory.

Q6 : After building the (biogas) factory, how much percentage of the odour release would decrease? Will there be any affect on the environment?
A6 : The question was answered during the stakeholder consultation meeting. In principle, the covered lagoon should be able to capture up to 99% of the odour released (from the biogas reactor). There will be no untreated waste water discharged to the environment.

Q7 : Will there be waste water and waste from the cassava factory discharge to normal ground water source and underground water?
A7 : The question was answered during the stakeholder consultation meeting. TBEC explained that the construction will be built according to civil engineering standards. Before construction TBEC will conduct soil tests and complete civil design works to determine whether soil compaction is sufficient to prevent leakage. If soil conditions are not sufficient a suitable lining will be utilised to prevent leakage to the ground water.

Q8 : Will there be increased environmental impact and will it (the biogas plant) cause high temperature?
A8 : The question was answered during the stakeholder consultation meeting. TBEC explained that cassava factory already burns coal for heat, and local people are not exposed to high temperatures. The use of gas as a fuel will reduce the environmental impacts because gas does not produce soot like coal does.

Q9 : Will there be any pollution?
A9 : The question was answered during the stakeholder consultation meeting. TBEC explained that they will obtain permission from Lao Ministry of Industry and Environment. The pollution limits specified by Lao law will not be exceeded. In addition, the project is being developed as a CDM project which requires additional approvals and monitoring. This will ensure that the project does not exceed government requirements for pollution.

Q10 : How long will the construction take? And if there is a lot of rain, will the water spill from the waste water lagoon? How would the factory operate during the construction period if there is a lot of rain?
A10 : The question was answered during the stakeholder consultation meeting. If there is a lot of rain the factory will stop the operation to maintain the quality of the process, therefore there will be no wastewater released from the factory. Before the construction of the reactor pond, the factory already has 11 wastewater treatment ponds and will not spill water to the environment.

Q11 : Will bad odour harm lungs and liver?
A11 : The question was answered during the stakeholder consultation meeting. The cassava factory produces powder by processing and drying the cassava root. The factory does not add any chemicals to the process. The biogas fuel is mainly methane which will be converted to carbon dioxide. Carbon dioxide does not harm the lungs or liver.

Q12 : Will the gas be sold only to the factory or will it be sold to others too?
A12 : The question was answered during the stakeholder consultation meeting. TBEC is not considering selling gas outside the factory because gas bottling is very expensive and dangerous.

Q13 : What is the policy toward people and villagers from this project?
A13 : The question was answered during the stakeholder consultation meeting. TBECs project will control odour from the cassava factory, provide employment and give knowledge to people about the factory. In addition, TEBC will have funds to support local projects such as assistance to schools.

Q14 : What stage is this project in terms of CDM aspect?
A14 : The question was answered during the stakeholder consultation meeting. It was explained that the project is at an early stage and TBEC is still collecting data in order to complete the detailed project design. A preliminary conceptual design has been prepared but no construction activity has begun.

Q15 : What will you use for biogas; will you use cassava as feedstock?
A15 : The question was answered during the stakeholder consultation meeting. TBEC explained that only waste water from the cassava factory will be used as feedstock, no raw cassava will be used.

Q16 : What is the volume of wastewater?
A16 : A diagram of the CLBR was presented and the question was answered during the stakeholder consultation meeting.

Q17 : How does the lab test work? Do you have to send all samples to test abroad?
A17 : The question was answered during the stakeholder consultation meeting. TBEC explained that they are checking if there is a laboratory in Vientiane with the appropriate quality, if not the closest laboratory is in Khon Kaen Thailand.

Q18 : Would you have a laboratory at the site?
A18 : The question was answered during the stakeholder consultation meeting. TBEC explained that all of their projects have a laboratory on sites. TBEC would invest about 2 million Thai Baht to build the laboratory and buy equipments. We will send the sample to other institutions in case we need to confirm results through a 3rd party.

Q19 : How will you get CERs?
A19 : The question was answered during the stakeholder consultation meeting. TBEC explained that they will have to follow the CDM guidelines and the process is very long. It is a big risk to the business because TBEC needs to sell carbon credit to supplement the gas sales.

Q20 : 30,000 tonnes of methane is produced, is it enough for the cassava factory?
A20 : The question was answered during the stakeholder consultation meeting. TBEC explained that the factory energy demand depends on the type of technology used in the factory; old technology would use more fuel for same amount of starch. In general, the biogas produced from a cassava factories wastewater is more than enough to cover the energy demand of the dry factory process.

Q21 :You mentioned ISO standards earlier; do they apply for the whole project or only some parts such as laboratory?
A21 : The question was answered during the stakeholder consultation meeting. TBEC explained that TBEC applies engineering standards to the design and installation of equipment.

Q22 : The ISO quality standard is applied systematically to the business and includes safety in the operation of the plant. In term of CDM, does it apply to the biogas project only?
A22 : The question was answered during the stakeholder consultation meeting. TBEC explained that the CDM is only applied to TBECs project which is the biogas plant.

Q23 : Does the project involve the treatment or use of any chemical?
A23 : The question was answered during the stakeholder consultation meeting. TBEC explained that the TBEC design does not require the use of chemical but instead utilises naturally occurring bacteria to produce methane. Similarly, the scrubber system does not use chemicals but instead uses natural microorganisms to digest H2S.

Q24 : Raised concern about training for staff, the linkage between the (cassava) factory and biogas owners might be an issue. They should work closely together.
A24 : The question was answered during the stakeholder consultation meeting. TBEC explained that they will advise the starch factory about the purchase of an appropriate boiler and will request the boiler company to provide operation training. TBEC staff usually attend training from the boiler supplier together with staff from the starch factory.
TBEC policy is to provide the Lao staff with the same scheme of benefit as in Thailand, adjusted according to cost of living index, and will ensure it is accordance with local labour law.

Q25 : Though the TBEC is not responsible for the starch factory operation, is there any opportunity to transfer environmental management to the factory?
A25 : The question was answered during the stakeholder consultation meeting. TBEC explained that the host factory often learns from TBECs business practice and adopts their approach to design, construction and employee policy. However, TBEC cannot force our customers to maintain the same standards. TBEC's project will process the mill waste, which is more than half of the factories environmental management concern. TBEC has already advised the starch factory about improving the operation of its existing open lagoons and they must follow regulations from ministry of environmental regarding standards of construction.

Q26 : TBEC will discharge the treated wastewater from the covered lagoon into the existing wastewater treatment lagoon system. TBEC has already assisted to improve the design of the open wastewater treatment lagoon system at LIG. Can TBEC work with the operation of wastewater treatment lagoons?
A26 : The question was answered during the stakeholder consultation meeting. TBEC explained that LIG has built 11 large wastewater treatment lagoons, the large volume and the loss of water through evaporation means that there is zero discharge. If there is any discharge to environment, TBEC help LIG to test the wastewater outflow in order to help maintain high levels of environmental compliance.

Q27 : There was an article in Vientiane Times about cyanide discharge.
A27 : The question was answered during the stakeholder consultation meeting. TBEC explained that sometimes all the facts are not presented in the newspaper. Cassava contains natural cyanide; therefore it should not be eaten raw. The cyanide producing chemical can simply be transformed into non-toxic by-products by sunlight or other sources of heat. TBEC can support LIG to maintain its environmental compliance by providing laboratory tests to determine the quality of water discharged to the environment, i.e. COD, pH and BOD.

SECTION F. Approval and authorization

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The Lao's DNA issued the Letter of Approval for the project on 12th April 2011.

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

Project participant and/or responsible person/ entity	☒ Project participant ☐ Responsible person/ entity for application of the selected methodology (ies) and, where applicable, the selected standardized baselines to the project activity
Organization name	TBEC (Lao) Co., Ltd.
Street/P.O. Box	No.103 Thong Kham Khan Rd
Building	Rm.306 Bounhom Tower
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State/Region	Vientiane Capital
Postcode	
Country	Lao PDR
Telephone	
Fax	
E-mail	gustaf@tbec.co.th; gustaf@pemfund.com
Website	www.tbec.co.th
Contact person	
Title	Managing Director
Salutation	Mr.
Last name	Godenhielm
Middle name	
First name	Lars Gustaf
Department	
Mobile	
Direct fax	+66 2 6509179
Direct tel.	+66 2 6509150
Personal e-mail	Gustaf@tbec.co.th; Gustaf@pemfund.com

Project participant and/or responsible person/ entity	☒ Project participant ☐ Responsible person/ entity for application of the selected methodology (ies) and, where applicable, the selected standardized baselines to the project activity
Organization name	Carbon Bridge Pte Ltd.
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State/Region	
Postcode	089316
Country	Singapore
Telephone	
Fax	
E-mail	bmcintosh@carbon-bridge.com
Website	www.carbon-bridge.com

Contact person	
Title	Managing Director
Salutation	Ms.
Last name	McIntosh
Middle name	
First name	Bridget
Department	
Mobile	
Direct fax	+6564239979
Direct tel.	+6564239969
Personal e-mail	bmcintosh@carbon-bridge.com

Project participant and/or responsible person/ entity	☒ Project participant ☐ Responsible person/ entity for application of the selected methodology (ies) and, where applicable, the selected standardized baselines to the project activity
Organization name	Swedish Energy Agency
Street/P.O. Box	Kungsgatan 43
Building	-
City	Eskilstuna
State/Region	-
Postcode	SE-631 04
Country	Sweden
Telephone	-
Fax	-
E-mail	-
Website	-
Contact person	-
Title	-
Salutation	Mr.
Last name	Hansen
Middle name	-
First name	Ola
Department	-
Mobile	-
Direct fax	-
Direct tel.	-
Personal e-mail	-

Appendix 2. Affirmation regarding public funding

This project will not receive any public funding from Annex 1 Parties.

Appendix 3. Applicability of methodology and standardized baseline

All information is addressed in Section B.2

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

BASELINE INFORMATION

Lagoon #	Width	Length	Surface	Depth	Volume
	meter	meter	m^2	meter	m^3
1	50	200	10,000	8	80,000
2	50	250	12,500	8	100,000
3	50	250	12,500	8	100,000
4	50	200	10,000	8	80,000
5	50	200	10,000	8	80,000
6	50	200	10,000	8	80,000
7	50	160	8,000	7	56,000
8	50	200	10,000	6	60,000
9	50	200	10,000	6	60,000
10	50	160	8,000	5	40,000
11	50	160	8,000	5	40,000
12	50	200	10,000	6	50,000
	Total		119,000		826,000

Table Annex 4a: Details of Tapioca Starch Lagoons

Sample No.	Date of Sample	COD of effluent into first pond	COD report number	COD of treated effluent at final pond	COD report number
		(mg/l)		(mg/l)	
1	7/5/11	15,800	RP 120554/2-2	256	RP 120554/2-10
2	8/5/11	12,267	RP 120554/2-4	240	RP 120554/2-12
3	12/5/11	16,000	RP 120554/2-8	304	RP 120554/2-16
4	13/5/11	11,616	RP 190554/2-2	236	RP 120554/2-10
5	19/5/11	16,474	RP 190554/2-8	338	RP 120554/2-16
6	21/5/11	14,380	RP 250554/2-2	300	RP 250554/2-8
7	27/5/11	15,420	RP 310554/2-4	214	RP 310554/2-14
8	28/5/11	16,585	RP 310554/2-6	222	RP 310554/2-16
9	31/5/11	13,872	RP 060654/4-2	212	RP 060654/4-10
10	4/6/11	16,728	RP 060654/4-8	200	RP 060654/4-16

Table Annex 4b: Details of 10 day COD campaign

Appendix 5. Further background information on monitoring plan

MONITORING INFORMATION

Operational and Management Structure
TBEC will be responsible for the on-site monitoring and implementation of the quality assurance and quality control procedures and compiling the CDM monitoring report for Verification. The operational and management structure that will be implemented is described below.

Shift Leader/Process Operator
TBEC will designate a shift leader/process operator to fulfil the primary monitoring activities. The shift leader/process operator will be responsible for checking the SCADA report and the Electricity Report on daily basis and discuss/share data with the Senior Lab technician.

Senior/ Lab Technician
TBEC will designate a Senior Lab Technician to fulfil the primary monitoring activities, mostly relating to wastewater analysis. The Senior Lab Technician will be responsible for checking of wastewater analysis reports on a daily basis and providing relevant information to the shift leader. The senior lab technician is also responsible for collating all monitored data into the monitoring and verification workbook and submitting to the plant manager daily.

Plant Manager
The Plant manager will be responsible for checking all the monitoring data which they receive from the senior lab technician daily to ensure that the data in section B.7.1 continues to be recorded as per the monitoring requirements of each parameter. The Plant manager is responsible for sending the data on a weekly basis to the QESH Engineer.

QESH Engineer/ CDM Officer
TBEC will designate a QESH Engineer/ CDM Officer to administer the monitoring plan and ensure Quality Assurance and Quality Control Procedures are adhered to. The QESH Engineer/ CDM Officer will be responsible for integrating the Monitoring Plan into TBECs operation and maintenance procedures for the LIG Biogas Plant site. They will be responsible for training the Shift leader/ Process operator and Senior/ lab technician in the correct procedures and to ensure that they understand the requirements of the monitoring plan.

Prior to operation of the project, the QESH Engineer/ CDM Officer will ensure that all meters and monitoring equipment meet the required accuracy and manufacturing standards. During the project, they will ensure the ongoing maintenance and calibration of the all meters and monitoring equipment. Any equipment faults recorded by the Shift leader/Process operator and Senior/ lab technician will be followed up by the QESH Engineer/ CDM Officer who will ensure that the equipment is repaired/replaced as necessary.

The QESH Engineer/ CDM Officer is responsible for compiling the quarterly report and submitting it to TBEC management. They will also participate in a yearly audit. Periodically the QESH Engineer/ CDM Officer undertake a cross check with the data report and the raw data.

Senior Engineer/ QESH&CDM Project Manager
TBEC will designate a Senior Engineer/ QESH&CDM Project Manager to oversee the preparation of the project annual Monitoring Report. They will review the monitored data provided quarterly by the Quality Control Officer and write the report for submission to the Designated Operational Entity (DOE). The Manager may also participate in and review the annual audit in co-ordination with the QESH Engineer/ CDM Officer.

Appendix 6. Summary of post registration changes

There have been no post registration changes for this project activity.

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Document information

Version	Date	Description
06.0	9 March 2015	Revisions to: • Include provisions related to statement on erroneous inclusion of a CPA; • Include provisions related to delayed submission of a monitoring plan; • Provisions related to local stakeholder consultation; • Provisions related to the Host Party; • Editorial improvement.
05.0	25 June 2014	Revisions to: • Include the Attachment: Instructions for filling out the project design document form for CDM project activities (these instructions supersede the "Guidelines for completing the project design document form" (Version 01.0)); • Include provisions related to standardized baselines; • Add contact information on a responsible person(s)/ entity(ies) for the application of the methodology (ies) to the project activity in B.7.4 and Appendix 1; • Change the reference number from *F-CDM-PDD* to *CDM-PDD-FORM;* • Editorial improvement.
04.1	11 April 2012	Editorial revision to change version 02 line in history box from Annex 06 to Annex 06b
04.0	13 March 2012	Revision required to ensure consistency with the "Guidelines for completing the project design document form for CDM project activities" (EB 66, Annex 8).
03.0	26 July 2006	EB 25, Annex 15
02.0	14 June 2004	EB 14, Annex 06b
01.0	03 August 2002	EB 05, Paragraph 12 Initial adoption.

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