CLEAN DEVELOPMENT MECHANISM
PROJECT DESIGN DOCUMENT FORM (CDM-PDD)
Version 03 - in effect as of: 28 July 2006

CONTENTS

Annexes

SECTION A. General description of project activity

A.1. Title of the project activity:

The title of the project activity: Methane Recovery from Advanced Wastewater Treatment System in an Ethanol Plant

The current version number of the document: Version 12

The date of the document was completed: 18/12/2012

A.2. Description of the project activity:

Purpose of the project activity: The purpose of the project activity is to mitigate greenhouse gas (GHG) emissions by applying an anaerobic digester system at an ethanol plant. The proposed system will recover the biogas (containing CH_4) generated from the anaerobic digestion to produce steam and electricity. The steam produced from biogas will displace bunker fuel oil (CO_2 emissions) used at the ethanol plant's boiler in absence of this project. The electricity generated from biogas will displace electricity (CO_2 emissions) from the Philippines Luzon-Visayasgrid.

The project activity is a Greenfield project, where the ethanol plant and wastewater treatment facility did not exist prior to the project activity. It involves the installation of an advanced wastewater treatment system - an upflow-anaerobic sludge blanket (UASB) digester - at the newly-built Roxol Bioenergy Corporation's Ethanol Plant. The system will recover methane gas and use it, together with bagasse and dry vinasse, for steam production (101 TJ/y) and electricity generation (1,067 MWh/y)[1]. Under the project activity, the methane emissions generated during the ethanol plant wastewater treatment will be captured. Under the baseline scenario (open anaerobic lagoons), these methane emissions would be released to the atmosphere.

The common practices for wastewater treatment in distilleries in the Philippines is the use of open anaerobic lagoons, which implies low technological risks, low investment and operation costs compared to the proposed CDM project activity. In absence of CDM incentives, the baseline scenario for the wastewater treatment would be a series of open lagoons (baseline scenario) as defined in section B.4 of this PDD. Electricity would be outsourced from the Luzon-Visayas_grid since it is available at the project site. Furthermore, the fuel that is traditionally used and largely available for boilers in Philippines is bunker fuel oil and therefore in absence of the proposed CDM project activity, the ethanol plant would use bunker fuel as the primary source of fuel[2] to generate steam at the ethanol plant.

The CDM project activity will generate an average of 101,122 tCO_2e emission reductions per year.

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[1] 101 TJ/y and 1,067 MWh/y are quantities of steam and electricity associated with biogas strictly, other renewable fuels are not considered for emission reductions calculations.

[2] Most sugar factories meet their steam needs by burning bagasse. However, factories operating distilleries and refineries (e.g. ethanol plant) often cannot produce sufficient steam from their bagasse to meet all their processing needs. An intermittent supply of bagasse is not sufficient for a stable production of ethanol, and as a result most factories in the Philippines meet their thermal energy needs with bunker fuel oil. Thus bunker oil is considered the primary and reliable source of fuel for boilers, while bagasse is a supplementary fuel used when available at the factory.

Contributions to sustainable development:

- The project activity will reduce the methane emissions by the installation of an enclosed reactor instead of an open lagoon to treat the ethanol plant wastewater effluent. The project will also reduce the fossil fuel consumption at the ethanol plant by utilizing renewable fuel (i.e., methane) instead of the traditional bunker fuel. Furthermore, the project will substitute electricity produced from biogas to electricity from the national grid reducing CO_2 emissions.

- The project activity will improve the local environment and human health. The closed anaerobic treatment proposed will limit bad odor and eliminate possible health hazard caused by other gases that would have been released to the surroundings. Furthermore, the use of evaporator-drier system and recirculation system will eliminate all discharge of treated effluent into the nearby river preventing water pollution.

- The project activity will provide job opportunities to skilled labor during construction and long-term operation and maintenance of equipment and systems.

- The project activity will establish a good model of wastewater treatment practice in distillery industry that could be replicated in other ethanol plants in the country.

A.3. Project participants:

Table A.1. Project participants

Name of Party involved (*) (host) indicates a host Party)	Private and/or public entity(ies) project participants (*) (as applicable)	Kindly indicate if the Party involved wishes to be considered as project participant (Yes/No)
Philippines (Host country)	Roxol Bioenergy Corporation/ Roxas Holdings inc.	No
The Netherlands	The International Bank for Reconstruction and Development (IBRD) as Trustee for the Community Development Carbon Fund (CDCF)	Yes

Contact information for each party is provided in Annex I

A.4. Technical description of the project activity:

A.4.1. Location of the project activity:

Brgg. Nagasi, La Carlota City, Negros Occidental

A.4.1.1. Host Party(ies):

Philippines

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

Province of Negros Occidental

A.4.1.3. City/Town/Community etc.:

La Carlota City

A.4.1.4. Details of physical location, including information allowing the unique identification of this project activity (maximum one page):

The project is located at the Roxol Ethanol Production Plant in La Carlota City in the Province of Negros Occidental. The coordinates are the following:
Latitude: +10.4, Longitude: +122.933

Figure 1. Location Maps

A.4.2. Category(ies) of project activity:

The project activity comes under Sectoral Scope No.13 on: "Waste Handling and Disposal"

A.4.3. Technology to be employed by the project activity:

The project activity involves the installation of: 1) an advanced anaerobic digester system (UASB) for the treatment of ethanol wastewater; 2) a cogeneration unit feeds with the biogas generated from the wastewater treatment. The project will be designed, built and operated by a private entity contracted by Roxol Bioenergy Corporation.

1.0 Advanced wastewater treatment (UASB):
The wastewater treatment plant is designed to **treat 1,000**[3] **cubic meters per day** of wastewater effluent known as vinasse. The ethanol plant will be operated 300 days per year.

The baseline for this Greenfield project (prior this project activity, there was no ethanol and no wastewater treatment facilities) is open anaerobic lagoons as described in detail in section B.4. The methane generated in the UASB reactor will be captured and used to generated electricity and heat. During maintenance, biogas will be flared.

In the proposed project activity, the wastewater will first be collected in a buffer tank. It will then be sent to two UASB reactors where the majority of the organic pollutants will be degraded while generating biogas. The wastewater will enter the UASB by the bottom and flow upward through a blanket of microorganisms suspended by the balance between gravity and the velocity of the flow. In the UASB, the microorganisms will aggregate and form granules. This will occur under proper operation of several parameters, particularly up-flow velocity and pH. The microorganisms will degrade the organic matter immobilised on granules. Degradation will produce several microbial products, including biogas containing the flammable gas methane. At the top of the reactor a Gas Solid Separator (baffled structure) will regulate the flow velocity and separate the biogas, microorganisms and liquid effluents. The baffle structure allows the collection of the gas and the retention of the microorganisms in the UASB reactor. The UASB will reduce the COD concentration of the wastewater by **65%**[4]**.**

The effluent from the UASB reactors will be sent to an evaporator and dryer to dehydrate the remaining solids in the effluent[5]. This process will increase the solids content in the treated wastewater from 8% to 50%. Following the dryer, the final concentrated effluent will be mixed with bagasse for combustion as fuel in the boiler. Sludge produced by the system will be composted. The sludge under the baseline situation would also be composted, thus there are no changes from the baseline.

An open flare[6] will be used to combust biogas during occasional maintenance of the heat/electricity generation unit.

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[3] Contract Supply Annexure (signed between Roxol and KBK Chem-engineering PVT. Ltd., hereafter KBK). 27 June 2008. Page 3.
[4] KBK. Biogas Plant Process description, 23 July 2008. Page 3.

[5] This is a first-of-its-kind technology which has never been used before in the Philippines, and that aims to achieve Roxol commitment towards zero discharge. Given the uncertainties of the technology implementation in the Philippines, this project activity will not claim ER associated with the use of the vinasse as fuel.
[6] KBK Chem-Engineer. Transmittal No.: KBK-813-RBC-TRN-040, 2 April 2010. The flare is designed for a flow of 1,083 kg biogas/hr, the minimum flare temperature is 580°C and minimum biogas flow sets at 50% of the technical capacity.

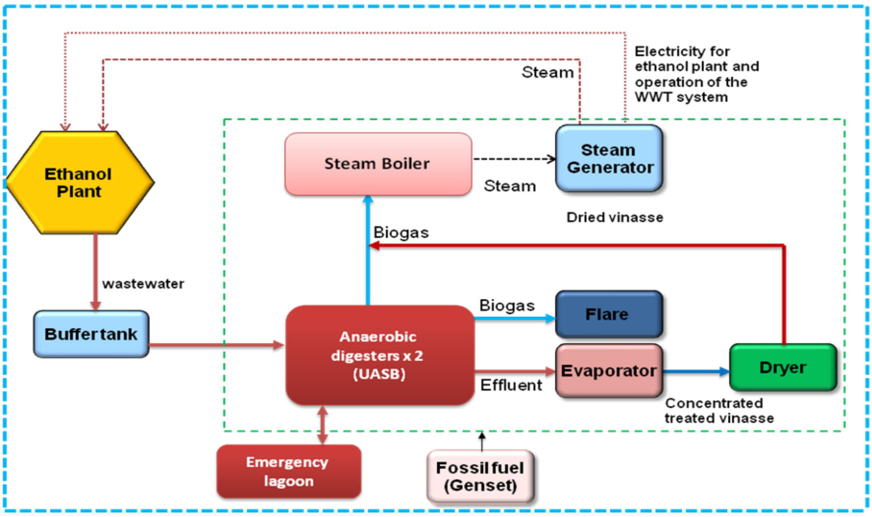

Figure 2. Illustration of the project activity

2) Heat and electricity generation unit (cogeneration unit)
The biogas[7] will be directed to a boiler also feeds with bagasse[8] and dry vinasse (residue from evaporator). Steam generated at the boiler will then be directed to a turbine generating steam and electricity. The boiler and turbine technical specifications are reported below:

Boiler[9]:

- Maximum continuous rating : 40 TPH
- Steam Temp. Outlet at MCR : 380°C ± 10°C
- Steam pressure at outlet : 34 kg/cm^2

Steam turbine[10]

- Inlet steam pressure, : 34 kg/cm^2
- Extraction Steam Pressure : 1.5 kg/cm^2
- Condenser Pressure : 0.15 kg/cm^2
- Extraction Steam Flow : 15- 20 tph
- Power at Alternator Terminals : 4 MW

Biogas and turbine will both be imported from non Annex 1 countries. The system will generate from biogas: 1) **steam** equivalent to 101 TJ annually; and 2) **electricity** equivalent to 1,067 MWh annually. The steam will displace CO_2 emissions from bunker fuel oil and electricity will displace electricity from the grid (baseline scenario). Under this project activity, there is no electricity imported from the grid for the project.

[7] Biogas methane content was estimated at 55%, ref: EIA, Oct 2008, page 3.8.

[8] Note that in the absence of the proposed project activity, the boiler would be fed with bunker fuel oil as a primary source and bagasse as a supplementary fuel (when available due to seasonal production of sugar cane). Therefore, ERs associated with the use of bagasse have not been claimed; and bagasse has not been considered in the investment analysis calculations.

[9] Boiler 40 TPH & Paddle Mixer Technical Specifications, KBK Chem-Engineer, 10 September 2008.

[10] KBK Chem-Engineer. Proposal for Turbine 4 MW Technical Specifications, 30 July 2008.

The quantity of steam that will be generated from biogas will represent about 30%[11] of the total energy produced from the turbine[12]. As a conservative approach, the project strictly covers emission reductions associated with the use of biogas (i.e., not the dry vinasse and bagasse). Furthermore, under this project activity, there is no electricity imported from the grid for the project.

The monitoring and sampling points are represented in the flow sheet diagram in Annex 4.

The operational lifetime of the project is 25 years[13].

A.4.4. Estimated amount of emission reductions over the chosen crediting period:

Years	Annual estimation of emission reductions in tonnes of CO_2e
31/12/2012 – 31/12/2012	277
01/01/2013 – 31/12/2013	101,122
01/01/2014 – 31/12/2014	101,122
01/01/2015 – 31/12/2015	101,122
01/01/2016 – 31/12/2016	101,122
01/01/2017 – 31/12/2017	101,122
01/01/2018 – 31/12/2018	101,122
01/01/2019 – 30/12/2019	100,845
Total estimated reductions (tonnes of CO_2e) – first crediting period	**707,854**
Total number of crediting years	7
Annual average over the crediting period of estimated reduction (tonnes of CO_2e)	101,122

A.4.5. Public funding of the project activity:

The project does not receive any public funding.

SECTION B. Application of a baseline and monitoring methodology

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

The baseline methodology and tools applied to this project activity are:

- ACM0014 - Version 4.1.0 - “Mitigation of greenhouse gases emissions from treatment of industrial wastewater”.

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[11] Roxol Ethanol Plant Power Mix, 2009.

[12] Refer to energy balance in emission reduction calculations excel sheet provided with this PDD.

[13] KBK Chem-Engineer, Transmittal No.: KBK-813-RBC-TRN-039, April 2010. [14] This is a Greenfield activity and thus the average depth is based on design of the baseline lagoon detailed in section B.4 of this Project Design Document.

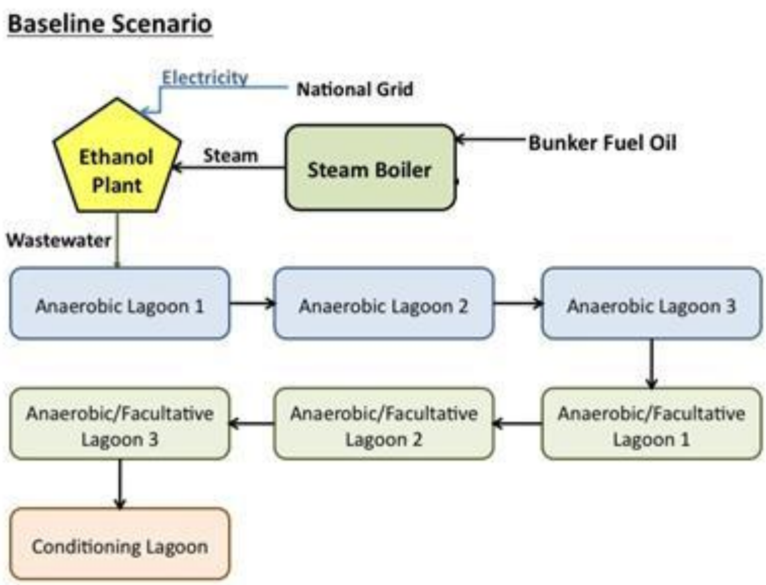
- Tool to calculate the emission factor for an electricity system - Version 2.2.1.
- Tool to determine project emissions from flaring gases containing methane – Version 1.
- Tool for the demonstration and assessment of - Version 06.1.0
- Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion - Version 2.

B.2. Justification of the choice of the methodology and why it is applicable to the project activity:

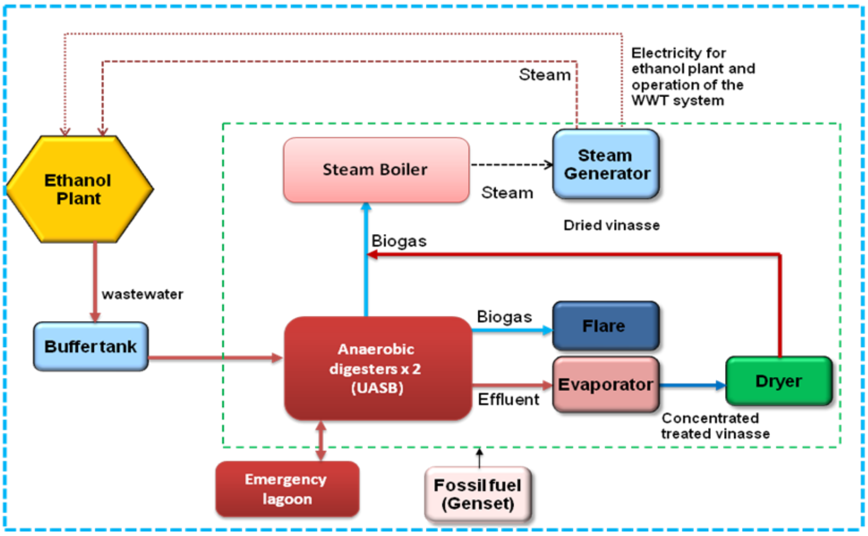
The approved methodology **ACM0014 -Version 4.1.0** is applicable to the proposed project because the project activity fulfils all applicability criteria defined in Scenario 1 of the approved methodology, as justified below and illustrated in figure 3:

Baseline	Project Activity
The wastewater is not treated, but directed to open lagoons that have clearly anaerobic conditions.	The wastewater is treated in a new anaerobic digester. The biogas extracted from the anaerobic digester is used as fuel to generate heat and electricity. The residual from the anaerobic digester is treats under clearly aerobic conditions that do not allowed anaerobic bacteria to survive (wastewater is directed to river after treatment; dried residues are used in boiler).

Figure 3. Illustration of Baseline and Project Activity (as identified in Section B.4)



Project Activity:



Applicability of the methodology. The following are the applicability criteria for **Scenario 1** defined in ACM0014 - Version 4.1.0:

Applicability of ACM0014-Version 4.1.0	Justification
This methodology is applicable to project activities that aim at reducing methane emissions from industrial wastewater treatment. The methodology is applicable to the following conditions:	The proposed project activity will change the proposed wastewater management practice (open lagoon) to that which uses an anaerobic digestion system equipped with a methane recovery and power generation system.
(a) The average depth of the open lagoons in the baseline scenario is at least 1 m.;	(a) The average depth of the open anaerobic lagoons is 6.5 meters as demonstrated in section B.4 of this Project Design Document (PDD)[14].
(b) Heat and electricity requirements per unit input of the water treatment facility remain largely unchanged in the baseline scenario and the project activity;	(b) There is no heat or electricity requirement for wastewater treatment in the baseline scenario. The project activity requires 240 kWh of electricity which will be supplied by the system generated electricity.[15]
(c) Data requirement as laid out in this methodology is fulfilled;	(c) Data requirement as laid out in the methodology is fulfilled in this PDD.
(d) The residence time of the organic matter in the open lagoon system should be at least 30 days;	(d) The residence time of the organic matter in the design open anaerobic lagoons is 355 days as demonstrated in section B.4 of this PDD and Baseline Study for Lagoon[16].
(e) Local regulations do not prevent discharge of wastewater in open lagoons.	(e) There is no regulation that prevents discharge of wastewater into open lagoons. (*Ref. Republic Act 9275 – Philippines Clean Water Act of 2004 and its Implementing*

[14] This is a Greenfield activity and thus the average depth is based on design of the baseline lagoon detailed in section B.4 of this Project Design Document.

[15] 240 kWh *24h/d *300 d/y *1/1000* 0.5416tCO_2e/MWh (EF for national grid) = 936 tCO_2/y which is less than 1% of the overall expected average annual emissions reductions.

[16] Roxol Bioenergy Corporation, 30 March 2010, Lagoon Design Baseline Report v. 3.

Applicability of ACM0014-Version 4.1.0	Justification
	Rules and Regulations contained in DENR DAO 2005-10).

Solid material are not separated prior to the treatment under the baseline and project activity and thus consideration of the solid material as described in version 4.1.0 of the methodology ACM0014 is not applicable to this CDM project activity.

A request for deviation[17] to the methodology ACM0014 v. 4.1.0 was submitted in 02/03/2012, and accepted in 08/05/2012. The aim of this request was to allow the determination and use of a new parameter "$w_{biogas,y}$: fraction of heat/electricity associated with biogas" in order to calculate the portion of emissions reductions associated with biogas only (not bagasse nor dry vinasse) The proposed deviation changes the procedure for measuring the net quantity of electricity generated in year y with biogas from the new anaerobic system ($EG_{PJ,y}$) and the net quantity of heat generated in year y with biogas from the new anaerobic digester ($HG_{PJ,y}$) by introducing the new parameter $w_{biogas,y}$.

Tools applicability:

The "*Tool to calculate the emission factor for an electricity system"* is used to calculate the avoided emissions from grid-connected electricity generation from biogas.

The "Tool to determine project emissions from flaring gases containing methane" is applicable to projects where residual gas stream to be flared contains no other combustible gases than methane, carbon monoxide and hydrogen and the residual gas to be flared is obtained from decomposition of organic material. The project activity includes the flaring of the residual gas (not used to generate electricity or heat), obtained from degradation of organic material during the wastewater treatment and thus the tool is applicable to the project.

The "*Tool for the demonstration and assessment of additionality"* is used to demonstrate the additionality of project as required by the methodology.

There is no consumption of electricity from the grid under this project activity and thus the "*Tool to calculate baseline, project and/or leakage emissions from electricity consumption*" does not apply to this project activity. Electricity is generated using a diesel generator for start-up and during maintenance. These project emissions are calculated using the "*Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion"*. This tool can be used in cases where CO_2 emissions from fossil fuel combustion are calculated based on the quantity of fuel combusted and its properties which applies to the project activity.

B.3. Description of the sources and gases included in the project boundary:

The project boundary is defined and illustrated in figure above.

The emission sources and type of GHG which are included or excluded within the project boundary are shown in the following table:

[17] M-DEV0470 - http://cdm.unfccc.int/Projects/deviations/66676

Emission sources and gases that are included in project boundary

	Source	**Gas**		Justification /Explanation
Baseline	Wastewater treatment processes or sludge disposal	CH_4	Included	The major source of emissions in the baseline from open lagoons (Scenario 1).
		N_2O	Excluded	Excluded for simplification. This is conservative.
		CO_2	Excluded	CO_2 emission from the decomposition of organic waste are not accounted for
	Electricity consumption/ generation	CO_2	Included	Electricity from the grid will be displaced by electricity generated with biogas under the project activity.
		CH_4	Excluded	Excluded for simplification. This is conservative.
		N_2O	Excluded	Excluded for simplification. This is conservative.
	Thermal energy generation	CO_2	Included	Bunker fuel will be displaced by the biogas used to generate thermal energy in boiler.
		CH_4	Excluded	Excluded for simplification. This is conservative.
		N_2O	Excluded	Excluded for simplification. This is conservative.
Project activity	Wastewater treatment processes or sludge treatment process	CH_4	Included	The treatment of wastewater or sludge under the project activity may cause different emissions: (i) Methane emissions from the lagoons (if effluent from the treatment under the project activity is directed to lagoons); this is included in case wastewater is stored in the emergency pond. (ii) Physical leakage of methane from the digester system; this is included. (iii) Methane emissions from flaring (if biogas from the digester is flared); this is included. (iv) Methane emissions from land application of wastewater/sludge; this is not applicable since wastewater and sludge are not disposed to land. (v) Methane emissions from wastewater removed in the dewatering process: this is not applicable to this project.
		CO_2	Excluded	CO_2 from wastewater is from organic source and hence does not count as incremental greenhouse gas.
		N_2O	excluded	This project activity does not involve land application of sludge.
	On-site electricity use	CO_2	Excluded	Electricity is not outsourced from the grid.
		CH_4	Excluded	Excluded
		N_2O	Excluded	Excluded
	On-site fossil fuel consumption	CO_2	Included	Included. Diesel generator will be used at start-up and during maintenance.
		CH_4	Excluded	Excluded for simplification. This emission source is assumed to be very small.
		N_2O	Excluded	Excluded for simplification. This emission source is assumed to be very small.

B.4. Description of how the baseline scenario is identified and description of the identified baseline scenario:

The most plausible baseline scenario is identified through the application of the following steps outlined as per the ACM0014 Version 4.1.0 Sectoral Scope 13 as stated below.

Step 1: Identification of alternative scenarios. Identification of alternatives scenarios is undertaken following guidance of methodology ACM0014 Version 4.1.0 and Step 1a of the "Tool for the demonstration and assessment of additionality" version 06.1.0.

Alternative scenarios for wastewater treatment
The following alternatives are considered for the treatment of the wastewater generated by the ethanol plant:

W1. The use of open lagoons for the treatment of the wastewater;
W2. Direct release of wastewater to a nearby water body;
W3. Aerobic wastewater treatment facilities (e.g., activated sludge or filter bed type treatment);
W4. Anaerobic digester with methane recovery and flaring;
W5. Anaerobic digester with methane recovery and utilization for electricity or heat generation by the project developer (the project activity) – without being developed as a CDM project;
W6. Anaerobic digester with methane recovery and production of electricity or heat generation sale to the grid (electricity) or nearby off-takers – without being developed as a CDM project;
W7: Wastewater is directed to land application without dewatering; and
W8: Wastewater is dewatered and directed to land application/used as fuel in energy applications.

Alternative scenarios for electricity
Since the project activity includes electricity generation with biogas from a new anaerobic digester, below are the plausible alternative scenarios determined for electricity generation:

E1. Power generation using fossil fuels in a captive power plant;
E2. Electricity generation in the grid;
E3. Electricity generation using renewable sources;
E4. Electricity generated from biogas undertaken without being registered as a CDM Project Activity.

Alternative scenarios for heat generation
The project activity will also include heat generation with biogas from a new anaerobic digester, plausible alternative scenarios for the generation of heat:

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;
H4: Heat generated from biogas undertaken without being registered as a CDM Project Activity.

This project covers Scenario 1 and thus the sludge disposal scenarios are not included. Furthermore, the solids are not separated prior to the wastewater treatment and thus the analysis of various solid management scenarios is not applicable.

Credible alternatives are identified as follow:

- W1: The use of open anaerobic lagoons: **Plausible**. The common industrial practice in the Philippines is to use open lagoons to naturally degrade the compounds in the effluent before its discharge. There are two ethanol manufacturers in the Philippines[18], namely Leyte Agri Corporation and San Carlos Bioenergy Incorporated. San Carlos facility also includes an anaerobic digestion[19] and was registered as a CDM project[20] for the renewable energy use. However, Leyte Agri Corporation adopted stabilizer pond as to ensure that the final effluent meets national standard, the pond is not covered and does not involved renewable energy production[21]. Because of the low operating cost and the general availability of land in the areas where distilleries are typically located, open anaerobic lagoons are commonly employed in ethanol plants located outside municipal areas where ample space is available. It is generally considered the most economical and practical option to meet the regulatory criteria. The capital investment, operating and maintenance costs are acceptable to the ethanol plant owners.

  Furthermore, this project is a Greenfield project and thus scenario W1 is further defined as per the 4 steps approaches describe in the methodology.

- W2: Direct release of wastewater to a nearby water body: **Plausible**, but not permitted by law and thus disqualified at step 2.

- W3: Aerobic wastewater treatment facilities: **Not plausible**. It is suitable for treating effluent with medium to low organic charge in wastewater[22]. If this management technique is applied to treat wastewater with high organic charge, as it is the case with Ethanol Plant, the electricity consumed for forced aeration will be high.

- W4: Anaerobic digester with methane recovery and flaring: **Not plausible**. Using the closed-tank anaerobic digester system and flaring the biogas generated is technologically viable. However, the recovery of methane with flaring implies only costs, no costs saving or revenues and is not mandatory by law. Moreover, the successful design and installation of anaerobic system with methane recovery necessitate high technical expertise in the field of wastewater treatment and consideration of the specific properties of the effluent. The operation of the system is highly complex as anaerobic systems are living systems[23,24]. These technological risks are not covered by any economic incentive other than CDM. As demonstrated in section B.5 (investment analysis), even for a system including cost saving (with electricity generation), it is not profitable to go ahead without CDM revenues.

- W5: Anaerobic Digester with methane recovery and utilization for electricity and/or heat generation

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[18] List of accredited bio-ethanol producers as of 17/08/2009, Philippines Department of Energy.

[19] PDD for San Carlos Renewable Energy Project, registered on 13April 2007, page 22.

[20] Project reference no. 0931, registered on 13 April 2007

[21] E-mail communication with Leyte Agro Corporation, 2010.

[22] Government of the Philippines, 2005. Philippines Sanitation Sourcebook and Decision Aid, page 7

[23] Ibid.

[24] The Government of the Philippines.,2005. Philippines Sanitation Sourcebook and Decision Aid, page 66.

without CDM revenues. **Plausible**. Technically feasible, however as demonstrated in section B.5 (Step 2: investment analysis), this scenario (i.e. the proposed project activity without CDM revenues) is not profitable without CDM revenues in spite of the cost saving associated with the electricity/heat production.

- W6: Anaerobic digester with methane recovery and production of electricity or heat generation sale to the grid (electricity) or nearby off-takers - without being developed as a CDM project. **Not plausible**. There are no potential off takers in the vicinity of the plant[25] since the nearest potential off-taker is located 30 km from the project activity site. The sale to the electricity to the grid is not relevant because there will be no extra capacity available for sale after the ethanol plant own consumption. Furthermore the regulatory context is not favorable to the sale of electricity to the grid (refer to E1).

- W7: Wastewater is directed to land application without dewatering. **Plausible**, but not permitted by law and thus disqualified at step 2.

- W8: Wastewater is dewatered and directed to land application/used as fuel in energy applications. Dewaterering of wastewater and land application is possible but not permitted by law and disqualified in step 2. The use of wastewater as a fuel in energy application is not possible under the proposed project activity[26].

- E1: Power generation using fossil fuels in a captive power plant: **Not Plausible**. The production of power using fossil fuel is hampered by the potential high operating cost and fluctuating prices of fossil fuel according to market prices[27]. Furthermore, the adoption of The Electric Power Industry Reform Act of 2001 (EPIRA)[28] has changed the regulatory framework and stipulates that the NPC "shall not incur any new obligations to purchase power through bilateral contracts with generation companies and other suppliers" (Section 47(i) of EPIRA). Hence, it does not secured investment in generation of additional electrical power for sell to the national grid.

- E2: Electricity generation in the grid: **Plausible.** The electricity for the grid can be used at the plant. This is the common practice at distilleries due to relatively low price at 3.90 PHP per kWh[29].

- E3: Electricity generation using renewable sources: **Not Plausible**. The sugarcane harvesting and milling is seasonal in the Philippines[30]. Therefore bagasse is not readily available all year round. Because of the limited availability, power generation using renewable such as biomass (bagasse) can only be considered if additional resources (e.g. biogas) are available to supply the power

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[25] Map of the Negros with localization of the other plants in the region, 2010, submitted to DOE at validation.

[26] Dry vinasse, the residue from wastewater treatment after evaporation will be used as a source of energy at boiler, however no emission reductions are to be accounted for conservativeness.

[27] Philippines Department of Energy Oil price Monitor 2007-2009 the average retail price of Diesel ranges between 31.75-44.45 PHP/l or 40% fluctuation.

[28] Philippines Republic Act No. 9136, approved on 08/06/2001.

[29] Philippine average price, 2007, National Power Corporation.

[30] Mr Jose Maria T. Zabaleta,1997. Will the Philippines revert to its net sugar exporter status? Prepared for the Food and Agriculture Organization of the United Nations.

generation unit. Generating electricity from other renewable energy sources such as wind and solar are not applicable as the project entity core business is the production of ethanol.

- E4: Electricity generated from biogas undertaken without being registered as a CDM Project activity: **Plausible.** Technically this is feasible, however, as demonstrated in section B.5 (Step 2: investment analysis), this scenario (i.e. the proposed project activity without CDM revenues) is not profitable without CDM revenues in spite of the cost saving associated with the electricity/heat production.

- H1: Co-generation of heat using fossil fuels in a captive cogeneration power plant: **Not Plausible**. There are very few experiences in the Philippines with co-generation plants due to limited availability of the technology, lack of concrete incentives for investors, lack of track records, limited access to financing and access limited access to power market[31]. Securing upfront financing in the Philippines is also a challenge due to the technical perceived risks[32].

- H2: Heat generation using fossil fuels in a boiler: **Plausible**. It is common practice for ethanol production facility to generate heat from fossil fuel (bunker fuel oil). The primary fuel[33] for this project without CDM would be to use bunker fuel oil for the boilers.

- H3: Heat generation using renewable sources: **Onlyplausible in combination with additional resources**. Bagasse is a sub-product of the sugarcane industry, which is always used for steam generation when available. The supply of raw material such as bagasse is limited. The sugarcane harvesting and milling is seasonal in the Philippines[34], and therefore, bagasse is not readily available all year round for use in the ethanol production. Therefore, the supply of renewable energy sources such as biomass (bagasse) is not readily available for electricity production. Because of the limited availability, heat generation using renewable such as biomass (bagasse) can only be considered if additional resources (e.g. biogas) are available.

- H4: Heat generated from biogas undertaken without being registered as a CDM Project activity: **Plausible.** Technically this is feasible, however, as demonstrated in section B.5 (Step 2: investment analysis), this scenario (i.e. the proposed project activity without CDM revenues) is not profitable without CDM revenues in spite of the cost saving associated with the electricity/heat production.

Summary of credible alternatives are summarised in the table below:

Combination	Wastewater treatment	Electricity generation	Heat generation
1	W1 (open anaerobic lagoons)	E2 (grid)	H2 (fossil fuel boiler) + H3 (bagasse)
2	W2 (Direct release to water body)	E2 (grid)	H2 (fossil fuel boiler) + H3 (bagasse)
3	W5 (anaerobic digester with	E2 (grid)	H4 (biogas) + H3 (bagasse)

[31] Antonio V. del Rosario. 2004. Philippine Cogeneration Outlook: Immediate Opportunities.

[32] ibid

[33] When available, bagasse is always used in the sugarcane industry to generate heat. However, due to seasonal cane production and thus unstable supply, bagasse is considered a supplementary fuel to heavy fuel oil.

[34] Mr Jose Maria T. Zabaleta. 1997. Will the Philippines revert to its net sugar exporter status? Prepared for the Food and Agriculture Organization of the United Nations.

	biogas recovery and use)		
4	W5 (anaerobic digester with biogas recovery and use)	E4 (biogas)	H2 (fossil fuel boiler) + H3 (bagasse)
5	W5 (anaerobic digester with biogas recovery and use)	E4 (biogas)	H4 (biogas) + H3 (bagasse)
6	W7 (wastewater not dewatered to land)	E2 (grid)	H2 (fossil fuel boiler) + H3 (bagasse)
7	W8 (wastewater dewatered to land)	E2 (grid)	H2 (fossil fuel boiler) + H3 (bagasse)

Since the project consists in the simultaneous production of heat and electricity using biogas, the intermediary scenarios considering biogas for only one source of energy (thermal or electrical, combinations 3, 4) are no longer considered.

Greenfield facility and design of the baseline lagoon (W1 scenario):
This project is implemented in a Greenfield facility and thus the specifications of the **W1** scenario shall be defined following four steps:

Step (a) Define several lagoon design options for the particular wastewater stream that meet the relevant regulations and take into consideration local conditions

For this Greenfield project (new ethanol plant and new wastewater treatment plant), three anaerobic lagoon configurations with different dimensions and depth have been defined[35].

These three configurations (reported in Table B.4.1) have been developed based on the wastewater steam, local conditions of the site, land availability and local regulations.

Under the current regulatory system in the Philippines, distilleries are required to treat their effluent before discharged it or disposing of it. As the final effluent (if treated in open lagoons) would be discharged to the nearby river, the specific criteria for discharged to a river was applied to the design of the lagoons[36] : regulation limits the BOD_5 concentration of the final effluent to 99% removal or 300 mg/l – whichever is the minimum.

The COD of the inflow is 125,000 mg/l[37], which is equivalent to a BOD_5 of 62,500 mg/l using a conversion factor of 2[38]. A removal efficiency of 99.52% is required to obtain a BOD_5 of 300 mg/l[39], which is more conservative when compared to 99%; thus 99.52% is used for the design of the lagoons.

[35] Roxol Bioenergy Corporation, 30 March 2010, Lagoon Design Baseline Report v. 3.
[36] DENR DAO No. 10 Series of 2005 and DA AO No. 26 Series of 2007.

[37] Contract Supply Annexure (signed between Roxol and KBK). 27 June 2008.

[38] The ratio BOD_5/COD vary between 0.3 to 0.7. ref: Beltran de Heredia, J.R. Dominguez and E. Partido. Physico-chemical treatment for the depuration of wine distillery wastewaters (vinasses).Water Science and Technology Vol 51, No 1, pp.159–166. IWA Publishing 2005

[39] Treatment efficiency (%) = $100 * BOD5_{in} - BOD5_{out} / BOD5_{out}$ = 100*(62,500-300)/62,500 = 99.52%.

Industries are not required to install any specific type of the wastewater treatment facility to meet this criteria, as long as the performance meet the regulatory discharged criteria. The current practice in distilleries in the Philippines is a series of open lagoons[40].

The options for the open lagoons have been designed to meet the applicable regulatory criteria (300 mg/l (BOD_5) equivalent to 600 mg/l (COD)[41]) while considering the land availability and geological characteristic of the site. The local conditions, wastewater characteristic and treatment performance are shown in *Table B.4.1.*

Table B.4.1 Detail of open anaerobic lagoons

Category	Data & Parameters	Value	Source
Local Conditions	Annual Average temperature	27.4 °C	Environmental Impact Assessment, Oct. 2008
	Land availability for the open lagoons	10 ha	Lagoon Baseline Report v 3, Roxol Bioenergy Corporation, 30 March 2010
Wastewater Generation	Wastewater generation	1,000 m^3/day	Contract Supply Annexure (signed between Roxol and KBK). 27 June 2008.
	Annual Operation days of ethanol plant	300 days/year	Environmental Impact Assessment, Oct. 2008
	COD of inflow to anaerobic open lagoon	125,000 mg/l	Contract Supply Annexure (signed between Roxol and KBK). 27 June 2008.
Wastewater Treatment performance for inland water discharge	COD of outflow	Approximately 600 mg/l	Calculated. Lagoon Baseline Report v3, Roxol Bioenergy Corporation, 30 March 2010
	COD removal (corresponding to 99.52% efficiency)	37,320 tons COD per year[42]	Calculated. Lagoon Baseline Reportv 3, Roxol Bioenergy Corporation, 30 March 2010
	Design removal efficiency (AD_{BL})	99.52 %	Calculated. Lagoon Baseline Report v 3, Roxol Bioenergy Corporation, 30 March 2010
	Maximum BOD_5 for discharge to river	300 mg/l	DENR DAO No. 10 Series of 2005 and DA AO No. 26 Series of 2007

The following additional information about the conditions at the project site has been confirmed:

- There is sufficient gradient at the site to allow the wastewater to flow from lagoon to lagoon by gravity alone and without the use of pumps and electricity; and

[40] In 2010, there is only one accredited ethanol plant that has successfully capture and utilized methane gas for use as fuel; this project was developed as a CDM project. See details in section B5 of this PDD.

[41] Calculated using a conversion factor of 2.

[42] COD removal = (125,000 mg/l-600 mg/l) * 1000 l/m^3 * 1000 m^3/d *300 d/y / (1E09 tons/ mg).

- Land availability at the project site for wastewater treatment facility is approximately 10 hectares.

Based on the above parameters and a COD removal rate of 0.3 kg COD/(m^3 d)[43], three lagoons with various depths are designed. Major design specifications are summarized as follows:

Table B.4.2 Design specifications for three design options (open lagoon - W1) [44]

Design Specification	Unit	Option 1	Option 2	Option 3
Volume of lagoon	1000 m^3	350	350	350
Surface Area	m^2	100,000	63,670	53,870
Average depth	m	3.5	5.5	6.5
Hydraulic retention time	Day	355	355	355

For all options, no electricity consumption is considered as there is sufficient gradient for gravity flow, therefore, EC_{BL}=0.

Step (b) Carry out an economic assessment of the identified options

An economic assessment was carried out to compare the options identified above. The following parameters and values have been considered:

- Land cost is estimated at 27.45 Php/square meter[45].
- Excavation/construction costs are estimated at 540.71 Php/cubic meter[46].
- Operation & maintenance, administration costs are assumed to be negligible and no difference is assumed between the options.
- Electricity cost: no electricity consumption is required for water pumping since there is sufficient gradient at the site to allow the wastewater to flow from lagoon to lagoon by gravity alone and without the use of pumps.
- Sludge disposal costs: not considered for this analysis as the costs would be about the same for all design options. Sludge would be composted and disposed to land under the baseline. Fossil fuel consumption for mechanical equipment involved in the sludge disposal is not considered as assumed to be about the same for all options.

Table B.4.3 Cost Comparison[47]

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[43] US Environmental Protection Agency (EPA), Wastewater Technology Factsheet, Anaerobic lagoon, 2002.

[44] Volume required = 37,320,000 kg COD/y / (365 d/y *0.3 kg/ m^3 d) = 340,822 m^3, round-up to 350,000 m^3. As the land available is limited to 100,000 m^2, a depth of 3.5 m is calculated (i.e., 350,000/100,000). For options 2 and 3, the volume is kept constant (350,000 m^3) while variable depth are tested (i.e., 5.5 m and 6.5 m). Source: Roxol Bioenergy Corporation, 30 March 2010, Lagoon Design Baseline Report v. 3.

[45] Cost based on sale contract for land (deed of absolute sale), and adjusted to 2007 (time of the investment decision) using the inflation rate from the National Statistics Office of the Philippines

[46] Cost based on purchase order for an open lagoon for another site owned by the project entity. Costs have been adjusted to the volume required for this project and year 2007.

[47] Volume required = 37,500,000 kg COD/y / (365 d/y *0.3 kg/ m^3 d) = 342,465 m^3, round-up to 350,000 m^3. As the land available is limited to 100,000 m^2, a depth of 3.5m is necessary (350,000/100,000). For options 2 and 3, the volume is kept constant (at 350,000 m^3- since this volume is required to treat the effluent at the required criteria, while

Design Specification	Unit	Option 1	Option 2	Option 3
Electricity consumption	mPhP	0	0	0
Excavation + HDPE membrane	mPhP	**196.30**	**196.40**	**196.38**
Land cost	mPhP	**2.87**	**1.83**	**1.55**
Total Cost	mPhP	**199.17**	**198.23**	**197.93**

As per the methodology, the lowest cost option is selected, i.e., **Option 3**.

Step (c) Verify the average depth of the lagoon

Anaerobic ponds/lagoons have been used for treatment of wastewater with high BOD concentration such as piggery waste, slaughterhouse and beverage industries (Von Sperling et al, 2005). A typical depth of anaerobic lagoon in the Philippines ranges between 2.5-7 m[48]. This depth range is also confirmed by the Environmental Protection Agency (2002), which recommends depth approaching 6 m[49]. According to Von Sperling et *al.*[50], the depth of the lagoon/pond is critical because oxygen produced in the surface could penetrate to the lower layers and kill the methane forming bacteria. In fact, in order to guarantee the predominance of anaerobic conditions, the deeper the pond the better. The limiting factor preventing the construction of deeper ponds is the cost of excavation, the geological structural change below 7.5 meters will increase the construction cost dramatically[51].

Step (d): If the average depth of the lagoon design identified in Step (b) is deeper than the depth identified through literature review or control group in Step (c), provide credible explanation why assumption of the least cost design are valid:

Not applicable.

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

Sub-step 1b of the latest version (version 06.1.0) of the "Tool for the demonstration and assessment of additionality" is applied to eliminate alternatives that are not in compliance with all applicable legal and regulatory requirements. Treatment methods W1, W3, W4, W5, W6; electricity generation methods E1, E2, and E3; and heat generation H1, H2 and H3 are in compliance with all applicable legal and regulatory requirements.

Distilleries in Philippines are required to treat their effluent to meet the quality set by the Clean Water Act before being discharged or disposed, therefore the option W2 (i.e., Direct release of wastewater to a nearby water body) [52], W7 (i.e., wastewater is directed to land application without dewatering) and W8 (wastewater is dewatered and directed to land application)[53] are not allowed under the applicable laws and regulations.

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the depth varied between 5.5 m and 6.5 m.). The excavation costs remains constant for the given volume of soil, however the cost are higher for depth of more than 6.5 m due to soil properties ref: Soil Investigation report 2008.

[48] Farms Compliance Assistance Center, Philippines, 2009, Lagoon system.

[49] US EPA. 2002Wastewater technology Factsheet - Anaerobic Lagoons. Page 4, see lagoon dimensions.

[50] Von Sperling, M., C.A. de Lemos Chernicharo and F. Fernandes, 2002. *Biological Wastewater Treatment in Warm Climate Regions*, IWA Publishing.

[51] Guerrero Surveying Office, October 2008. Soil Investigation Report for Ethanol Plant.

[52] DENR DAO No. 35 Series of 1990; Republic Act No. 9275- Philippines Clean Water Act of 2004.

[53] DENR DAO No. 34, Series of 1990; Revised Water usage and Classification /Water quality Criteria Amending Section Nos.68 and 69, Chapter III of the 1978 NPCC Rules and Regulations.

The standard for industrial effluent specifies that the wastewater must be treated to meet the following standard:

Disposal to the river: lower limit between 99% removal or 300 mg/L BOD limit[54].

W2, W7, W8 are not plausible under the applicable laws and regulations and no longer considered under this analysis.

Summary of credible alternatives and combination of alternatives remaining after Step 2:

Combination	Wastewater treatment	Electricity generation	Heat generation
1	W1 (open anaerobic lagoons)	E2 (grid)	H2 (fossil fuel boiler) + H3 (bagasse)
5	W5 (anaerobic digester with biogas recovery and use)	E4 (biogas)	H4 (biogas) + H3 (bagasse)

Step 3: Eliminate alternatives that face prohibitive barriers
Alternatives that are not credible are identified in Step 1 of this section.

Step 4: Compare economic attractiveness of remaining alternatives
Economic attractiveness without CERs revenues of the remaining alternatives is compared by applying Step 2 of the "Tool for the demonstration and assessment of additionality". Using investment comparison (refer to Section B.5), it is demonstrated that the most costs effective scenario, selected as the baseline, is the Combination 1 (W1, E2, H2).

B.5. Description of how the anthropogenic emissions of GHG by sources are reduced below those that would have occurred in the absence of the registered CDM project activity (assessment and demonstration of additionality):

The project reduces anthropogenic emissions of GHG through the destruction of methane, which is produced through the anaerobic decay of wastewater from the ethanol plant at Negros occidental. The advanced and enclosed wastewater treatment that is proposed under this project activity would not be possible without CDM incentives, as demonstrated below.

Start date and implementation timeline

The start date of the project was prior the date of validation. Evidences that the incentive from the CDM was seriously considered in the decision to proceed are show below.

Project Timeline	Dates	Supporting Evidences
Project Idea Note submitted to the World Bank	21 March 2007	Pin, 2007
Feasibility Study for Ethanol Project integrating CDM revenues for the proposed project activity	27 July 2007	July 27 2007 FS

[54] Table 3B, Section 6, DENR DAO No. 35 Series of 1990; Republic Act No. 9275- Philippines Clean Water Act of 2004; DENR DAO No. 10 Series of 2005, Implementing Rules and Regulations of RA 9275, Rule No. 19.6

compared to the open lagoon (baseline)[55]		
Project information report presenting the proposed project activity with reference to CDM revenues	01 October 2007	World Bank Report 2007[56]
Letter of Intent signed with the World Bank	09 October 2007	WB LOI, 2008
Invitation for bidding with reference to CDM	12 November 2007	Email from Ramon A. Picornell, Jr. CEO of the company 2007
Board Meeting and decision to go ahead with the project (including reference to CDM)	15 November, 2007	Minutes meeting hold on 15, Nov. 2007 & Investment Presentation including CDM revenues, Roxol, 2007[57]
Request for revision of CDM approved methodology (ACM0014) for this project to cover Greenfield activity	12 January 2008	AM_REV_0078[58]
Construction Contract for ethanol plant and wastewater treatment Signed between Roxol and KBK[59]	**27 June 2008**	**Roxol, 2008b**
Site planning for construction	2 July 2008	Construction schedule
Stakeholder Consultations	20 September 2008	Roxol, 2008
EIA completed	October, 2008	CADP Group Corp. Oct 2008
EIA Approval	9 January 2009	DENR, 2009
ERPA signed	14 January 2009	ERPA, 2009

The civil works of the project started in February 2010. The waste water treatment plant was commissioned in June 2011, but it has not commenced its commercial run yet.

According to the above timeline, the date of the decision is **15 November 2007[60].**

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[55] The feasibility study explores different options for wastewater treatment including open lagoons (reported as the least cost option among technically viable alternatives that are consistent with local regulation) and the project activity (presented as the highest costs options). The project activity is presented with CDM revenues.

[56] World Bank, 01/10/2007, Project Information Document.

[57] Presentation made at the Board meeting includes carbon revenues estimated at 11$/ton CO_2e * 123,560 tons for 10 years (slide 4, page 5).

[58] Request for revision to include Greenfield projects (submitted 12 Jan 08).

[59] Turn-key contract covering engineering, construction and operation of the plant.

[60] Also the reference time for the investment analysis.

ACM0014 version 4.1.0 requires that the additionality of the project be demonstrated and assessed using the latest version of the “Tool for the demonstration and assessment of additionality” version 06.1.0.

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

As described and evidenced in section B.4 following the elimination of alternatives that are not credible or do not comply with the laws and regulation, the list of possible baseline scenarios are as follow:

Combination	Wastewater treatment	Electricity generation	Heat generation
1	W1 (open anaerobic lagoons)	E2 (grid)	H2 (fossil fuel boiler) + H3 (bagasse)
5	W5 (anaerobic digestor with biogas recovery and use)	E4 (biogas)	H4 (biogas) + H3 (bagasse)

The project owner would not adopt the proposed wastewater treatment system (i.e., combination 5, enclosed anaerobic reactors with electricity and heat production, W5-E4-H4), in absence of CDM incentives. The wastewater would be treated in open anaerobic lagoon systems (combination 1). The CH_4 emissions generated by the open lagoons would be emitted to the atmosphere. As detailed in this section, the industrial practices in the country are the use of open anaerobic lagoons without methane recovery to generate heat and electricity. As described and evidenced in section B.4 of this PDD, this is due to the low investment and operating cost associated with open lagoon, higher perceived technological risks associated with the proposed project and lack of incentives/laws and regulations for methane recovery and energy generation.

Sub-step 1(b): Enforcement of applicable laws and regulations:

As indicated in B.4 all of the above alternatives are consistent with existing laws and regulations.

Wastewater discharges are regulated under the Philippines Clean Water Act (RA 9275) of 2004 which adopts the effluents standards of DENR DAO 35-1990. This law does not impose any restrictions or prescriptions on wastewater treatment technology to be used. Industries can choose wastewater treatment method independently as long as the final effluent meets the specified effluent standards. The Clean Water Act imposes concentration limits on BOD and other pollutants. The BOD concentration limit of 99% or 300mg/l (lower value) is applicable for river discharge.

The Philippines Clean Air Act (RA 8749) of 1999 which governs industrial air emissions does not impose any restrictions on GHG emissions. Hence, the project owner is not compelled by law to control methane emissions from the wastewater treatment plant.

Step 2: Investment analysis

Sub-step 2(a): Determine appropriate analysis method

An investment analysis is undertaken to further substantiate the additionality of the project activity. Since at least two alternatives are associated with costs, an investment comparison analysis (Option II) should be conducted on all remaining combinations.

Sub-step 2(b): Option II. Apply investment comparison

This step offers some options for making an investment comparison analysis such as identification of IRR, NPV, cost benefit ratio, or unit cost of service and amongst these options the NPV identification is used for investment comparison analysis of different alternatives.

Sub-step 2 (c): Calculation and comparison of financial indicators
The following tables summarizes the project's NPV (before taxes) calculation computed for the lifetime of the project (25 years), including all assumptions made.

Costs or revenues (USD)	Project activity without CDM (W5, E4, H4)	Baseline (W1, E2, H2)
Investment cost	10,068,661	3,718,449
Annual revenues bunker fuel oil saving	231,933	0
Annual revenues electricity saving	1,132,053	0
Annual O & M costs	696,033	100
Project lifetime	25 years	25 years
Residual value (including salvage value of based on 5% depreciation rate on equipment[61])	2,078,334	28,812
Discount rate	12%	12%
NPV (before taxes)	(4,224,007)	(3,319,043)

From the above comparison, it is clear that the project activity without CDM, with a NPV of (4,498,401), is financially less attractive than the baseline, with a NPV of (3,319,043). Therefore, the project is additional.

Assumptions for calculation of all scenarios' NPV

Inputs data (applicable to all scenarios)	Value	Units	Source
Exchange rate	51.31	PhP/US$	Av. exchange rate, Central Bank of Philippines, 2006 [62]
land price	20,000	US $ /ha	FSR, page 10
Residual value of the plant and energy generation system after 25 years	2,078,334	US$	KBK, Transmittal No.: KBK-813-RBC-TRN-039, April 2010
Year of reference for the investment analysis	2007	-	Certified extract of the minutes meetings hold on 15, Nov. 2007 (time of the investment decision).
Discount rate[63]	12	%	Philippines DOE, http://www.doe.gov.ph/Downloads/PDP.pdf)

Assumptions for calculation of the project's NPV (W5, E4, H4)

Initial investments	Cost (US)	Cost (PhP)	Comments/Source
Biogas Anaerobic Digester System	1,948,775	100,000,000	FS report, 2007, page 37 & Ethanol Project Cost Estimates Revised 2008 12 08
Vinasse Evaporator and condensate treatment	2,241,091	115,000,000	FS report, 2007, page 37 & Ethanol Project Cost Estimates Revised 2008 12 08

[61] IMF Working Paper WP/08/207, Investment Incentives and Effective Tax Rates in the Philippines.

[62] http://www.bsp.gov.ph/statistics/spei_pub/Table%2036.pdf

[63] The discount rate used (12%) is derived from the Power Supply Plan for the Philippine national grid published on the official webpage of the Philippine Department of Energy. This value is before tax, and therefore it is considered to be more conservative than the default (post-tax) value (12.75%) of the EB *"Guidelines on the assessment of investment analysis"*.

system			
Turbine & electrical items	1,728,000	88,671,110	FS report, 2007, page 10 & Ethanol Project Cost Estimates Revised 2008 12 08
Paddle mixer and dryer	487,194	25,000,000	FS report, 2007, page 37 & Ethanol Project Cost Estimates Revised 2008 12 08
Emergency Pond	4,215	216,283	Based excavation + HDPE costs (540.71 PhP/m^3) for 400m^3 lagoon (equivalent to the capacity of one reactor for one day retention)
Land	19,600	1,005,760	Calculated: area for the treatment (0.98ha) * price land/ha (20,000 US $/ha) . Price of the land: FSR page 10
Site development apportion to the wastewater treatment (0.98 hectare)	24,500	1,275,200	From the FS report, 2007, page 10 & Plant Layout
Boiler	1,431,600	73,461,552	FS Report, page 10
Water Treatment (for boiler feed water)	243,000	12,469,375	FS Report, page 10
Holding lagoon for concentrated vinasse slops	275,000	14,111,433	FS Report, page 10
Contingencies	882,687	45,294,484	FS Report, page 10
Support facilities	200,000	10,262,860	FS Report, page 10
Civil & structural works (foundations, buildings and related structures)	115,000	5,901,145	FS Report, page 10
TOTAL (initial investment)	**10,068,661**	**452,944,845**	-
Operation and Maintenance	696,033	452,944,845	Cost per year /Refer to Excel Sheet FA August 2010 v4

Costs saving		Value	Unit	Notes
Costs saving	Heat	231,933	USD/y	Based on 194 TJ/y of heat generated from biogas and vinasseper year and the Price bunker fuel oil 23.62 PhP/l[64]
	Electricity	1,132,053	USD/y	Based on 14,908 MWh of electricity generated from biomass+vinasse+bagasse, and price of electricity (2007) : 3.90 PhP/kWh[65]

[64] Based on PO purchase of bunker fuel in Philippine, 2007

[65] Electricity tariff for Luzon grid, National Power Corporation average price, 2007. Only electricity tariff for Luzon grid has been used as this will be the real tariff the project owner will have to pay. In addition, Luzon's tariff is higher, and therefore more conservative, than the Visaya's one (2.90PhP/kWh)

Luzon's electricity tariff 2007: http://www.napocor.gov.ph/power%20rates/eff_rates_for_luzon_grid_prev.htm

Visaya's electricity tariff 2007: http://www.napocor.gov.ph/Power%20Rates/eff_rates_for_visayas_grid_prev.htm

Assumptions for calculation of the NPV for the combination W1, E2, and H2

Initial investments	Cost (US)	Cost (PhP)	Comments/Source
Excavation + HDPE membrane	3,689,637	189,331,161	Roxol Bioenergy Corporation, 30 March 2010, Lagoon Design Baseline Report v. 3.
Land	28,812	1,478,471	Calculated: area for the treatment * price land/m^2 Price of the land: from the sale contract for land.
TOTAL (initial investment)	3,718,449	190,809,632	-
Operation and Maintenance	100	5,119	Purchase order n-19517 sludge disposal from lagoon from other plants owned by the company, comparable dimensions .

Sub-step 2d: Sensitivity analysis

In order to test the robustness of the assumptions made, sensitivity analyses were carried out on the following parameters:

- Bunker fuel avoided from biogas
- Electricity produced from biogas
- Bunker fuel oil tariff
- Electricity tariff
- Capital costs
- O&M costs

As showed in the following table, the sensitivity analysis shows that in spite of the range of realistic and optimistic assumptions made, the project returns remain unfavorable compared to the baseline scenario.

Parameters	NPV project (W5, E4, H4) - Sensitivity analysis		
	-10%	0%	10%
Bunker fuel oil avoided	(4,385,207)	(4,224,007)	(4,062,808)
Electricity production	(5,010,816)	(4,224,007)	(3,437,199)
Bunker fuel oil tariff	(4,385,207)	(4,224,007)	(4,062,808)
Electricity tariff	(5,010,816)	(4,224,007)	(3,437,199)
Capital costs	(3,325,020)	(4,224,007)	(5,122,995)
O& M costs	(3,740,245)	(4,224,007)	(4,707,770)

Parameters	NPV baseline (W1, E2, H2) - Sensitivity analysis		
	-10%	0%	10%
Capital costs	(2,987,038)	(3,319,043)	(3,651,047)
O& M costs	(3,318,973)	(3,319,043)	(3,319,112)

Additional analysis has been conducted to evaluate the values of the parameters required to change the conclusions of the analysis.

For the combination W5, E4, H4 (project activity):

- Bunker fuel avoided: increase by 50% (from 194 to 380 t/y), this is not possible as all biogas and vinasse available were taken into considerations in the calculations.
- Electricity production: increase by 11%, this is not possible as all biogas, vinasse and bagasse available were taken into considerations in the calculations.
- Bunker fuel oil price: increase by 50%, this is unlikely due to historical variations of heating oil (similar to bunker fuel oil and heavy fuel oil) price. The average annual percentage change during 1997 – 2007 (10 years prior to the investment decision) was only 15.73%[66].
- Electricity tariff: increase by 11% is unlikely due to historical variations of electricity price[67]. Electricity tariff of the Luzon grid have been used for the financial analysis (as compared to the Visayas grid). This is reflecting how electricity is charged in the Philippine depending on location of the client. Furthermore, this is conservative given the higher price in Luzon[68].
- Capital costs: decrease by 10% (from 9,002,406USD to 8,102,165 USD). Since the actual costs for the project[69] are close to the costs estimate in the Feasibility Study and used in the financial analysis, a decrease of the capital costs by 10% is very unlikely to occur[70].
- O&M costs: decrease by 17%. These costs are covering direct labor, fuel costs, maintenance, material fee, administrative costs and insurance. They are based on different sources, each being clearly identified in the financial analysis sheet, including Feasibility Study and KBK[71]. These figures are conservative since they exclude contingencies/major overhaul. Furthermore, as the material price and wages for the workers have been keeping increasing because the inflation rates in Philippines: the average inflation rate was 5.1% for the period 2003-2007 (just before the investment decision was made), 5.2% for the period 2008-2011.[72] Therefore, based on the positive trend in the inflation, it is highly unlikely that the O&M cost of the proposed project will be reduced.

For the combination W1, E2, H2:

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[66] http://www.indexmundi.com/commodities/?commodity=crude-oil&months=240&commodity=heating-oil

[67] **Average tariffs for the <u>Luzon</u> have** remained constant from mid 2005-2008, while variation was only 2% in mid 2005 as compared to 2004. This is justified by the published historical data by: National Power Corporation average price http://www.napocor.gov.ph/power%20rates/eff_rates_for_luzon_grid_prev.htm

[68]Luzon's electricity tariff 2007: 3.90 PhP/kWh - http://www.napocor.gov.ph/power%20rates/eff_rates_for_luzon_grid_prev.htm

Visaya's electricity tariff 2007: 2.90 PhP/kWh - http://www.napocor.gov.ph/Power%20Rates/eff_rates_for_visayas_grid_prev.htm

[69] Actual costs figures have been made available to the DOE.

[70] FS report, 2007, page 12.

[71] Contract Supply Annexure (signed between Roxol and KBK Chem-engineering PVT. Ltd., hereafter KBK). 27 June 2008. Page 3

[72] IMF World Economic Outlook Report April 2012 (page 201) and April 2011 (page 192)..

- Capital costs: increase by 100% in order to reach the project NPV (without variation, i.e., 6,718,388 which is not realistic as the costs are mainly associated with excavation and land, which is supported with the signed contract for land purchased. The effect of considering the residual value of the land or not has no significant impact on the result. Fixed excavation costs, for which an increase by 100% is very unlikely to occur, depend primarily on the location (type of soil and topography), depth and volume of soil excavated. As for the variable fraction of the excavation costs (such as labour costs or equipment rental), the Philippines annual percentage change in wage rates (2%) and services inflation rates (7.66%)[73], clearly shows an increase far below the 100% increase required to reach the project NPV.

- O&M costs: are minor and have almost no effect on the NPV (costs are strictly associated with annual sludge removal, assumption based on another similar site for sludge removal, water flow is based on gravity only). For instance, an increase by 10,000% (from 100 USD/y to 10,074 USD/y), which is very unlikely to occur in the future, would have no effect on the baseline NPV value (from (3,319,043) to (3,388,365)).

Step 3. Barrier analysis
A barriers analysis is undertaken in section B.4 for the elimination of alternatives scenarios. Furthermore, the additionality is of the project activity is substantiated with the investment analysis (section B.5, step 2).

Step 4: Common practice analysis

According to the "Tool for the demonstration and assessment of additionality" version 06.1.0, the project activity falls under the following Measure (see paragraph 6 of the Tool): c) Methane Destruction. To prove that the project activity is not a common practice within a sector, the following 4 steps as per the Tool have been applied:

The scope of the common practice analysis is specifically related to wastewater utilization resulting from ethanol plants and not to anaerobic treatment of wastewater because wastewater from ethanol plant has specific characteristics compared to other type of wastewater.

Step 1: Calculate the applicable output range +/-50% of the design output or capacity of the proposed project activity.
The wastewater treatment plant is designed to treat 1,000 cubic meters per day of wastewater effluent, which means that any ethanol wastewater treatment plant with a capacity to treat between 500-1,500 m3 would be within the applicable output range.

Outcome of Step 1: The applicable output of the project activity is 500-1,500 m3 of treated ethanol waste water.

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.
The applicable geographical area is the Philippines. To date, there are two ethanol plants within the country[74] and one accredited ethanol plant that has successfully captured and utilized methane gas for use as

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[73] Bangko Sentral NG Pilipinas - http://www.bsp.gov.ph/statistics/statistics_selected_monthly.asp

[74] List of accredited bio-ethanol producers as of 17/08/2009. Philippines Department of Energy.

fuel and this project is a CDM project[75], however the technology utilized for the registered CDM project differs significantly from the proposed CDM project activity (the San Carlo project involved a covered in ground anaerobic reactor[76]). Furthermore, the final effluent of the registered CDM project is used for irrigation and thus needs to meet a standard less strict than the one for in-land water quality as prescribed by DENR DAO No. 10 Series of 2005. There is no other accredited ethanol plant that has adopted technology allowing methane recovery and energy generation in the Philippines. The second ethanol plant in the Philippines is Leyte Agri Corporation, using a stabilizer where the wastewater is treated in a collecting pond.

Therefore, there is only another ethanol plant in Philippines which is not registered as a CDM. Thus, N_{all} = 1

Outcome of step 2: N_{all} is equal to 1

Step 3: Within plants identified in Step 2, identify those that apply technologies different that the technology applied in the proposed project activity.
The existing ethanol plant in the Philippines uses a different technology based on a stabilizer where the wastewater is treated in collecting pond. Thus, N_{diff} = 1

Outcome of step 3: N_{diff} = 1.

Step 4: Calculate Factor: $F = 1 – N_{diff}/N_{all}$
In this case F=1-(1/1) = 0, meaning the proposed project activity is not a "common practice" since F = 0 (less than 0.2) and N_{all}-N_{diff} = 0 (less than 3).

Therefore the outcome of the stepwise approach is that the project activity is not the common practice for ethanol wastewater treatment plants within the Philippines.

B.6. Emission reductions:

B.6.1. Explanation of methodological choices:

The project activity is implemented in a Greenfield facility, thus only the Methane Conversion Factor Method applies. Emission reductions are estimated following the approved methodology ACM0014 version 4.1.0. The estimation of baseline, project and leakages emissions are described below.

Baseline emissions:

Baseline emissions are calculated using the following equation:

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

Where:

BE_y Baseline emissions in year *y* (tCO_2e/yr)

[75] The ethanol plant is San Carlos which has been registered as a CDM project in 13/04/2007.
[76] PDD for CDM Project San Carlos Renewable Energy Project (0931), page 22.

BE_{CH4} Methane emissions from anaerobic treatment of the wastewater in open lagoons (scenario 1) in the absence of the project activity in year *y* (tCO_2e/yr)

$BE_{EL,y}$ CO_2 emissions associated with electricity generation that is displaced by the project activity and/or electricity consumption in the absence of the project activity in year *y* (tCO_2/yr)

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

Baseline emissions are calculated in three steps, as follow:

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

The methodology proposes two alternatives methods for the estimation of the methane emissions from open lagoons:

a) The Methane Conversion Factor method
b) The Organic Removal Ratio method

The Methane Conversion Factor Method was selected.

Step 1a) Methane Conversion Factor Method

The baseline methane emissions from anaerobic treatment of wastewater in open lagoons (Scenario 1) are calculated as follow:

$$BE_{CH4,y} = GWP_{CH4} \times MCF_{BL,y} \times B_o \times COD_{BL,y} \quad (2)$$

Where:

BE_{CH4} Methane emissions from anaerobic treatment of the wastewater in open lagoons in year *y* (tCO_2e/yr).

GWP_{CH4} Global Warming Potential of methane valid for the commitment period (tCO_2e/tCH_4).

B_o Maximum methane producing capacity, expressing the maximum amount of CH_4 that can be produced from a given quantity of chemical oxygen demand ($tCH_4/tCOD$).

$MCF_{BL,y}$ Average baseline methane conversion factor (fraction) in year *y*, representing the fraction of ($COD_{PJ,y}$ x B_o) that would be degraded to CH_4 in the absence of the project activity (see following paragraphs for calculations).

$COD_{BL,y}$ Quantity of chemical oxygen demand that would be treated in open lagoons (Scenario 1) in the absence of the project activity in year y (tCOD/yr)

Determination of $COD_{BL,y}$

As a conservative assessment, it is assumed there will be an effluent from the lagoons in the baseline. Therefore the COD is adjusted with the following equations:

$$COD_{BL,y} = AD_{BL} \times COD_{PJ,y} \quad (3)$$

$$AD_{BL} = 1 - \frac{COD_{out,x}}{COD_{in,x}} \quad (4)$$

Where

$COD_{BL,y}$ Quantity of chemical oxygen demand that would be treated in open lagoons (Scenario 1) in the absence of the project activity in year *y* (tCOD/yr)

$COD_{PL,y}$ Quantity of chemical oxygen demand that is treated in anaerobic digester or under clearly aerobic conditions in the project activity in year *y* (tCOD/yr)

AD_{BL} Effluent adjustment factor expressing the percentage of COD that is degraded in open lagoons in the absence of the project activity

$COD_{out,x}$ COD of the effluent in the period x (t COD)

$COD_{in,x}$ COD directed to open lagoons in the period x (t COD)

For project implemented in Greenfield facilities

In the case of project activities implemented in Greenfield facilities, where the baseline is new to be built anaerobic lagoon, AD_{BL} is determined based on the design features that were identified as the baseline in the procedure outline in Step 1 of the "procedure for the identification of the most plausible baseline scenario", by using in above the design COD inflow for COD_{in} and the design effluent COD flow for COD_{out}.

$$COD_{PJ,y} = \sum_{m=1}^{12} F_{PJ,dig,m} \times w_{COD,dig,m} \qquad (5)$$

$COD_{PJ,y}$ Quantity of chemical oxygen demand that is treated in the anaerobic digester or under clearly aerobic conditions in the project activity in year y (tCOD/yr)

$F_{PJ,dig,m}$ Quantity of wastewater that is treated in the anaerobic digester or under clearly anaerobic conditions in the project activity in month m (m^3/month)

$w_{COD,dig,m}$ Average chemical oxygen demand in the wastewater or sludge that is treated in the anaerobic digester or under clearly anaerobic conditions in the project activity in month *m* (tCOD/ m^3)

m Months of year y of the crediting period

Determination of $MCF_{BL,y}$

$$MCF_{BL,y} = f_d \times f_{T,y} \times 0.89 \qquad (6)$$

Where:

f_d Factor expressing the influence of the depth of the lagoon or sludge pit on methane generation

$f_{T,y}$ Factor expressing the influence of the temperature on the methane generation in year *y*.

0.89 Conservativeness factor

Determination of $f_{T,y}$

The factor $f_{T,y}$ is calculated with the help of a monthly stock change model which aims at assessing how much COD degrades in each month. For each month m, the quantity of wastewater directed to the lagoon, the quantity of organic compounds that decay and the quantity of any effluent water from the lagoon is balanced, giving the quantity of COD that is available for degradation in the next month: The amount of organic matter available for degradation to methane ($COD_{available,m}$) is assumed to be equal to the amount of organic matter directed to the open lagoon or sludge pit, less any effluent, plus the COD that may have remained in the lagoon or sludge pit from previous months, as follows:

$$COD_{available,m} = COD_{BL,m} + (1 - f_{T,m}) \times COD_{available,m-1} \quad (7)$$

$$COD_{BL,m} = AD_{BL} \times COD_{PJ,m} \quad (8)$$

$$COD_{PJ,m} = F_{PJ,dig,m} \times w_{COD,dig,m} \quad (9)$$

Where:

$COD_{available,m}$	Quantity of chemical oxygen demand available for degradation in the open lagoon or sludge pit in month *m* (t COD/month)
$COD_{BL,m}$	Quantity of chemical oxygen demand that would be treated in open lagoons (Scenario 1) in the absence of the project activity in month *m* (t COD/month)
$COD_{PJ,m}$	Quantity of chemical oxygen demand that is treated in the anaerobic digester or under clearly aerobic conditions in the project activity in month *m* (t COD/month)
AD_{BL}	Effluent adjustment factor expressing the percentage of COD that is degraded in open lagoons (Scenario 1) in the absence of the project activity
$F_{PJ,dig,m}$	Quantity of wastewater or sludge that is treated in the anaerobic digester or under clearly aerobic conditions in the project activity in month *m* (m^3/month)
$w_{COD,dig,m}$	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* (t COD/m^3)
$f_{T,m}$	Factor expressing the influence of the temperature on the methane generation in month *m*
m	Months of year *y* of the crediting period

This project activity is implemented in Greenfield facilities, where the baseline is a new to be built anaerobic lagoon, thus the residence time of organic matter was set according to the design features of the lagoon that was identified as the baseline in Step 1 of the section “Procedure for the identification of the most plausible baseline scenario”.

$$f_{T,m} = \begin{cases} 0 & \text{if } T_{2,m} < 283\,K \\ \exp\left(E * \left(\frac{T_{2,m} - T_1}{R * T_1 * T_{2,m}}\right)\right) & \text{if } 283\,K < T_{2,m} < 303\,K \\ 1 & \text{if } T_{2,m} > 303\,K \end{cases}$$

(eq. 10)

Where:

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

The factor expressing the influence of the temperature on the methane generation in year *y* is calculated with the following equation:

$$f_{T,y} = \frac{\sum_{m=1}^{12} f_{t,m} \times COD_{available,m}}{\sum_{m=1}^{12} COD_{BL,m}}$$

(eq. 11)

where:

$f_{T,y}$ Factor expressing the influence of the temperature on the methane generation in year *y*

$f_{T,m}$ Factor expressing the influence of the temperature on the methane generation in month, calculated using previous equation.

$COD_{available,m}$ Quantity of chemical oxygen demand available for degradation in the open lagoon or sludge pit in month m (tCOD/month). Calculated using the fallowing equation:
$\mathbf{COD_{available,m} = COD_{BL,m} + (1 - f_{T,m}) \times COD_{available,m-1}}$

$COD_{BL,m}$ Quantity of chemical oxygen demand that would be treated in open lagoons (scenario 1) in the absence of the project activity in month *m* (t COD/month).

m Months of year *y* of the crediting period

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

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

$BE_{EL,y} = (EC_{BL,y} + EG_{PJ,y}) \text{ x } EF_{BL,EL,y}$ (12)

$BE_{EL,y}$ CO_2 emissions associated with electricity generation that is displaced by the project activity and/or electricity consumption in the absence of the project activity in year *y*

$EC_{BL,y}$ Annual quantity of electricity that would be consumed in the absence of the project activity for the treatment of the wastewater (Scenario 1) (MWh/yr)

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

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

The net quantity of electricity generated from biogas is calculated as follow:

$EG_{PJ,y} = (w_{biogas,y} * E_{tot,y}) - E_{con,WWT,y}$

$w_{biogas,y} = (NCV_{biogas,boiler} * F_{biogas,boiler,y})/[(NCV_{dry\ vinasse,boiler} * F_{dry\ vinasse,boiler,y}) + (NCV_{bagasse,boiler} * F_{bagasse,boiler,y}) + (NCV_{biogas,boiler} * F_{biogas,boiler,y})]$ (13)

where:

$w_{biogas,y}$ Fraction of heat/electricity associated with biogas at the turbine in year y

$E_{tot,y}$ Electricity generated from the turbine in year *y* (MWh)

$E_{con,WWT,y}$ Electricity consumed for the wastewater treatment in year *y* (MWh)

$NCV_{biogas,boiler}$ Net calorific value of biogas (kJ per volume or mass unit)
$NCV_{dry\ vinasse,\ boiler}$ Net calorific value of dry vinasse (kJ per volume or mass unit)
$NCV_{bagasse,boiler}$ Net calorific value of bagasse (kJ per volume or mass unit)
$F_{biogas,boiler,y}$ Amount of biogas sent to boiler in year *y* (m^3/y)
$F_{dry\ vinasse,\ boiler,y}$ Amount of dry vinasse sent to boiler in year y (t/y)
$F_{bagasse,boiler,y}$ Amount of bagasse sent to boiler in year y (t/y)

Baseline emission factor for electricity generated in the absence of the project activity in year y is calculated on following the Tool to calculate the emission factor for an electricity system version 2.2.1. Refer to Annex 3 of this PDD for details.

Step 3: Baseline emissions from the generation of heat

Baseline emissions associated with fossil fuel combustion for heating equipment that is displaced by the project is as follows:

$$BE_{HG,y} = (HG_{PJ,y} * EF_{CO2,FF,boiler})/n_{BL,boiler} \quad (14)$$

Where:

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

$$HG_{PJ,y} = w_{biogas,y} * [(F_{steam,y} * E_{steam,y}) - (E_{feed\ water,y})] \quad /10E9 \quad (15)$$

Where
$w_{biogas,y}$ Fraction of heat/electricity associated with biogas at the turbine in year y
$F_{steam,y}$ Quantity of steam generated from the turbine in year *y* (kg/y)
$E_{steam,y}$ Enthalpy of the steam generated by the turbine in year y (kJ/kg)
$E_{feed\ water,y}$ Heat content of the feed water entering the boiler in year y (kJ/y)

$E_{feed\ water,y} = F_{feed\ water,y} * T_{feed\ water,y} * 4.1868$ kJ/kg C
$F_{feed\ water,y}$ Quantity of feed water in year *y* (kg/y)
$T_{feed\ water,y}$ Temperature of feed water in year *y* (deg C)

Project emissions:

Emissions that need to be considered in this case (new anaerobic treatment, scenario 1) are the following:

(i) Methane emissions from the open lagoons or dewatering process (applicable if residual from the anaerobic digester, after treatment under the project activity, is directed to either open lagoons or to a dewatering facility);
(ii) Physical leakage of methane from the digester system;
(iii) Methane emissions from flaring (applicable if biogas from the digester is flared);

(iv) Methane and nitrous oxide emissions from land application of sludge;
(v) Methane and nitrous oxide emissions from land application of wastewater
(vi) CO_2 emissions from consumption of electricity and or fossil fuels in the project activity.

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

(equation 16)

PE_y	=	Project emissions in year *y* (tCO_2e/yr)
$PE_{CH4,effluent,y}$	=	Project emissions from treatment of wastewater effluent from the anaerobic digester in year *y* (tCO_2e/yr)
$PE_{CH4,digest,y}$	=	Project emissions from physical leakage of methane from the anaerobic digester in year *y* (tCO_2e/yr)
$PE_{flare,y}$	=	Project emissions from flaring of biogas generated in the anaerobic digester in year *y* (tCO_2e/yr)[77]
$PE_{sludge,LA,y}$	=	Project emissions from land application of sludge in year *y* (tCO_2e/yr)
$PE_{ww,LA,y}$	=	Project emissions from land application of wastewater in year *y* (tCO_2e/yr)
$PE_{EC,y}$	=	Project emissions from electricity consumption in year *y* (tCO_2e/yr)
$PE_{FC,y}$	=	Project emissions from fossil fuel consumption in year *y* (tCO_2e/yr)

(i) ***Project methane emissions from effluent from the digester***

This emission source is only applicable if a new digester is installed under the project activity and if the effluent from this digester is directed to open lagoons or a dewatering facility. In this case, the effluent will be direct to an open lagoon (emergency pond) only in case maintenance/reparation is required on the reactors (effluent will then be re-circulated in the UASB reactor). In case the emergency lagoon is used, this will be documented and project emissions will be considered. The same method as for the baseline emissions will be applied.

Methane conversion factor method

Project methane emissions from treatment of the effluent from the digester are estimated as follows:

$$PE_{CH4,effluent,y} = GWP_{CH4} \times MCF_{PJ,y} \times B_o \times \left(COD_{PJ,effl,dig,y} - COD_{PJ,effl,lag,y}\right) \quad (17)$$

$$COD_{PJ,effl,dig,y} = \sum_{m=1}^{12} F_{PJ,effl,dig,m} \times w_{COD,effl,dig,m} \quad (18)$$

$$COD_{PJ,effl,lag,y} = \sum_{m=1}^{12} F_{PJ,effl,lag,m} \times w_{COD,effl,lag,m} \quad (19)$$

[77] The parameters used to determine the project emissions from flaring of the residual gas stream in year *y* should be monitored as per the: “Tool to determine project emissions from flaring gases containing methane”.

Where:

$PE_{CH4,effluent,y}$	=	Project emissions from treatment of wastewater effluent from the anaerobic digester in year *y* (tCO_2e/yr)
GWP_{CH4}	=	Global Warming Potential of methane valid for the commitment period (tCO_2e/tCH_4)
$MCF_{PJ,y}$	=	Project methane conversion factor (fraction) in year *y*, representing the fraction of ($COD_{PJ,effluent,y}$ x B_o) that degrades to CH_4
B_o	=	Maximum methane producing capacity, expressing the maximum amount of CH_4 that can be produced from a given quantity of chemical oxygen demand ($tCH_4/tCOD$)
$COD_{PJ,effl,dig,y}$	=	Quantity of chemical oxygen demand in the effluent from the digester in year *y* (tCOD/yr)
$COD_{PJ,effl,lag,y}$	=	Quantity of chemical oxygen demand in the effluent of the open lagoon in which the effluent from the digester is treated in year *y* (tCOD/yr)
$F_{PJ,effl,dig,m}$	=	Quantity of effluent from the digester in month *m* (m^3/month)
$w_{COD,effl,dig,m}$	=	Average chemical oxygen demand in the effluent from the digester in month *m* (t COD/m^3)
$F_{PJ,effl,lag,m}$	=	Quantity of effluent from the open lagoon in which the effluent from the digester is stored in month *m* (m^3/month)
$w_{COD,effl,lag,m}$	=	Average chemical oxygen demand in the effluent from the open lagoon in which the effluent from the digester is treated in month *m* (t COD/m^3)

The quantity of methane generated from COD disposed to the open lagoon or in dewatering facility is calculated as follows:

$$MCF_{PJ,y} = f_d \times f_{PJ,T,y} \quad (20)$$

Where:

$MCF_{PJ,y}$	=	Project methane conversion factor (fraction) in year *y*, representing the fraction of ($COD_{PJ,effluent,y}$ x B_o) that degrades to CH_4
f_d	=	Factor expressing the influence of the depth of the lagoon on methane generation
$f_{PJ,T,y}$	=	Factor expression the influence of the temperature on the methane generation under the project activity in year *y*

The factor $f_{T,PJ,y}$ is calculated, as under baseline emissions, with the help of a monthly stock change model which aims at assessing how much COD degrades in each month, as follows:

$$COD_{PJ,available,m} = \left(COD_{PJ,effl,dig,m} - COD_{PJ,effl,lag,m}\right) + (1 - f_{T,m}) \times COD_{PJ,available,m-1} \quad (21)$$

$$COD_{PJ,effl,dig,m} = F_{PJ,effl,dig,m} \times w_{COD,effl,dig,m} \quad (22)$$

$$COD_{PJ,effl,lag,m} = F_{PJ,effl,lag,m} \times w_{COD,effl,lag,m} \quad (23)$$

Where:

$COD_{PJ,available,m}$	=	Quantity of chemical oxygen demand available for degradation in the open lagoon under the project activity in month *m* (t COD/month)
$COD_{PJ,effl,dig,m}$	=	Quantity of chemical oxygen demand in the effluent from the digester in month *m* (tCOD/month)
$COD_{PJ,effl,lag,m}$	=	Quantity of chemical oxygen demand in the effluent of the open lagoon in which the

		effluent from the digester is treated in month *m* (tCOD/month)
$F_{PJ,effl,dig,m}$	=	Quantity of effluent from the digester in month *m* (m³/month)
$w_{COD,effl,dig,m}$	=	Average chemical oxygen demand in the effluent from the digester in month *m* (t COD/m³)
$F_{PJ,effl,lag,m}$	=	Quantity of effluent from the open lagoon in which the effluent from the digester is treated in month *m* (m³/month)
$w_{COD,effl,lag,m}$	=	Average chemical oxygen demand in the effluent from the open lagoon in which the effluent from the digester is treated in month *m* (t COD/m³)
$f_{T,m}$	=	Factor expressing the influence of the temperature on the methane generation in month *m*
m	=	Months of year *y* of the crediting period

In this case the residence time in the open lagoon will be less than one year, thus as per the methodology the carry-on calculations will be limited to the period where the wastewater will remain in the lagoon. Project participants will provide evidence of the residence time of the organic matter in the lagoon.

The monthly factor to account for the influence of the temperature on methane generation is calculated as per equation above.

Based on the monthly values $f_{T,m}$ the annual value $f_{T,PJ,y}$ is calculated as follows:

$$f_{PJ,T,y} = \frac{\sum_{m=1}^{12} f_{T,m} \times COD_{PJ,avaialble,m}}{\sum_{m=1}^{12}\left(COD_{PJ,effl,dig,m} - COD_{PJ,effl,lag,m}\right)} \qquad (24)$$

Where:

$f_{PJ,T,y}$	=	Factor expressing the influence of the temperature on the methane generation under the project activity in year *y*
$f_{T,m}$	=	Factor expressing the influence of the temperature on the methane generation in month *m*
$COD_{PJ,available,m}$	=	Quantity of chemical oxygen demand available for degradation in the open lagoon facility under the project activity in month *m* (t COD/month)
$COD_{PJ,effl,dig,m}$	=	Quantity of chemical oxygen demand in the effluent from the digester in month *m* (tCOD/month)
$COD_{PJ,effl,lag,m}$	=	Quantity of chemical oxygen demand in the effluent of the open lagoon in which the effluent from the digester is treated in month *m* (tCOD/month)
m	=	Months of year *y* of the crediting period

The subsequent steps in the process (dewatering through evaporator and CPU) will not be generating methane as the temperature at the evaporator is higher than 90 ºC, which is an inhibiting factor for the anaerobic activity to occur[78].

(ii) ***Project emissions related to physical leakage from the digester***

[78] Microbiology and Chemistry for Environmental Scientists and Engineers (2nd Edition) J.N. Lester and J.W. Birkett: Most bacteria are thermophilicphiles, which grow within the range 10-45º C with an optimum temperature for maximum growth occurring at 30-40ºC. Thermophilic bacteria grow only poorly at temperatures of 50-60 º C.

This emission sources is only applicable if the project activity includes the construction of a new anaerobic digester. The emissions directly associated with the operation of the digesters involve physical leakage of methane from the digester system. Methane emissions from the new digester are calculated as follows:

$$PE_{CH4,digest,y} = F_{biogas,y} \text{ x } FL_{biogas,digest} \text{ x } w_{CH4,biogas,y} \text{ x } GWP_{CH4} \text{ x } 0.001 \qquad (25)$$

$PE_{CH4,digest,y}$	Project emissions from physical leakage of methane from the anaerobic 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 the digester (m^3 biogas leaked/m^3 biogas produced)
$w_{CH4,biogas,y}$	Concentration of methane in the biogas in the outlet of the new digester (kg CH_4/m^3)

(iii) ***Methane emissions from flaring***

This emission source is only applicable if under the project activity biogas is generated in a new anaerobic digester and if all or a part of the biogas is flared. Methane may be released as a result of incomplete combustion in case of biogas use for electricity and/or heat production. To calculate project emissions from flaring of a residual gas stream containing methane ($PE_{flare,y}$) the *"Tool to determine project emissions from flaring gases containing Methane"* will be used.

Emissions due to flaring of biogas in year "y" (tCO_2e)

$$PE_{flare,y} = \sum_{h=1}^{8760} TM_{RG,h} * (1 - \eta_{flow,h}) * \frac{GWP_{CH4}}{1000} \qquad (26)$$

The plant will use open flare. According to the *Tool to determine project emissions from flaring gases containing methane*, in case of open flares, the flare efficiency cannot be measured in a reliable manner (i.e. external air will be mixed and will dilute the remaining methane) and a default value of 50% is to be used provided that it can be demonstrated that the flare is operational (e.g. through a flame detection system reporting electronically on continuous basis). If the flare is not operational the default value to be adopted for flare efficiency is 0%.

This tool involves the following seven steps:
STEP 1: Determination of the mass flow rate of the residual gas that is flared
STEP 2: Determination of the mass fraction of carbon, hydrogen, oxygen and nitrogen in the residual gas
STEP 3: Determination of the volumetric flow rate of the exhaust gas on a dry basis
STEP 4: Determination of methane mass flow rate of the exhaust gas on a dry basis
STEP 5: Determination of methane mass flow rate of the residual gas on a dry basis
STEP 6: Determination of the hourly flare efficiency
STEP 7: Calculation of annual project emissions from flaring based on measured hourly values or based on default flare efficiencies.

Project participants shall apply these steps to calculate project emissions from flaring ($PE_{flare,y}$) based on the measured hourly flare efficiency or based on the default values for the flare efficiency ($\eta_{flare,h}$). Note that steps 3 and 4 are only applicable in case of enclosed flares and continuous monitoring of the flare efficiency and thus do not apply to this case.

STEP 1. Determination of the mass flow rate of the residual gas that is flared

$$FM_{RG,h} = \rho_{RG,n,h} \times FV_{RG,h} \qquad (27)$$

Where:

$FM_{RG,h}$	=	Mass flow rate of the residual gas in hour h, kg/h.
$\rho_{RG,n,h}$	=	Density of the residual gas at normal conditions in hour h, kg/m^3.
$FV_{RG,h}$	=	Volumetric flow rate of the residual gas in dry basis at normal conditions in the hour h, m^3/h.

$$\rho_{RG,n,h} = \frac{P_n}{\frac{R_u}{MM_{RG,h}} \times T_n} \qquad (28)$$

Where:

P_n	=	Atmospheric pressure at normal conditions (101 325), Pa
R_u	=	Universal ideal gas constant (8 314), Pa.m^3/kmol.K
$MM_{RG,h}$	=	Molecular mass of the residual gas in hour h, kg/kmol
T_n	=	Temperature at normal conditions (273.15), K

$$MM_{RG,h} = \sum_i (fv_{i,h} \times MM_i) \qquad (29)$$

Where:

fv_i,h	=	Volumetric fraction of component i in the residual gas in the hour h
MM_i	=	Molecular mass of residual gas component i, kg/kmol
i	=	limited to the two main components CH_4 and N_2.

Note that according to the recommendation of the methodological “Tool to determine project emissions from flaring gases containing methane”, as a simplified approach, only the volumetric fraction of methane can be measured and the difference to 100% can be considered as being nitrogen (N_2). This option is selected for this project activity.

STEP 2. Determination of the mass fraction of carbon, hydrogen, oxygen and nitrogen in the residual gas

Not applicable (refer to step 1.1), the simplified approach was selected, thus only the volumetric fraction of methane is to be measured and the difference to 100% is to be considered as being nitrogen (N_2).

STEP 3. Determination of the volumetric flow rate of the exhaust gas on a dry basis

Step 3 and Step 4 of the *Tool to determine project emissions from flaring gases containing methane* do not apply to open flare.

STEP 4. Determination of methane mass flow rate of the exhaust gas on a dry basis

Step 3 and Step 4 of the *Tool to determine project emissions from flaring gases containing methane* do not apply to open flare.

STEP 5. Determination of methane mass flow rate in the residual gas on a dry basis

$$TM_{RG,h} = FV_{RG,h} \times fv_{CH4,RG,h} \times \rho_{CH4,n} \qquad (30)$$

Where:

$TM_{RG,h}$	=	Mass flow rate of methane in the exhaust gas of the flare in dry basis at normal conditions in the hour h
$fv_{CH4,RG,h}$	=	Volumetric fraction of methane in the residual gas on dry basis in hour h.
$\rho_{CH4,n}$	=	Density of methane at normal conditions (0.716), kg/m^3.

STEP 6 Determination of the hourly flare efficiency

In case of **open flares**, the flare efficiency in the hour h ($\eta_{flare,h}$) is

- 0% if the flame is not detected for more than 20 minutes during the hour h.
- 50%, if the flare is detected for more than 20 minutes during the hour h.

STEP 7. Calculation of annual project emissions from flaring

$$PE_{flare,y} = \sum_{h=1}^{8760} TM_{RG,h} \times (1 - \eta_{flare,h}) \times \frac{GWP_{CH4}}{1000} \quad (31)$$

Where:

$PE_{flare,y}$	=	Project emissions from flaring of the residual gas stream in year y, tCO_2e
$\eta_{flare,h}$	=	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***

Under the project activity, sludge will not be disposed to land, but used to generated energy in the boiler.

(v) ***Project emissions from land application of wastewater***

This emission source is not applicable since this project activity does not involve land application.

(vi) ***Project emissions from electricity consumption and combustion of fossil fuels in the project***

Electricity is generated with biogas under the project activity, the electricity consumption for the operation of the project activity will be subtracted from the total on-site electricity generation with biogas in calculating $EG_{PJ,y}$. Electricity is also supplies using a diesel generator at start up or during maintenance. In case the emergency lagoon is used, fossil fuel consumption for the water pumping will also be included.

This source of emissions is calculated according to the "Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion" - Version 02.

$$PE_{FC,j,y} = \sum_i \mathrm{FC}_{i,j,y} \times \mathrm{COEF}_{i,y} \qquad (32)$$

$PE_{FC,j,y}$	=	Are the CO_2 emissions from fossil fuel combustion in process j during the year y (tCO_2/yr)
$FC_{i,j,y}$	=	Is the quantity of fuel type i combusted in process j during the year y (mass or volume unit/yr);
$COEF_{i,y}$	=	Is the CO_2 emission coefficient of fuel type i in year y (tCO_2/mass or volume unit)
i	=	Are the fuel types combusted in process j during the year y

Two options are available as per the tool (Options A and B). Option B is based on net calorific value and CO_2 emission factor of diesel fuel. This option was chosen because of the data required was readily available. In contrast, data for Option A is not available.

Option B: The CO_2 emission coefficient $COEF_{i,y}$ is calculated based on net calorific value and CO_2 emission factor of the fuel type i, as follows:

$$\mathrm{COEF}_{i,y} = NCV_{i,y} \times \mathrm{EF}_{CO2\,i,y} \qquad (33)$$

Where:

$COEF_{i,y}$	=	Is the CO_2 emission coefficient of fuel type i in year y (tCO_2/mass or volume unit)
$NCV_{i,y}$	=	Is the weighted average net calorific value of the fuel type i in year y (GJ/mass or volume unit)
$EF_{CO2,i,y}$	=	Is the weighted average CO_2 emission factor of fuel type i in year y (tCO_2/GJ)
i	=	Are the fuel types combusted in process j during the year y

The CO_2 emission coefficient of diesel ($COEF_{i,y}$) is calculated based on net calorific value and CO_2 emission factor from the 2006 IPCC guidelines, Vol. 2: Energy, Chapter 1, Tables 1.2 and 1.4.

Under this project activity, there is no other source of fossil fuel consumption than diesel generator. There is no electricity outsourced from the grid.

Leakage

As per the version 4.1.0 of the methodology, leakage emissions are only calculated for Scenario 1 type projects that include the treatment of solid materials in the digester in the project activity. This is not applicable to this project activity.

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

Data / Parameter:	-$COD_{out,x}$ -$COD_{in,x}$

Data unit:	Ton COD/ unit of time (year, month)
Description:	- COD of the effluent in the period x - COD directed to the open lagoons in the period x
Source of data used:	The design COD inflow for COD in and the design effluent COD flow for COD out corresponding to the design features of the lagoon system identified in the procedure for the selection of the baseline scenario.
Value applied:	Value used for the purposes of calculation of emission reductions: $COD_{in,x}$ = 37,500 t COD/yr $COD_{out,x =}$ 180 t COD/yr
Justification of the choice of data or description of measurement methods and procedures actually applied :	As this is a Greenfield project, there is no measurement in place. The data used is based on the design COD of the influent and effluent of the wastewater treatment plant.
Any comment:	x = Representative historical reference period (at least one year)

Data / Parameter:	B_o
Data 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 used:	2006 IPCC Guidelines
Value applied:	0.21 $tCH_4/tCOD$
Justification of the choice of data or description of measurement methods and procedures actually applied :	The default IPCC value for Bois 0.25 kg CH_4/kg COD. Taking into account the uncertainty of this estimate, project participants should use a value of 0.21 kg CH_4/kg COD as a conservative assumption for B_o. As the wastewater containing materials not akin to simple sugars, a CH_4 emissions factor of 0.21 $tCH_4/tCOD$ has to be estimated and applied.
Any comment:	-

Data / Parameter:	f_d
Data unit:	-
Description:	Factor expressing the influence of the depth of the lagoon or sludge pit on methane generation
Source of data used:	ACM0014 provides references values that are varied in function of the depth. Depth > 5m: 70% Depth 1-5 m: 50% Depth <1m: 0%
Value applied:	Depth of lagoon is 6.5 m: 70% is applied
Justification of the	Cost comparison of different depths as presented to DOE in : Roxol Bioenergy

choice of data or description of measurement methods and procedures actually applied :	Corporation, 30 March 2010, Lagoon Design Baseline Report v. 3
Any comment:	Applicable to the methane conversion factor method

Data / Parameter:	D
Data unit:	m
Description:	Average depth of the lagoon
Source of data used:	As per the baseline lagoon design as identified in step 1 of the section “Procedure for the identification of the most plausible baseline scenario Identification of alternative scenarios”
Value applied:	6.5 m.
Justification of the choice of data or description of measurement methods and procedures actually applied :	As summarized in section B.4 while carrying an economic assessment, the depth of the anaerobic lagoon is assumed to be 6.5 m (reference: Roxol Bioenergy Corporation, 30 March 2010, Lagoon Design Baseline Report v. 3).
Any comment:	-

Data / Parameter:	EC_{BL}
Data unit:	MWh/y
Description:	Annual quantity of electricity that would be consumed in the absence of the project activity for the treatment of the wastewater.
Source of data used:	According to the baseline lagoon design as identified in step 1 of the section “Procedure for the identification of the most plausible baseline scenario”
Value applied:	0
Justification of the choice of data or description of measurement methods and procedures actually applied :	In the absence of the project activity, the lagoon based system will be used and there is no electricity requirement for the system. The wastewater will flow through the lagoon system by gravity. Hence there is no demand for electricity.
Any comment:	-

Data / Parameter:	- $EF_{grid,y}$ - $EF_{BL,EL,y}$
Data unit:	tCO_2/MWh
Description:	- Grid emission factor in year *y* - Baseline emission factor for electricity generated and/or consumed in the absence of the project activity in year *y* (tCO_2,MWh)
Source of data used:	Calculated in accordance with the latest approved version (2.2.1) of the tool “Tool to calculate the emission factor for an electricity system”
Value applied:	0.5416
Justification of the	Calculated from the latest available data set for 2006-2008 for Luzon-Visayas, the

choice of data or description of measurement methods and procedures actually applied :	detailed calculation is illustrated in Annex 3.
Any comment:	Set ex-ante for the crediting period

Data / Parameter:	$EF_{CO2,FF,boiler}$
Data unit:	tCO_2/TJ
Description:	CO_2 factor of the fossil fuel type used in the boiler (bunker fuel oil)
Source of data used:	2006 IPCC Guidelines, Table 1.4. “Default CO_2 Emission Factors for Combustion”.
Value applied:	72.60 tCO_2/TJ
Justification of the choice of data or description of measurement methods and procedures actually applied :	Actual measure or local data are not available, thus IPCC data are used.
Any comment:	-

Data / Parameter:	$\eta_{EL,boiler}$
Data unit:	%
Description:	Efficiency of the boiler that would be used for heat generation in the absence of the project activity
Source of data used:	Technical specification: Boiler 40 TPH that would be used under the baseline (heavy fuel oil fired boiler)
Value applied:	89.8%
Justification of the choice of data or description of measurement methods and procedures actually applied :	Based on the specification of the proposed boiler for the system the efficiency is 70% (68+/- 2 %). However, for conservativeness reasons a value of 89.8% is selected.
Any comment:	-

Data / Parameter:	$FL_{biogas,digest}$
Data unit:	m^3 biogas leaked/m^3 biogas produced
Description:	Fraction of biogas that leaks from the digester
Source of data used:	IPCC (2006 IPCC Guideline for National Greenhouse Gas Inventories, Volume 5, Chapter 4, Page 4.4)
Value applied:	Use default leak factor of 0.05 m^3 biogas leaked/ m^3 biogas produced
Justification of the choice of data or description of measurement methods	default leak factor as per the approved methodology ACM0014 version 4.1.0

and procedures actually applied :	
Any comment:	-

Data / Parameter:	GWP_{CH4}
Data unit:	tCO_2e/tCH_4
Description:	Global warming potential for CH_4
Source of data used:	IPCC
Value applied:	21
Justification of the choice of data or description of measurement methods and procedures actually applied :	Default to be applied: 21 for the first commitment period.
Any comment:	Shall be updated according to any future COP/MOP decisions.

Data / Parameter:	A
Data unit:	Unit of area (ha)
Description:	Surface of the lagoon
Source of data used:	In case of project activities implemented in Greenfield facilities: According to the baseline lagoon design as identified in Step 1 of the section “Procedure for the identification of the most plausible baseline scenario”
Value applied:	5.39 ha
Justification of the choice of data or description of measurement methods and procedures actually applied :	As per the procedures for the identification of the most plausible baseline scenario.
Any comment:	-

Data / Parameter:	MM_{CH4}
Data unit:	kg/kmol
Description:	Molecular mass of methane
Source of data used:	Constant
Value applied:	16.04
Justification of the choice of data or description of measurement methods and procedures actually applied :	As per “*Tool to determine project emissions from flaring gases containing methane”* version 1.
Any comment:	-

Data / Parameter:	MM_{N2}
Data unit:	kg/kmol

Description:	Molecular mass of nitrogen
Source of data used:	Constant
Value applied:	28.02
Justification of the choice of data or description of measurement methods and procedures actually applied :	As per “*Tool to determine project emissions from flaring gases containing methane”* version 1.
Any comment:	-

Data / Parameter:	P_n
Data unit:	Pa
Description:	Atmospheric pressure at normal conditions
Source of data used:	Constant
Value applied:	101,325
Justification of the choice of data or description of measurement methods and procedures actually applied :	As per “*Tool to determine project emissions from flaring gases containing methane”* version 1.
Any comment:	-

Data / Parameter:	R_u
Data unit:	$Pa.m^3/kmol.K$
Description:	Universal ideal gas constant
Source of data used:	Constant
Value applied:	8,314.472
Justification of the choice of data or description of measurement methods and procedures actually applied :	As per “*Tool to determine project emissions from flaring gases containing methane”* version 1.
Any comment:	-

Data / Parameter:	T_n
Data unit:	K
Description:	Temperature at normal conditions
Source of data used:	Constant
Value applied:	273.15
Justification of the choice of data or description of measurement methods and procedures actually	As per “*Tool to determine project emissions from flaring gases containing methane”* version1.

applied :	
Any comment:	-

Data / Parameter:	$\rho_{CH4,n}$
Data unit:	tCH_4/m^3CH_4
Description:	Methane density at normal conditions
Source of data used:	"*Tool to determine project emissions from flaring gases containing methane*" version 1
Value applied:	0.0007168
Justification of the choice of data or description of measurement methods and procedures actually applied :	At standard T and P (0 degrees C and 1,013 bar)
Any comment:	For flare efficiency, as per the "*Tool to determine project emissions from flaring gases containing methane*" version 1.

B.6.3. Ex-ante calculation of emission reductions:

Baseline emissions:

Baseline emissions are calculated using the following equation:

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

Where:

BE_y Baseline emissions in year *y* (tCO_2e/yr)

BE_{CH4} Methane emissions from anaerobic treatment of the wastewater in open lagoons (scenario 1) in the absence of the project activity in year *y* (tCO_2e/yr)

$BE_{EL,y}$ CO_2 emissions associated with electricity generation that is displaced by the project activity and/or electricity consumption in the absence of the project activity in year *y* (tCO_2/yr)

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

Step 1: Methane emissions from anaerobic treatment of the wastewater in open lagoons (BE_{CH4})

$BE_{CH4,y}$	99,504	tCO_2e
GWP_{CH4}	21	tCO_2e/tCH_4
B_o	0.21	$tCH_4/tCOD$
$MCF_{BL,y} = 0.89 \times f_d \times f_{T,y}$	0.60	
f_d	0.7	Effective Depth of Lagoon is 6.5 m.
Conservativeness factor	0.89	
$f_{PJ,T,y} = \frac{\sum_{m=1}^{12} f_{t,m} \times COD_{PJ,available,m}}{\sum_{m=1}^{12}\left(COD_{PJ,dig,in,m} - COD_{PJ,dig,final,m}\right)}$	0.97	
$COD_{BL,y} = AD_{BL} \times COD_{PJ,y}$	37,320	tCOD/yr
$AD_{BL} = 1 - \frac{COD_{out}}{COD_{in}}$	0.9952	
COD_{in}	37,500	tCOD/yr
COD_{out}	180	tCOD/yr
$COD_{pj,y} = \sum_{m=1}^{12} F_{pj,dig,m} \times w_{COD,dig,m}$	37,500	tCOD/yr
$F_{PJ,dig,m}$	300,000	m^3/y

Step 2: Baseline emissions from generation and/or consumption of electricity ($BE_{EL,y}$)

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

- Baseline emissions from consumption of electricity associated with the treatment of wastewater (scenario 1). **As described in Section B.4 step (a), the electricity consumption for open lagoon is zero. ($EC_{BL,y}$ =0)**

- If electricity is generated with biogas from a new anaerobic digester under the project activity: baseline emissions from the generation of electricity in the grid (E2) and/or with a captive fossil fuel fired power plant (E1) in the absence of the electricity generation with biogas.

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

$BE_{EL,y}$	578	tCO_2e
$EC_{BL,y}$	0	MWh/y
$EG_{PJ,y}$	1,067	MWh/y
$EF_{BL,EL,y}$	0.5416	tCO_2/MWh
$EF_{BL,EL,y} = EF_{GRID,y}$	Calculated in accordance with the “Tool to calculate the emission factor for an electricity system”, see Annex 3 for detail.	

The net quantity of electricity generated from biogas is calculated as follow:

$w_{biogas,y} = (NCV_{biogas,boiler} * F_{biogas,boiler,y})/[(NCV_{dry\ vinasse,\ boiler} * F_{dry\ vinasse,\ boiler,y}) + (NCV_{bagasse,boiler} * F_{bagasse,boiler,y}) + (NCV_{biogas,boiler} * F_{biogas,boiler,y})$

parameters	*values*	*Sources (for ex ante calculations)*
$NCV_{biogas,boiler}$	*24,480 kJ/m³*	Biogas technology center, 2004, monitored ex-post
$NCV_{dry\ vinasse,\ boiler}$	*12,540kJ/kg*	Roxol Energy Balance.pdf, monitored ex-post
$NCV_{bagasse,boiler}$	*7,500 kJ/kg*	Calorific value of bagasse, L. Wong Sak Hoi, 2002, monitored ex-post
$F_{biogas,boiler,y}$	*34,450 m³/d*	Roxol Energy Balance.pdf, monitored ex-post
$F_{dry\ vinasse,\ boiler,y}$	*62,400 kg/d*	Roxol Energy Balance.pdf, monitored ex-post
$F_{bagasse,boiler,y}$	*142,000 kg/d*	Roxol Energy Balance.pdf, monitored ex-post

*$w_{biogas,\ y}$ = (24,480 kJ/m³ * 34,450 m³/d*300d/y)/[(12,540kJ/kg * 62,4000 kg/d*300d/y)+(7,500 kJ/kg*142,000 kg/d*300d/y) + (24,480 kJ/m³ * 34,450 m³/d*300d/y)]*

$w_{biogas,y}$ = 0.3134

$EG_{PJ,y} = (w_{biogas,y} * E_{tot,y}) - E_{con,\ WWT,y}$
$EG_{PJ,y}$ = [(*0.3134 * \2,800 kW*[79] **300 d/y *24 h/d) – (729 kW*[80] **300d/y *24 h/d)]/1,000*
$EG_{PJ,y}$ = *1,067 MWh/y*

Step 3: Baseline emissions associated with fossil fuel combustion for heating equipment that is displaced by the project ($BE_{HG,,y}$)

The boiler would use bunker fuel oil as a primary source of fuel, the boiler will perform at its best efficiency and the supply is constant. Bagasse will not be use as primary fuel as supply of bagasse is not stable. Bagasse will only be used when available at the factory.

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[79] Source: Roxol power requirements.

[80] Source: Roxol power requirements

$BE_{HG,y} = (HG_{PJ,y} * EF_{CO2,FF,boiler})/n_{bl,boiler}$

$BE_{HG,y}$	8,195	tCO_2e
$HG_{PJ,y}$	101	TJ/y
$EF_{CO2,ff,boiler}$	72.60	tCO_2/TJ
$n_{bl,boiler}$	0.898	

The quantity of heat generated from biogas is calculated as follow:

$HG_{PJ,y} = w_{biogas,y} * [(F_{steam,y} * E_{steam,y})- (E_{feed\ water,y})]$ / 10E9

parameters	*values*	*Sources (for ex ante calculations)*
$F_{steam,y}$	*360,000 kg/d*	Energy balance sheet, projection, KBK, monitored ex-post
$E_{steam,y}$	*3,238.9 kJ/kg*	at T_{steam} =380°C and P_{steam} = 1.5 kg/cm^2 ,source: NIST webbook; Determined ex-post based on monitored temperature and pressure and of steam supplied to the turbine (T_{steam};P_{steam}).

For purpose of ex ante calculations, the enthalpy of feed water entering to the boiler is assumed to be 2.64 E10 kJ/y.. Temperature and flow of feed water will be monitored ex-post.

$E_{feed\ water,y} = F_{feed\ water,y} * T_{feed\ water,y} * 4.1868$ kJ/kg C
$E_{feed\ water,y}$ = 2.64 E10 kJ/y

parameters	*values*	*Sources (for ex ante calculations)*
$F_{feed\ water,y}$	*210,000 kg/d*	Roxol Energy Balance.pdf, monitored ex-post
$T_{feed\ water,y}$	*100 deg C*	Roxol Energy Balance.pdf, monitored ex-post

$HG_{PJ,y}$= [*0.3134** [(360,000 kg/d*300d/y) * *3,238.9 kJ/kg]*- [210,000 kg/d *300 d/y * 100 deg C* 4.1868 kJ/kg C] / 10E9

$HG_{PJ,y}$= 83 TJ/y

SUMMARY - BASELINE EMISSIONS:

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

BE_y	108,277	tCO_2e/y
$BE_{CH4,y}$	99,504	tCO_2e/y
$BE_{EL,y}$	578	tCO_2e/y
$BE_{HG,y}$	8,195	tCO_2e/y

Project emissions:

Emissions that need to be considered in this case (new anaerobic treatment, scenario 1) are the following:

(i) Methane emissions from the open lagoons or dewatering process (applicable if residual from the anaerobic digester, after treatment under the project activity, is directed to either open lagoons or to a dewatering facility);
(ii) Physical leakage of methane from the digester system;
(iii) Methane emissions from flaring (applicable if biogas from the digester is flared);
(iv) Methane and nitrous oxide emissions from land application of sludge;
(v) Methane and nitrous oxide emissions from land application of wastewater;
(vi) CO_2 emissions from consumption of electricity and or fossil fuels in the project activity.

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

Where:

PE_y	Project emissions in year *y* (tCO_2e/yr)
$PE_{CH4, effluent, y}$	Project emissions from treatment of wastewater effluent from the anaerobic digester in year *y* (tCO_2e/yr)
$PE_{CH4, digest, y}$	Project emissions from physical leakage of methane from the anaerobic digester in year *y* (tCO_2e/yr)
$PE_{flare,y}$	Project emissions from flaring of biogas generated in the anaerobic digester in year *y* (tCO_2e/yr)
$PE_{sludge,LA,y}$	Project emissions from land application of sludge in year *y* (tCO_2e/yr)
$PE_{ww,LA,y}$	Project emissions from land application of wastewater in year y (tCO2e/yr)
$PE_{EC,y}$	Project emissions from electricity consumption in year *y* (tCO_2e/yr)
$PE_{FC,y}$	Project emissions from combustion of fossil fuel in process *j* during the year *y* (tCO_2e/yr)

(i) Project emissions from treatment of wastewater effluent from the anaerobic digester ($PE_{CH4,effluent, y}$)

The only open lagoon associated with the proposed project activity is the emergency lagoon that will only be used in the case of emergency (maintenance is required on one of the reactor). This source of emission was not considered for ex ante estimate since it will only be included in the unlikely event of an emergency.

(ii) Project emissions from physical leakage of methane from the anaerobic digester ($PE_{CH4,digest,y}$).

The new digester is a system completely enclosed, piping system will be new and the required maintenance (as specified by manufacturer and technical guidance) will be performed. Project emissions from physical leakage are calculated as follow:

$$PE_{ch4,digest,y} = F_{biogas,y} * FL_{biogas,digest} * W_{CH4,biogas,y} * GWP_{CH4} * 0.001$$

$PE_{ch4,digest,y}$	4,278	tCO_2e/y
$F_{biogas,y}$	10,335,000	m^3/y
$FL_{biogas,digest}$	0.05	
$W_{CH4,biogas,year}$	0.3942	$kg\ CH_4/m^3$

GWP_{CH4}	21	tCO_2e/tCH_4

(iii) Project emissions from flaring of biogas generated in the anaerobic digester ($PE_{flare,y}$)

Methane may be released as a result of incomplete combustion in case of biogas use for electricity and/or heat production. To calculate project emissions from flaring of a residual gas stream containing methane ($PE_{flare,y}$) the *"Tool to determine project emissions from flaring gases containing Methane"* will be used.

The list of parameters, as required under the *Tool to determine project emissions from flaring gases containing Methane* will be monitored ex-post and $PE_{flare,y}$ will be adjusted accordingly.

For ex-antes emissions, 50% is used for the efficiency (open system) and the higher limit of the expect biogas generated in the reactor: 34,450 m^3 /day. The system is expected to operate 20 days per year (for maintenance only). The estimate content of methane in biogas (55%) and density of methane at normal conditions (0.716 kg / m^3) are also used for the ex-antes calculations. It is estimated that no biogas will be flared under the project activity except during maintenance. The boiler and electricity generator will consumed all the biogas generated from the system. Therefore, the biogas generated will only be flared in emergency case when the boiler and the generator are out of service. The amount of flared biogas will be recorded and accounted for project emission accordingly. The flare is expected to be in operation for 20 days per year, although the plant is expected to operate 330 days per year. This is because after the ethanol plant has shut down for annual inspection and maintenance, there will be wastewater undergoing treatment and biogas will be produce for about 20 days, there will be wastewater entering the system to generate biogas for the next 15 days.

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

$PE_{flare,y}$	2,852	tCO_2e/y
$\eta_{flare,h}$	0.5	Open Flare
$TM_{RG,h}$	271,631	m^3/day

(iv) Project emissions from land application of sludge ($PE_{sludge, LA, y}$)

The sludge will not be disposed to land, but used to generate energy in the boiler.

(v) Project emissions from land application of wastewater

This emission source is not applicable since this project activity does not involve land application.

(vi) Project emissions from fossil fuel consumption in year y ($PE_{FC, y}$)

$$PE_{FC,j,y} = FC_{i,j,y} \times NCV_{i,y} \times EF_{CO2,i,y}$$

The CO2 emission coefficient of diesel ($COEF_{i,y}$) is calculated based on net calorific value and CO_2 emission factor from the 2006 IPCC guidelines, Vol. 2: Energy, Chapter 1, Tables 1.2 and 1.4. The density of diesel is 0.85 kg/L.

$PE_{FC,j,y}$	23.89	tCO_2e/y

$FC_{i,j,y}$	8,678	L
$NCV_{i,y}$	43.3	Gj/t
$EF_{CO2,i,y}$	74.8	tCO_2/TJ

Project emissions from fossil fuel consumption ($PE_{fc,y}$)
Fossil fuel is strictly consumed for electricity generation and thus already accounted.

SUMMARY - PROJECT EMISSIONS:

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

PE_y	7,154	tCO_2e/y
$PE_{CH4,effluent,y}$	0	tCO_2e/y
$PE_{CH4,digest,y}$	4,278	tCO_2e/y
$PE_{flare,y}$	2,852	tCO_2e/y
$PE_{sludge,la,y}$	0	tCO_2e/y
$PE_{EC,y}$	0	tCO_2e/y
$PE_{fc,y}$	23.89	tCO_2e/y

Leakages
Leakages are not applicable to the proposed CDM project activity and thus $LE_y = 0$.

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

Emission reductions for any given year of the crediting period are obtained by subtracting project emissions from baseline emissions:
$ER_y = BE_y – PE_y – LE_y$

Year	Estimation of project activity emissions (tCO_2e)	Estimation of baseline emissions (tCO_2e)	Estimation of leakage (tCO_2e)	Estimation of overall emission reductions (tCO_2e)
31/12/2012 – 31/12/2012	20	297	0	277
01/01/2013 – 31/12/2013	7,154	108,277	0	101,122
01/01/2014 – 31/12/2014	7,154	108,277	0	101,122
01/01/2015 – 31/12/2015	7,154	108,277	0	101,122
01/01/2016 – 31/12/2016	7,154	108,277	0	101,122
01/01/2017 –	7,154	108,277	0	101,122

31/12/2017				
01/01/2018 – 31/12/2018	7,154	108,277	0	101,122
01/01/2019 – 30/12/2019	7,135	107,980	0	100,845
Total (tonnes of CO_2e)	**50,080**	**757,936**	**0**	**707,854**

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

B.7.1 Data and parameters monitored:

Data / Parameter:	$\mathbf{F_{PJ,dig,m}}$
Data unit:	m^3/month
Description:	Quantity of wastewater that is treated in the anaerobic digester in month m
Source of data to be used:	Measured by using flow meter
Value of data applied for the purpose of calculating expected emission reductions in section B.5	25,000. During implementation of the project activity, the actual monitored data will be applied.
Description of measurement methods and procedures to be applied:	Flow rate will be measured by magnetic flow meter installed in-line of the influent pipe to the digester. Measurements will be carried out continuously.
QA/QC procedures to be applied:	The flow meter shall be subject to regular maintenance and calibration, based on the manufacturer's specifications to ensure accuracy, which is assumed to be above 95%.
Any comment:	Parameter monitored continuously but aggregated monthly for calculations. Data will be archived electronically, minimum for two years, after last issuance of CERs. See Monitoring diagram, Annex 4, this monitoring point corresponds to WF1.

Data / Parameter:	$\mathbf{w_{COD, dig,m}}$
Data unit:	t COD / m^3
Description:	Average chemical oxygen demand in the effluent entering the digester in month *m*
Source of data to be used:	Measured
Value of data applied for the purpose of calculating expected emission reductions in section B.5	0.125 tCOD/m^3 was applied for ex-ante calculations. Measure the COD daily according to national or international standards. Data will be archived electronically, minimum for two years, after last issuance of CERs.

Description of measurement methods and procedures to be applied:	Measure the COD daily according to national or international standards.
QA/QC procedures to be applied:	Sampling and testing will be carried out adhering to appropriate national/international standards recognized procedures to ensure accuracy, which is assumed to be above 95%.
Any comment:	The measurement for COD will be conducted daily, the results will be aggregated for average monthly and annual values. Data will be archived electronically, minimum for two years, after last issuance of CERs. See Monitoring diagram, Annex 4, this monitoring point corresponds to SP1.

Data / Parameter:	**$T_{2,m}$**
Data unit:	K
Description:	Average temperature at the project site in month *m*
Source of data to be used:	Daily mean, minimum and maximum temperature readings from Philippines Meteorological Department for a temperature monitoring station, La Granja, La Carlota City, Neg. OCC Station, the closest to the project site will be obtained.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	Annual average temperature of 27.38 °C was applied. During implementation of the project activity, the actual monitored data will be applied.
Description of measurement methods and procedures to be applied:	Temperature data is monitored continuously, and aggregated in monthly average values. International recognized standard methods are used by Philippines Meteorological Department in all its weather monitoring programs.
QA/QC procedures to be applied:	-
Any comment:	Daily average is monitored but monthly average is used in the calculation. Data will be archived electronically, minimum for two years, after last issuance of CERs.

Data / Parameter:	**$EG_{PJ,y}$**
Data unit:	MWh/year
Description:	Net quantity of electricity generated in year *y* with biogas from the new anaerobic system.
Source of data to be used:	Net quantity electricity generated will be measured. The quantity of electricity associated with biogas will be calculated.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	1,067 MWh/y. During implementation of the project activity, the actual monitored data will be applied.

Description of measurement methods and procedures to be applied:	The electricity output from the biogas fired generator sets will be recorded continuously by the meter provided with the electricity generator set. Data will be archived electronically, minimum for two years, after last issuance of CERs.
QA/QC procedures to be applied:	Electricity meters will undergo maintenance/calibration in accordance with appropriate national/international standards to ensure its accuracy, which is assumed to be above 95%.
Any comment:	The net quantity of electricity generated from biogas will be calculated based on energy mass balance (using the measured mass of biogas ($F_{biogas,boiler,y}$), bagasse ($F_{bagasse,boiler,y}$) and dry vinasse ($F_{dry\ vinasse,\ boiler,y}$) fed to boiler and respective NCV values ($NCV_{biogas,boiler}$; $NCV_{dry\ vinasse,\ boiler}$; $NCV_{bagasse,boiler}$) total electricity generated from the turbine ($E_{tot,y}$). Electricity generated from the turbine will be measured continuously. Mass of bagasse and dry vinasse will be measured continuously. NCV of bagasse, vinasse and biogas will be measured by a certified laboratory twice a year. The quantity of electricity generated from biogas will be calculated as follow: $w_{biogas,y} = (NCV_{biogas,boiler} * F_{biogas,boiler,y})/[(NCV_{dry\ vinasse,\ boiler} * F_{dry\ vinasse,\ boiler,y}) + (NCV_{bagasse,boiler} * F_{bagasse,boiler,y}) + (NCV_{biogas,boiler} * F_{biogas,boiler,y})$ $EG_{PJ,y} = (w_{biogas,y} * E_{tot,y}) - E_{con,\ WWT,y}$

Data / Parameter:	**$HG_{PJ,y}$**
Data unit:	TJ/y
Description:	Net quantity of heat generate in year *y* with biogas from the new anaerobic digester
Source of data to be used:	Net quantity heat generated will be measured. The quantity of heat associated with biogas will be calculated.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	101 TJ applied for ex-ante calculations. Once project is implemented, the data will be monitored.
Description of measurement methods and procedures to be applied:	Steam flow, pressure, temperature of the steam will be measured continuously. Mass of bagasse and dry vinasse will be measured continuously. NCV of biogas, bagasse and vinasse will be measured by a certified laboratory twice a year. The steam output from the biogas fired boilers will be measured continuously by the meter provided with the boiler, and recorded on a daily basis.. Data will be archived electronically, minimum for two years, after last issuance of CERs.
QA/QC procedures to be applied:	Steam meters will undergo maintenance/calibration in accordance with appropriate national/international standards to ensure its accuracy, which is assumed to be above 95%.
Any comment:	The net quantity of heat generated from biogas will be calculated based on energy mass balance, using the measured mass of biogas ($F_{biogas,boiler,y}$), bagasse

	($F_{bagasse,boiler,y}$) and dry vinasse ($F_{dry\ vinasse,\ boiler,y}$) fed to the boiler and respective NCV values ($NCV_{biogas,boiler}$; $NCV_{dry\ vinasse,\ boiler}$; $NCV_{bagasse,boiler}$), the total quantity of steam generated from the turbine ($F_{steam,y}$) along with the temperature and pressure of the steam (T_{steam};P_{steam}) to obtained the enthalpy of the steam ($E_{steam,y}$). The quantity of heat generated from biogas will be calculated as follow: $w_{biogas,y} = (NCV_{biogas,boiler} * F_{biogas,boiler,y})/[(NCV_{dry\ vinasse,\ boiler} * F_{dry\ vinasse,\ boiler,y}) + (NCV_{bagasse,boiler} * F_{bagasse,boiler,y}) + (NCV_{biogas,boiler} * F_{biogas,boiler,y})$ $HG_{PJ,y} = w_{biogas,y} * [(F_{steam,y} * E_{steam,y}) - E_{feed\ water,y}]/10E9$

Data / Parameter:	$w_{biogas,y}$
Data unit:	-
Description:	Fraction of heat/electricity associated with biogas at the turbine
Source of data to be used:	Calculated on monthly basis.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	0.3134
Description of measurement methods and procedures to be applied:	Calculated as follow: $w_{biogas,y} = (NCV_{biogas,boiler} * F_{biogas,boiler,y})/[(NCV_{dry\ vinasse,\ boiler} * F_{dry\ vinasse,\ boiler,y}) + (NCV_{bagasse,boiler} * F_{bagasse,boiler,y}) + (NCV_{biogas,\ boiler} * F_{biogas,boiler,y})]$
QA/QC procedures to be applied:	Parameters used in the calculation of $w_{biogas,y}$ have their own QA/QC procedures.
Any comment:	Averaged annually

Data / Parameter:	**$NCV_{biogas,boiler}$**
Data unit:	kJ per volume or mass unit.
Description:	Net calorific value of biogas
Source of data to be used:	Project developer
Value of data applied for the purpose of calculating expected emission reductions in section B.5	24,480 (source: Biogas technology center ; http://grove.ufl.edu/~bests/pdfs/050606%20Chuckree%20Senthong.pdf)
Description of measurement methods and procedures to be applied:	Will be measured by a certified laboratory twice a year (every six months).
QA/QC procedures to be applied:	Sampling and testing will be carried out adhering to appropriate national/international standards to ensure accuracy assumed to be above 95%.
Any comment:	See Monitoring diagram, Annex 4, this monitoring point corresponds to $NCV_{bio.}$

Data / Parameter:	**$NCV_{dry\ vinasse,\ boiler}$**
Data unit:	kJ per volume or mass unit.
Description:	Net calorific value of dry vinasse
Source of data to be used:	Project developer
Value of data applied for the purpose of calculating expected emission reductions in section B.5	12,540 kJ/kg (source: Roxol Energy Balance.pdf)
Description of measurement methods and procedures to be applied:	Will be measured by a certified laboratory twice a year (every six months).
QA/QC procedures to be applied:	Sampling and testing will be carried out adhering to appropriate national/international standards to ensure accuracy assumed to be above 95%.
Any comment:	See Monitoring diagram, Annex 4, this monitoring point corresponds to NCV_v.

Data / Parameter:	**$NCV_{bagasse,boiler}$**
Data unit:	kJ per volume or mass unit.
Description:	Net calorific value of bagasse
Source of data to be used:	Project developer
Value of data applied for the purpose of calculating expected emission reductions in section B.5	7,500 kJ/kg (between 7000-8000 kJ/kg, source: Calorific value of bagasse, L. Wong Sak Hoi, 2002)
Description of measurement methods and procedures to be applied:	Will be measured by a certified laboratory twice a year (every six months).
QA/QC procedures to be applied:	Sampling and testing will be carried out adhering to appropriate national/international standards to ensure accuracy assumed to be above 95%.
Any comment:	See Monitoring diagram, Annex 4, this monitoring point corresponds to NCV_b

Data / Parameter:	**$F_{steam,y}$**
Data unit:	volume or mass unit per year
Description:	Quantity of steam generated from the turbine in year y
Source of data to be used:	Project developer
Value of data applied for the purpose of calculating expected emission reductions in section B.5	360,000 kg/d (Energy Balance sheet, Projection, KBK)
Description of	Will be measured by using flow meter on continuous basis

measurement methods and procedures to be applied:	
QA/QC procedures to be applied:	Flow meters will undergo maintenance/calibration in accordance with appropriate national/international standards to ensure its accuracy, which is assumed to be above 95%.
Any comment:	Data will be archived electronically, minimum for two years, after last issuance of CERs. See Monitoring diagram, Annex 4, this monitoring point corresponds to Q.

Data / Parameter:	**T_{steam}**
Data unit:	°C
Description:	Temperature of the steam at the exit of the turbine
Source of data to be used:	Project developer
Value of data applied for the purpose of calculating expected emission reductions in section B.5	380°C (manufacturer specifications: KBK, Turbine 4MW generator.pdf)
Description of measurement methods and procedures to be applied:	To be measured using appropriate temperature measuring instrument, on a continuous basis, data will be aggregated monthly.
QA/QC procedures to be applied:	Temperature measuring instrument will undergo maintenance/calibration in accordance with appropriate national/international standards to ensure its accuracy, which is assumed to be above 95%. Data will be archived electronically, minimum for two years, after last issuance of CERs.
Any comment:	Daily average is monitored but monthly average is used in the determination of the steam enthalpy. See Monitoring diagram, Annex 4, this monitoring point corresponds to $T_{s.}$

Data / Parameter:	**P_{steam}**
Data unit:	kg/cm^2 or other appropriate unit
Description:	Pressure of the steam at the exit of the turbine
Source of data to be used:	Project developer
Value of data applied for the purpose of calculating expected emission reductions in section B.5	1.5 kg/cm^2 (manufacturer specifications: KBK, Turbine 4MW generator.pdf).
Description of measurement methods and procedures to be applied:	To be measured using appropriate pressure measuring instrument, on a continuous basis, data will be aggregated monthly.
QA/QC procedures to	Pressure measuring instrument will undergo maintenance/calibration in

be applied:	accordance with appropriate national/international standards to ensure its accuracy, which is assumed to be above 95%. Data will be archived electronically, minimum for two years, after last issuance of CERs.
Any comment:	Daily average is monitored but monthly average is used in the determination of the steam enthalpy. See Monitoring diagram, Annex 4, this monitoring point corresponds to P_s

Data / Parameter:	$\mathbf{T_{feed\ water,y}}$
Data unit:	°C
Description:	Temperature of the of feed water in year y
Source of data to be used:	Project developer
Value of data applied for the purpose of calculating expected emission reductions in section B.5	100 deg C
Description of measurement methods and procedures to be applied:	To be measured using appropriate temperature measuring instrument, on a continuous basis, data will be aggregated monthly.
QA/QC procedures to be applied:	Temperature measuring instrument will undergo maintenance/calibration in accordance with appropriate national/international standards to ensure its accuracy, which is assumed to be above 95%. Data will be archived electronically, minimum for two years, after last issuance of CERs.
Any comment:	Daily average is monitored but monthly average is used in the determination of the steam enthalpy. See Monitoring diagram, Annex 4, this monitoring point corresponds to $T_{f.}$

Data / Parameter:	$\mathbf{E_{steam,y}}$
Data unit:	kJ/kg or any other appropriate unit
Description:	Enthalpy of the steam generated by the turbine in year y
Source of data to be used:	From engineering data books (e.g. steam tables)
Value of data applied for the purpose of calculating expected emission reductions in section B.5	3,238.9 kJ/kg (NIST web book)
Description of measurement methods and procedures to be applied:	From engineering data books (e.g. steam tables) using monthly average pressure ($P_{steam)}$ and monthly average temperature (T_{steam}), and averaged annually.
QA/QC procedures to be applied:	-
Any comment:	Averaged annually.

Data / Parameter:	$\mathbf{E_{feed\ water,y}}$
Data unit:	kJ/y or any other appropriate units
Description:	Heat content of the feed water entering boiler in year y
Source of data to be used:	Calculated: $E_{feed\ water,y} = F_{feed\ water,y} * T_{feed\ water,y} * 4.1868$ kJ/kg C
Value of data applied for the purpose of calculating expected emission reductions in section B.5	$E_{feed\ water,y} = F_{feed\ water,y} * T_{feed\ water,y} * 4.1868$ kJ/kg C = 2.64 E10 kJ/y
Description of measurement methods and procedures to be applied:	Calculated on monthly basis
QA/QC procedures to be applied:	Parameters used in the calculation of $\mathbf{E_{feed\ water,y}}$ have their own QA/QC procedures.
Any comment:	Averaged annually.

Data / Parameter:	$\mathbf{F_{feed\ water,y}}$
Data unit:	kg/y or any appropriate units
Description:	Quantity of feed water in year y
Source of data to be used:	Project developer
Value of data applied for the purpose of calculating expected emission reductions in section B.5	210,000 kg/d for ex ante estimation
Description of measurement methods and procedures to be applied:	Parameter monitored continuously but aggregated monthly and annually for calculations of ERs. Data will be archived electronically, minimum for two years, after last issuance of CERs.
QA/QC procedures to be applied:	Flow meters will undergo maintenance/calibration in accordance with appropriate national/international standards to ensure its accuracy, which is assumed to be above 95%.
Any comment:	See Monitoring diagram, Annex 4, this monitoring point corresponds to WF4.

Data / Parameter:	$\mathbf{E_{TOT,y}}$
Data unit:	MWh
Description:	Electricity generated from the turbine in year *y*
Source of data to be used:	Electricity meter
Value of data applied for the purpose of calculating expected emission reductions in	20,1604 MWh/y (2,80 MW * 300 d/y *24 h/d)

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Description of measurement methods and procedures to be applied:	Measured continuously using electricity meter
QA/QC procedures to be applied:	Electricity meters will undergo maintenance/calibration in accordance with appropriate national/international standards to ensure its accuracy, which is assumed to be above 95%.
Any comment:	See Monitoring diagram, Annex 4, this monitoring point corresponds to $E_{1.}$

Data / Parameter:	$\mathbf{E_{con,\ WWT,y}}$
Data unit:	MWh
Description:	Electricity consumed for the wastewater treatment in year *y*
Source of data to be used:	Electricity meter
Value of data applied for the purpose of calculating expected emission reductions in section B.5	5,252 MWh (730 kW * 300 days of operation per y *24 h/d); source for the electricity consumption: Roxol Ethanol Plant Power Mix.pdf.
Description of measurement methods and procedures to be applied:	Measured continuously using electricity meter
QA/QC procedures to be applied:	Electricity meters will undergo maintenance/calibration in accordance with appropriate national/international standards to ensure its accuracy, which is assumed to be above 95%.
Any comment:	See Monitoring diagram, Annex 4, this monitoring point corresponds to E_2.

Data / Parameter:	$\mathbf{F_{PJ,effL,dig,m}}$
Data unit:	m^3/month
Description:	Quantity of effluent from the digester in month *m*
Source of data to be used:	Measurements using flow meter
Value of data applied for the purpose of calculating expected emission reductions in section B.5	$\mathbf{F_{PJ,effL,dig,m}}$ = 25,000. During implementation of the project activity, the actual monitored data will be applied.
Description of measurement methods and procedures to be applied:	Parameter monitored continuously but aggregated monthly and annually for calculations of ERs. Data will be archived electronically, minimum for two years, after last issuance of CERs.
QA/QC procedures to be applied:	Flow meters will undergo maintenance/calibration in accordance with appropriate national/international standards to ensure its accuracy, which is assumed to be above 95%.
Any comment:	See Monitoring diagram, Annex 4, this monitoring point corresponds to WF2.

Data / Parameter:	**$F_{PJ,effL,lag,m}$**
Data unit:	m^3/month
Description:	Quantity of effluent form the open lagoon (emergency lagoon) in month *m*
Source of data to be used:	Measurements by using flow meter
Value of data applied for the purpose of calculating expected emission reductions in section B.5	0 (emergency lagoon will only be used in case of reparation on the lagoons). During implementation of the project activity, the actual monitored data will be applied.
Description of measurement methods and procedures to be applied:	Parameter monitored continuously but aggregated monthly and annually for calculations of ERs. Data will be archived electronically, minimum for two years, after last issuance of CERs.
QA/QC procedures to be applied:	Flow meters will undergo maintenance/calibration in accordance with appropriate national/international standards to ensure its accuracy, which is assumed to be above 95%.
Any comment:	See Monitoring diagram, Annex 4, this monitoring point corresponds to WF3.

Data / Parameter:	**$w_{COD,effl,dig,m}$**
Data unit:	tCOD/m^3
Description:	Average chemical oxygen demand in the effluent from the digester in month *m*
Source of data to be used:	Measure from effluent COD
Value of data applied for the purpose of calculating expected emission reductions in section B.5	0.04 tCOD/m^3. During implementation of the project activity, the actual monitored data will be applied.
Description of measurement methods and procedures to be applied:	Measure the COD daily according to national or international standards. Calculate average monthly and annual values. Data will be archived electronically, minimum for two years, after last issuance of CERs.
QA/QC procedures to be applied:	Sampling and testing will be carried out adhering to appropriate national/international standards.
Any comment:	See Monitoring diagram, Annex 4, this monitoring point corresponds to SP2.

Data / Parameter:	**$w_{COD,effl,lag,m}$**
Data unit:	tCOD/m^3
Description:	Average chemical oxygen demand in the effluent from the lagoon (emergency lagoon) in month *m*
Source of data to be used:	Measure from effluent COD
Value of data applied for the purpose of calculating expected	0 tCOD/m^3 (emergency lagoon will only be used in case of reparation of the lagoons). During implementation of the project activity, the actual monitored data will be applied.

emission reductions in section B.5	
Description of measurement methods and procedures to be applied:	Measure the COD daily according to national or international standards. Calculate average monthly and annual values. Data will be archived electronically, minimum for two years, after last issuance of CERs.
QA/QC procedures to be applied:	Sampling and testing will be carried out adhering to appropriate national/international standards.
Any comment:	See Monitoring diagram, Annex 4, this monitoring point corresponds to SP3.

Data / Parameter:	$\mathbf{F_{biogas,y}}$
Data unit:	Nm^3/yr
Description:	Amount of biogas collected from the new digester in year *y*
Source of data to be used:	Measured via gas flow meter by project developer
Value of data applied for the purpose of calculating expected emission reductions in section B.5	10,335,000 m^3/year (34,450 m^3/day) for ex-ante calculations. During implementation of the project activity, the actual monitored data will be applied.
Description of measurement methods and procedures to be applied:	Measured with a gas flow meter incorporated into the main gas pipe. Flow rate will be monitored continuously in wet basis. Data will be archived electronically, minimum for two years, after last issuance of CERs.
QA/QC procedures to be applied:	Flow meters will undergo maintenance/calibration in accordance with manufacturer specifications to ensure its accuracy, which is assumed to be above 95%. Data collected will be compared with the amount of biogas utilization to ensure that the date collected to accurate.
Any comment:	Parameter monitored continuously but aggregated monthly and annually for calculations. See Monitoring diagram, Annex 4, this monitoring point corresponds to GF1.

Data / Parameter:	$\mathbf{F_{biogas,boiler,y}}$
Data unit:	m^3/y
Description:	Amount of biogas sent to boiler in year *y*
Source of data to be used:	Measured via gas flow meter by project developer
Value of data applied for the purpose of calculating expected emission reductions in section B.5	9,646,000 m^3/year for ex-ante calculations [(300 operating days/y – 20 days flaring) * 34,450 m^3/d biogas]. During implementation of the project activity, the actual monitored data will be applied.
Description of measurement methods and procedures to be applied:	Measured with a gas flow meter incorporated into the main gas outlet pipe. Flow rate will be monitored continuously. Data will be archived electronically, minimum for two years, after last issuance of CERs.
QA/QC procedures to	Flow meters will undergo maintenance/calibration in accordance with

be applied:	manufacturer specifications to ensure its accuracy, which is assumed to be above 95%. Data collected will be compared with the amount of biogas generated and amount of biogas sent to flare to ensure that the data collected to accurate.
Any comment:	Parameter monitored continuously but aggregated monthly and annually for calculations. See Monitoring diagram, Annex 4, this monitoring point corresponds to GF3.

Data / Parameter:	$F_{dry\ vinasse,\ boiler,y}$
Data unit:	kg/y
Description:	Amount of dry vinasse sent to boiler in year *y*
Source of data to be used:	Project developer
Value of data applied for the purpose of calculating expected emission reductions in section B.5	18,720,000 kg/year for ex-ante calculations [300 operation days/y * 62,400 kg/d]. During implementation of the project activity, the actual monitored data will be applied.
Description of measurement methods and procedures to be applied:	Mass measured using scale continuously. Data will be archived electronically, minimum for two years, after last issuance of CERs.
QA/QC procedures to be applied:	Scale will undergo maintenance/calibration in accordance with manufacturer specifications to ensure its accuracy, which is assumed to be above 95%.
Any comment:	Parameter monitored continuously but aggregated monthly and annually for calculations. See Monitoring diagram, Annex 4, this monitoring point corresponds to M_v

Data / Parameter:	$F_{bagasse,boiler,y}$
Data unit:	kg/y
Description:	Amount of bagasse sent to boiler in year *y*
Source of data to be used:	Project developer
Value of data applied for the purpose of calculating expected emission reductions in section B.5	42,600,000 kg/year for ex-ante calculations [300 operation days/y * 142,000 kg/d]. During implementation of the project activity, the actual monitored data will be applied.
Description of measurement methods and procedures to be applied:	Mass measured using scale continuously. Data will be archived electronically, minimum for two years, after last issuance of CERs.
QA/QC procedures to be applied:	Scale will undergo maintenance/calibration in accordance with manufacturer specifications to ensure its accuracy, which is assumed to be above 95%.
Any comment:	Parameter monitored continuously but aggregated monthly and annually for calculations. See Monitoring diagram, Annex 4, this monitoring point corresponds to M_b

Data / Parameter:	$F_{biogas,flare,y}$
Data unit:	m^3/yr
Description:	Amount of biogas sent to flare in year *y*
Source of data to be used:	Measured via gas flow meter by project developer
Value of data applied for the purpose of calculating expected emission reductions in section B.5	689,000 m^3/year for ex-ante calculations (20 days flaring * 34,450 m^3/d biogas m^3/year). During implementation of the project activity, the actual monitored data will be applied.
Description of measurement methods and procedures to be applied:	Measured with a gas flow meter incorporated into the main gas outlet pipe. Flow rate will be monitored continuously in wet basis. Data will be archived electronically, minimum for two years, after last issuance of CERs.
QA/QC procedures to be applied:	Flow meters will undergo maintenance/calibration in accordance with manufacturer specifications to ensure its accuracy, which is assumed to be above 95%.
Any comment:	Parameter monitored continuously but aggregated monthly and annually for calculations. See Monitoring diagram, Annex 4, this monitoring point corresponds to GF2.

Data / Parameter:	$w_{CH4,biogas,y}$
Data unit:	kg CH_4/m^3
Description:	Concentration of methane in biogas in the outlet of the new digester
Source of data to be used:	Measured
Value of data applied for the purpose of calculating expected emission reductions in section B.5	0.3942 for ex-antes estimation, the actual data will be monitored ex-post.
Description of measurement methods and procedures to be applied:	Measurement will be conducted quarterly based on a 95% confidence level using a calibrated portable gas meter by taking statistically valid number of sample measurements. Data will be archived electronically for a minimum of two years, after last issuance of CERs.
QA/QC procedures to be applied:	The gas analyzer shall be subject to regular maintenance and calibration, based on the manufacturer's specifications to ensure its accuracy, which is assumed to be above 95%.
Any comment:	Same basis (wet or dry) will be used for concentration of methane and flows of methane. See Monitoring diagram, Annex 4, this monitoring point corresponds to GM.

Data / Parameter:	$PE_{flare,y}$
Data unit:	tCO_2e
Description:	Project emissions from flaring of the residual gas stream in year y
Source of data to be used:	The parameters used for determining the project emissions from flaring of the residual gas stream in year *y* shall be monitored as per the "*Tool to determine*

	project emissions from flaring gases containing methane (Version 1)".
Value of data applied for the purpose of calculating expected emission reductions in section B.5	2,852 tCO_2e for ex-ante calculations. During implementation of the project activity, the actual monitored data will be applied.
Description of measurement methods and procedures to be applied:	According to the *Tool to determine project emissions from flaring gases containing methane (Version 1).*
QA/QC procedures to be applied:	As per the requirements of the *Tool to determine project emissions from flaring gases containing methane (Version 1).*
Any comment:	Plant will use open flare. Measurement according to the *Tool to determine project emissions from flaring gases containing methane (Version 1).*

Data / Parameter:	$\mathbf{T_{flare}}$
Data unit:	ºC
Description:	Temperature at flare exhaust
Source of data to be used:	Measurements by project developer
Value of data applied for the purpose of calculating expected emission reductions in section B.5	optimal T range of the flare
Description of measurement methods and procedures to be applied:	Continuously. Measurement according to the *Tool to determine project emissions from flaring gases containing methane (Version 1).*
QA/QC procedures to be applied:	Thermocouples will be replaced or calibrated every year. It will be subject to a regular maintenance, testing and calibration regime in accordance with manufacturer specifications to ensure its accuracy, which is assumed to be above 95%.
Any comment:	Data will be kept for 2 years after end of crediting period or last issuance of CERs for the project activity. See Monitoring diagram, Annex 4, this monitoring point corresponds to T_g.

Data / Parameter:	$\mathbf{fv_{CH4,h}}$
Data unit:	-
Description:	Volumetric fraction of component i in the residual gas in the hour h where i = CH_4
Source of data to be used:	Measurements by project participants using a continuous gas analyser
Value of data applied for the purpose of calculating expected emission reductions in	55% for ex-ante calculations. During implementation of the project activity, the actual monitored data will be applied.

section B.5	
Description of measurement methods and procedures to be applied:	Measurement according to the *Tool to determine project emissions from flaring gases containing methane (Version 1).* The same basis (dry or wet) will be considered for this measurement and the measurement of the volumetric flow rate of the residual gas ($FV_{RG,h}$) when the residual gas temperature exceeds 60 ºC This parameter will be measured continuously, and values to be averaged hourly or at a shorter time interval
QA/QC procedures to be applied:	Analysers must be periodically calibrated according to the manufacturer's recommendation. A zero check and a typical value check should be performed by comparison with a standard certified gas. Analyzers will be periodically calibrated according to the manufacturer's recommendation and in accordance with appropriate national/international standards to ensure its accuracy, which is assumed to be above 95%.
Any comment:	As a simplified approach, project participants have chosen to measure the methane content of the residual gas and consider the remaining part as N_2.*).* Data will be kept for 2 years after end of crediting period or last issuance of CERs for the project activity. See Monitoring diagram, Annex 4, this monitoring point corresponds to fv.

Data / Parameter:	$\mathbf{FV}_{RG,h}$
Data unit:	m^3/h
Description:	Volumetric flow rate of the residual gas at normal conditions in the hour h
Source of data to be used:	Project developer using flow meter
Value of data applied for the purpose of calculating expected emission reductions in section B.5	1,435 m^3/h (34,450 m^3/d /24 h)
Description of measurement methods and procedures to be applied:	Continuously, value to be averaged hourly. Same basis is to be considered for this measurement and the measurement of $\mathbf{fv}_{\mathbf{CH4,h}}$.
QA/QC procedures to be applied:	Flow meters will be periodically calibrated according to the manufacturer's recommendation to ensure its accuracy, which is assumed to be above 95%.
Any comment:	Data will be kept for 2 years after end of crediting period or last issuance of CERs for the project activity. See Monitoring diagram, Annex 4, this monitoring point corresponds to GF4.

Data / Parameter:	**Other flare operation parameters**
Data unit:	-
Description:	This should include all data and parameters that are required to monitor whether the flare operates within the range of operating conditions according to the manufacturer specifications including a flame detector.
Source of data to be used:	Project developer
Value of data applied	-

for the purpose of calculating expected emission reductions in section B.5	
Description of measurement methods and procedures to be applied:	Continuously
QA/QC procedures to be used:	-
Any comment:	Applicable to this case using default values for open flare.

Data / Parameter:	$FC_{diesel,y}$
Data unit:	t/y
Description:	Quantity of fuel type diesel combusted in the process during the year combusted in the process during the year *y*
Source of data to be used:	On-site measurement using fuel meters by the project developer
Value of data applied for the purpose of calculating expected emission reductions in section B.5	8,677.86 l*0.85 kg/l: Volume of diesel is assessed based on equipment detailed consumption of each equipment that will be used at start-up or during maintenance for wastewater plant (Refer to Excel emission reduction calculations for details).
Description of measurement methods and procedures to be applied:	Fuel usage will be measured using the fuel meters installed at the fuel storage tank. Meters will be periodically calibrated according to the manufacturer's recommendation to ensure its accuracy, which is assumed to be above 95%.
QA/QC procedures to be applied:	Data will be cross-checked with invoices.
Any comment:	Data monitor as per the Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion version 2. See Monitoring diagram, Annex 4, this monitoring point corresponds to M_d

Data / Parameter:	NCV_{diesel}
Data unit:	GJ/t
Description:	Weighted average net calorific value of fuel type diesel in year *y*
Source of data to be used:	IPCC since data from fuel supplier are not available. IPCC default values at the upper limit of uncertainty at a 95% confidence interval as provided in Table 1.2 of Chapter 1, Vol.2 (Energy), 2006 IPCC Guidelines on National GHG Inventories.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	43.3; IPCC default values at the upper limit of uncertainty at a 95% confidence interval as provided in Table 1.2 of Chapter 1, Vol.2 (Energy), 2006 IPCC Guidelines on National GHG Inventories.
Description of measurement methods	Any future revision of the IPCC Guidelines should be taken into account.

and procedures to be applied:	
QA/QC procedures to be applied:	-
Any comment:	See Monitoring diagram, Annex 4, this monitoring point corresponds to $NCV_{d.}$

Data / Parameter:	**$EF_{CO2,diesel,y}$**
Data unit:	tCO_2/TJ
Description:	Weighted average CO_2 emission factor of fuel type diesel in year *y*
Source of data to be used:	IPCC since data from fuel supplier are not available. IPCC default values at the upper limit of uncertainty at a 95% confidence interval as provided in Table 1.4 of Chapter 1, Vol.2 (Energy), 2006 IPCC Guidelines on National GHG Inventories.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	74.8; IPCC default values at the upper limit of uncertainty at a 95% confidence interval as provided in Table 1.4 of Chapter 1, Vol.2 (Energy), 2006 IPCC Guidelines on National GHG Inventories.
Description of measurement methods and procedures to be applied:	Any future revision of the IPCC Guidelines should be taken into account
QA/QC procedures to be applied:	-
Any comment:	-

Data / Parameter:	**Operation of the wastewater treatment per year**
Data unit:	Hours
Description:	Operating hours of the wastewater treatment plant (each digester) during the year *y*
Source of data to be used:	Project developer
Value of data applied for the purpose of calculating expected emission reductions in section B.5	300 d/y
Description of measurement methods and procedures to be applied:	Operating hours of the reactors will be recorded automatically and continuously
QA/QC procedures to be applied:	Project participant will record manually the operation of the UASB reactors in case the operation is stopped for maintenance, repair.
Any comment:	-

B.7.2. Description of the monitoring plan:

According to monitoring methodology in ACM0014 version 4.1.0 and relevant national and local regulations, monitoring plan will be made to ensure successful operation of the project. The application of monitoring mainly includes two parts, data management system and wastewater treatment plant operator. The monitoring plan as described in Annex 4 will be incorporated to the wastewater treatment plant operation manual.

1. Responsibility
Overall responsibility for daily monitoring and reporting lies with ROXOL, the project owner. The Pollution Control Officer (PCO) of the company appointed by management after undergoing training as required by regulations to get accreditation from the regulatory agency (Environmental Management Bureau) will carry out the monitoring work. The PCO will keep all records that pertain to the CDM project on top of the responsibility to ensure compliance of Roxol to environmental laws.

2. Data and parameters monitored
Refer to annex 4.

3. Installation of meters

The metering equipment will be installed as illustrated in the diagram in Annex 4.

4. Reporting
Data collection and reporting will be based on the description in B.7.1. and Annex 4, and the specific steps will be applied in the specific monitoring plan for different data by Roxol's Biogas plant operator. The report will be presented to Roxol's plant manager for verification and authorization.

5. Calibration
Calibration of the metering equipment will be made at the frequency recommended by the different equipment according to recommendation of each manufacturer. The frequency of calibration requirement will be recorded on the monitoring data log book to ensure that each metering devices are calibrated when required. In addition, the metering equipment will be calibrated and checked annually for accuracy by an independent and accredited body in accordance to the manufacturer's recommendations. Records of calibration and maintenance will be retained as part of the CDM monitoring system.

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

Date of completion of the baseline study and the monitoring methodology: 02/11/2011
Responsible Entity: Ms. Pongtip Puvacharoen and Ms. Julie Godin (not project participant).

SECTION C. Duration of the project activity / crediting period

C.1. Duration of the project activity:

C.1.1. Starting date of the project activity:

27/06/2008, the date of the signature of the construction contract.

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

25 years[81]

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

C.2.1. Renewable crediting period:

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

31/12/2012, but not before a complete request for registration has been submitted.

C.2.1.2. Length of the first crediting period:

7 years, renewal twice

C.2.2. Fixed crediting period:

C.2.2.1. Starting date:

N/A

C.2.2.2. Length:

N/A

SECTION D. Environmental impacts

D.1. Documentation on the analysis of the environmental impacts, including transboundary impacts:

In accordance with the EIA Coverage and Requirements Screening Checklist (ECRSC), the project category was identified and location determined. The project site is located in and industrial area, hence it is non-Environmental Critical Area (ECA). There an Environmental Impact Statement (EIS) was prepared to be submitted to the Environmental Management Bureau, Department of Natural Resources and Environment, for approval.

The specific environmental issues, their corresponding management/control measures are summarized in the Environmental Management Plan below.

Environmental Management Plan		
Environmental Aspect	Management/Control Measure	Verifiable Indicator
Wastewater (Vinasse)	Zero-Discharge System (The wastewater will undergo biodigestion then concentration through evaporation. The concentrated vinasse will be mixed	• Fully operational Biodigester, Evaporator and Paddle Mixer • River water quality measurements

[81] KBK, Transmittal No.: KBK-813-RBC-TRN-039, April 2010

Environmental Management Plan		
Environmental Aspect	Management/Control Measure	Verifiable Indicator
	with bagasse then dried and utilized as fuel for the boiler)	
Process Water (Cooling Tower Condensate)	Treatment in a wastewater treatment system and recycled back as process water.	• Fully operational process water recycling system • River water extraction Record/Log
Sludge	Will be continuously recycled into the TAD as part of the digestion process	• Absence of excess sludge disposal.
Boiler Air Emission	The boiler will be equipped with a wet scrubber. Milk of lime added to the scrubbing water.	• Fully operational wet scrubber installed • Air emission measurements • Ambient air quality measurements
Odor emission from spent wash	Provide covers to the following: (1) buffer tank (2) transfer sump; and, (3) emergency holding pond. (4) biodigester tanks	• Covers installed on the buffer tank, the transfer sump and the emergency holding pond.
Boiler ash disposal	Boiler ash will be stockpiled in a designated area and will be given off to farmers as fertilizer	• Presence of adequate storage area • Records of fertilizer recipients
Construction spoils	Reusable materials stockpiled in a designated area; Solid wastes will be disposed at municipal landfill/dumpsite	• Clean and orderly plant surroundings
Failure of Zero-Discharge System	Provision of 5,000 $m^3$3-capacity Emergency Containment Pond	• Existence of emergency pond
Potential groundwater contamination	Emergency pond is provided with HDPE-lining	• HPDE lining on emergency holding pond • Absence of leakage
Potential flooding and pooling of water	Drainage System	• Well-drained plant surroundings; absence of pools of water within the vicinity.
Health and Safety	Adoption of Health and Safety Policies/Procedures and Protocols	• Written health and safety policies • Safety Procedures Manual • Employees aware of policies • Policies and procedures are observed in the workplace

To ensure that the pollution prevention measures are effective and or are properly functioning periodic measures on the emission and ambient air and water quality will be undertaken as part of the Environmental Monitoring Plan.

Environmental Monitoring Plan		
Parameter	**Media/Location**	**Frequency**
Flow rate	Najalin River	Quarterly
BOD	Najalin River	Quarterly
PM	Boiler Stack Emission	Annual; measurements/sampling taken during full operation
Sox	Boiler Stack Emission	Annual; measurements taken during full operation
PM	Ambient Air	Quarterly; measurements/sampling to be taken during full operation

Social Development Plan (SDP)**.** The project will support activities to improve the quality of life of the local communities. A Community Benefits Plan (CBP) has been prepared to address the priority needs of the three communities immediately surrounding the proposed project/plant. These priority needs were identified through a social assessment and validated through series of consultations with the surrounding communities. The CBP will complement the ongoing community development and extension services of Central Azucarera de Don Pedro Group (CADPG) through its corporate social arm, the Roxas Gargollo Foundation Inc (RGFI), in the area. It will include the following activities:

- *Community Organizing and Development.* The communities need to develop a formal social structure that will empower them and provide their members a venue to participate in the development of a common plan of action for the resolution of their problems. The CBP will include community organizing and development activities which will focus on the formation and/or strengthening of peoples' organizations (POs) and/or cooperatives and the building of their capacities to engage in participatory planning for project identification and implementation.
- *Educational Services.* To improve access to basic and vocational education among school age population, the CBP will provide vocational skills training to drop-outs or out of school youths; grant scholarships to deserving high school students; and implement a reading program (in partnership with Department of Education's Basic Education Information System Module). The CBP will also undertake a rehabilitation of existing pre-school/day care center.
- *Health Services.* To address lack of access to health services, the project entity will organize quarterly medical outreach to members of the beneficiary communities in collaboration with local government health offices. The project entity will also assist members of the beneficiary communities avail of health insurance from PhilHealth. To address poor nutrition, the project entity will partner with the Department of Health in the implementation of Nutrition Education and Feeding Program.
- *Livelihood support.* Finally, to ameliorate unemployment, the project entity will provide livelihood and entrepreneurial support to community members through a micro-lending program for various livelihood activities such as animal dispersal, agricultural production, vending/trading, etc.

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

The environmental impacts caused by the project is not significant, there are appropriate environmental management plan to mitigate the impact at safe level. This was proved by the issuance of Environmental Clearance Certificate (ECC) by the Philippines Department of Environment and Natural Resources after a favorable review of the project's Environmental Impact Statement (EIS).

SECTION E. Stakeholders' comments

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

The local stakehoder were identified with assistant from the local government unite. In accordance with the Revised Procedural Manual for DNRE Administrative Order No. 20 Series of 2003, public participation through a public scoping with the community is required fro project implementation that will require an EIS document. Roxol has conducted an onsite public scoping on 30/05/2008. The proposed project was also presented to the Sangguniang Panlunsod of La Carlota City on 16/07/2008. A public consultation was held on 20/09/2008 at the covered court of Banrangay[82] Roberto S. Benedicto, La Carlota City. Stakeholders represented were the youth, women's labour, religious groups, fishpond owners of Pontevedra, academe and residents of the host and adjacent barangays.

Invitation letters were sent to village chairmen, and information was further cascaded to public by the local and zone leadersfor the 20/09/2008 meeting. There were 120 stakeholders attended the consultation from both public and private sector. The local stakeholders of the project are: residents of Barangay Roberto S. Benedicto, the sugar planters who may want to sell their molasses to the ethanol plant and the City Government of La Carlota City.

During the consultation, representative from Roxol Bioenergy Corporation, Mr. Jeffery G. Mijares presented the project feasibility study, project description and waste management options. An open forum was followed to allow the stakeholders to ask questions and comment on the proposed project.

E.2. Summary of the comments received:

During the meeting, questions were mainly raised on how the Project will positively or negatively impact the environment and other benefits it will have to the community. After the session in which all the questions were duly answered, no negative comments were received on the Project. Many expressed support of the Project due to its environmental effects.

Following are the summary of comments received.

Issue Raised	Response
Employment Opportunity for local community	Representative from Roxol assured that priority employment will be accorded to residents of the community provided they are qualified for the job that they applied for. This is backed by a condition in the Environmental Compliance Certificate (ECC) that will be issued by the Environmental Management Bureau, Region 6.
Supply of molasse and bagasse	The purchases of molasses and if needed in addition to the contracted sources will be governed by supply contract to ensure

[82] A village

	sufficient supply.
Possibility of river pollution of the estuarine portion downstream of project site where several fishponds are located.	The water quality of the receiving water body will be regularly monitored. In a case of emergency breakdown of the wastewater treatment system, the wastewater will be stored in a 500 m^3 lined storage pond.
Odor Control	All containment structures for slops adopted will be both enclosed control odor and lined with HDPE to prevent groundwater contamination.

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

The responses to the comments received are provided in Section E.2. As no negative comments were received, the Director of the Environmental Management Bureau Region 6, closed the session with an assurance that it was committed to the community and that the Project is designed to fully comply with the Environmental Compliance Certificate.

Annex 1

CONTACT INFORMATION ON PARTICIPANTS IN THE PROJECT ACTIVITY

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Annex 2

INFORMATION REGARDING PUBLIC FUNDING

Public funding was not used in this project.

Annex 3

BASELINE INFORMATION

I. Cost Estimates of Baseline Option 3

No.	Lagoon Name	Area	Depth	Total Volume	Cost
		m^2	m	m^3	
1	Anaerobic Pond 1	5,390	6.5	35,035	18,943,660
2	Anaerobic Pond 2	5,390	6.5	35,035	18,943,660
3	Anaerobic Pond 3	5,390	6.5	35,035	18,943,660
4	Anaerobic/Facultative Lagoon 1	10,770	6.5	70,005	37,852,174
5	Anaerobic/Facultative Lagoon 2	10,770	6.5	70,005	37,852,174
6	Anaerobic/Facultative Lagoon 3	10,770	6.5	70,005	37,852,174
7	Conditioning Lagoon	5,390	6.5	35,035	18,943,660
	Total	53,870		350,155	189,331,161
	Hydraulic Retention Time, days	355			
				Excavation + HDPE membrane	189,331,161
				Land cost	1,478,471
				TOTAL COST (PhP)	190,809,632
				TOTAL COST (USD)	3,718,449

II. Calculation of Emission Factor from the Grid

The Tool to Calculate the Emission Factor for an Electricity System (Version 2.2.1) is applied to calculate the combined margin emission factor. This section describes how the national emission factor has been determined as a combined margin (CM) based on the instructions for calculating the emission factors of the operating margin (OM) and build margin (BM).

According to the tool the grid emission factor is calculated as per the following six steps:

STEP 1: Identify the relevant electricity systems.

STEP 2: Choose whether to include off-grid power plants in the project electricity system (optional).
STEP 3: Select a method to determine the operating margin (OM).
STEP 4: Calculate the operating margin emission factor according to the selected method.
STEP 5: Calculate the build margin (BM) emission factor.
STEP 6: Calculate the combined margin (CM) emission factor.

STEP 1 - Identify the relevant electric systems

In accordance with the guidance given in the tool, the relevant electric power system for the project is the **Luzon-Visayas** grid in the Philippines. This system is not connected with other grids in the Philippines. The table below shows the net generation in MWh for the Luzon-Visayas grid.

Net Power Generation (MWh)					
LUZON	2004	2005	2006	2007	2008
Coal	15,548,335	13,400,254	12,763,103	13,038,425	12,177,615
Oil-based	4,590,814	1,313,015	1,235,537	1,738,742	1,398,171
Combined Cycle	738,437	86,787	207,849	611,322	494,200
Diesel	2,688,194	1,207,609	883,315	991,771	459,292
Gas Turbine	183	1,428	0	0	0
Oil Thermal	1,164,000	17,190	144,373	135,649	444,679
Natural Gas	12,384,467	16,497,276	16,012,627	18,427,195	19,190,817
Geothermal	3,033,417	2,555,477	3,307,599	3,393,496	3,523,159
Hydro	4,296,879	4,291,398	5,365,571	4,521,166	5,346,812
Wind	0	17,469	52,630	57,187	60,826
Biomass (LFG)					
Total Net Generation	39,853,911	38,074,889	38,737,066	41,176,210	41,697,400
VISAYAS	2004	2005	2006	2007	2008
Coal	646,077	510,680	618,278	738,845	647,603
Oil-based	1,997,708	1,657,540	1,181,577	1,396,379	1,569,902
Diesel	1,649,383	1,379,504	1,077,623	1,266,648	1,356,909
Gas Turbine	82,094	23,351	-309	8,971	36,179
Oil Thermal	266,231	254,685	104,264	120,760	176,814
Geothermal	6,338,317	5,806,878	5,686,951	5,355,959	5,798,277
Hydro	34,277	27,122	28,077	29,185	40,028
Biomass (LFG)	0				
Total Net Generation	9,016,379	8,002,220	7,514,882	7,520,368	8,055,811
LUZON-VISAYAS	2004	2005	2006	2007	2008
Coal	16,194,412	13,910,934	13,381,381	13,777,270	12,825,218

Oil-based	6,588,522	2,970,555	2,417,114	3,135,121	2,968,073
Natural Gas	12,384,467	16,497,276	16,012,627	18,427,195	19,190,817
Geothermal	9,371,734	8,362,355	8,994,550	8,749,455	9,321,436
Hydro	4,331,156	4,318,520	5,393,648	4,550,351	5,386,840
Wind	0	17,469	52,630	57,187	60,826
Biomass (LFG)	0	0	0	0	0
Total Net Generation	48,870,290	46,077,109	46,251,948	48,696,578	49,753,211
% low-cost/must run resources	28.04	27.56	31.22	27.43	29.68

Source: Power Planning and Development Division Electric Power Industry Management Bureau,Department of Energy, 2009

STEP 2 - Choose whether to include off-grid power plants in the project electricity system

The calculation of the operating margin and build margin emission factor is based on the option I of the tool: *Only grid power plants are included in the calculation*.

STEP 3 - Select a method to determine the operating margin (OM)

According to the Tool, calculating the Operating Margin Emission Factor $EF_{grid, OM,,y}$ can be based on one of the four available methods:
(a) Simple OM;
(b) Simple adjusted OM;
(c) Dispatch Data Analysis OM; or
(d) Average OM.

Any of the four methods above for calculating the operating margin emission factor can be used according to the tool. However, the Simple OM method (a) can only be used if low-cost/must-run resources constitute less than 50% of the total grid connection in: 1) average of the five most recent years, or 2) based on long-term average hydro-electric production.

The Luzon-Visayas grid in Philippines is predominantly fossil fuel-fired. Low-cost/must-run resources, consisting mostly of geothermal and hydro, have been responsible for less than 50% of generation during the past 5 years **(refer to the table above)**.

Based on the fact that the applicability condition of low cost/must run resources constituting less than 50% of the total grid in average of the five most recent years is satisfied, method (a) **Simple OM** has been selected as the method for calculating the operating margin.

According to the "*Tool to calculate the emission factor for an electricity system*", the Simple OM emission factor can be calculated using either of the two following data vintages:

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

- **Ex post option:** The year in which the project activity displaces grid electricity, requiring the emissions factor to be updated annually during monitoring. .

The **ex ante option** based on 3-year generation has been selected for the purpose of emission reductions calculation for the proposed project.

STEP 4 - Calculate the operating margin emission factor according to the selected method

The simple OM emission factor has been calculated based on a 3-year vintage (2006-2008), i.e.,the most recent data available at the time of submission of the CDM-PDD to the DOE for validation[83]. The OM is calculated as the generation-weighted emissions per electricity unit of all generating units serving the system, excluding low-cost and must-run power plants.

The OM is calculated as follows (Option A1), using a 3-year average.
Under this option, the simple OM emission factor is calculated based on average efficiency and electricity generation of each plant, not including low-cost/must run resources and the fuel type(s) and total fuel consumption of the project electricity system, as follows:

$$EF_{grid,OMsimple,y} = \frac{\sum_{m} EG_{m,y} \bullet EF_{EL,m,y}}{\sum_{m} EG_{m,y}}$$

Where:
$EF_{grid,OMsimple,y}$ Simple operating margin CO_2 emission factor in year *y* (tCO_2/MWh)
$EG_{m,y}$ Net quantity of electricity generated and delivered to the grid by power unit *m* in year *y* (MWh)
$EF_{EL,m,y}$ CO_2 emission factor of power unit *m* in year *y* (tCO_2/MWh)
m All power units serving the grid in year *y* except low-cost / must-run power units
y The relevant year of the chosen vintage data in Step 3 (i.e. 2006,2007,2008)

To determine $EF_{EL,m,y}$, Option A2 is applied given that the data on fuel consumption is not available. The emission factor then is determined based on the CO_2 emission factor of the fuel type used and the efficiency of the power unit, as follows:

$$EF_{EL,m,y} = \frac{EF_{CO2,m,i,y} \bullet 3.6}{\eta_{m,y}}$$

Where:
$EF_{EL,m,y}$ CO_2 emission factor of power unit *m* in year *y* (tCO_2/MWh)
$EF_{CO2,m,i,y}$ Average CO_2 emission factor of fuel type i used in power unit m in year *y* (tCO_2/GJ)
$\eta_{m,y}$ Average net energy conversion efficiency of power unit m in year y (ratio)

[83] Confirmed by the Department of Energy (DOE). Power Planning and Development Division Electric Power Industry Management Bureau.

m All power units serving the grid in year *y* except low-cost/must-run power units
y The relevant year of the chosen vintage data in Step 3 (i.e. 2006,2007,2008)

The calculation of Operating Margin is illustrated in the following table.

Net Power Generation for LUZON-VISAYAS grid (MWh)						
	2006	2007	2008	Default CEF (tCO_2/GJ)	$\eta_{m,y}$	EF_{EL} (tCO_2/MWh)
Coal	13,381,381	13,777,270	12,825,218	0.0873	39%	0.805846154
Oil-based	2,417,114	3,135,121	2,968,073			
Combined Cycle	207,849	611,322	494,200	0.0726	46%	0.568173913
Diesel	1,960,938	2,258,419	1,816,201	0.0726	39.5%	0.661670886
Gas Turbine	(309)	8,971	36,179	0.0726	39.5%	0.661670886
Oil Thermal	248,637	256,409	621,493	0.0755	39.5%	0.688101266
Natural Gas	16,012,627	18,427,195	19,190,817	0.0543	39.5%	0.494886076
Geothermal	8,994,550	8,749,455	9,321,436	-		-
Hydro	5,393,648	4,550,351	5,386,840	-		-
Wind	52,630	57,187	60,826	-		-
Biomass(LFG)	-	-	-	-		-
Total Net Generation	46,251,948	48,696,578	49,753,211			
Total Net Generation excluding low-cost/must run source	31,811,122	35,339,586	34,984,108			

When calculating the Operation Margin, the Gross generation data for year 2006, 2007, 2008 have been employed to ensure the conservativeness of the results. Ratios representing the average net energy conversion efficiency of power unit m in year y is taken from Annex 1 the Tool to Calculate the Emission Factor for an Electricity System (Version 2.2.1).

Therefore, the Simple operating margin emission factor for the Luzon-Visayas grid is 0.6296 tCO_2/MWh

« Operating Margin » (OM)	**EF in tCO_2/MWh**
2006	0.6380
2007	0.6295
2008	0.6222
OM	0.6296

STEP 5 - Calculate the build margin (BM) emission factor

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

Capacity additions from retrofits of power plants are not included in the calculation of the build margin emission factor. The sample group of power units *m* used to calculate the build margin is determined as per the following procedure:

The sample group of power units *m* used to calculate the build margin is determined as per the following procedures[84]:

(a) The set of five power units that started to supply electricity to the grid most recently ($SET_{5\text{-units}}$) and their annual electricity generation ($AEG_{SET\text{-}5\text{-units}}$) are listed in the table below (excluding power units registered as CDM project activities).

$SET_{5\text{-units}}$	**Installed Cap (MW)**	**Plant Type**	**$AEG_{SET\text{-}5\text{-units}}$ (GWh)**	**Original Year Commissioned**	**Cumulative Percentage (%)**
Sevilla Hydroelectric Plant	2.5	Hydro	1,330	Nov 2008	0.0%
PMDP II	15	Oil based	17,940	June 2008	0.0%
Northern Negro Geothermal Plant	49	Geothermal	shutdown	January 2007	0.0%
5 MW Bunker (GBPC)	5	Oil based	6,457	Sep 2006	0.1%
12.5 MW Bunker (GBPC)	12.5	Oil based		Aug 2006	0.1%
Total			**25,728**		

(b) The annual electricity generation in 2008 of the project electricity system, excluding power units registered as CDM project activities is: AEG_{total} = 49,753,211 MWh[85]. The set of power units, excluding power units registered as CDM project activities, that started to supply electricity to the grid most recently and that comprise 20% of AEGtotal are identified in table below as $SET_{\geq 20\%}$ along with their annual electricity generation ($AEG_{SET\text{-}\geq 20\%}$, in MWh).

SET≥20%	Installed Cap (MW)	Plant Type	AEGSET-≥20% (MWh)	Original Year Commissioned	Cumulative Percentage (%)
Sevilla Hydroelectric Plant	2.5	Hydro	1,330	Nov 2008	0.0%
PMDP II	15	Oil based	17,940	June 2008	0.0%
Northern Negro Geothermal Plant	49	Geothermal	shutdown	January 2007	0.0%
5 MW Bunker (GBPC)	5	Oil based	6,457	Sep 2006	0.1%
12.5 MW Bunker (GBPC)	12.5	Oil based	-	Aug 2006	0.1%
20 MW Bunker (GBPC)	20	Oil based	22,124	Feb 2006	0.1%
Northwind Power**	33	Wind	60,826	June 2005	0.2%
Guimaras Power Project	3.4	Oil based	6,554	April 2005	0.1%
San Roque HE	345	Hydro	1,079,877	May 2003	2.3%
San Lorenzo Nat Gas	500	Nat Gas	3,824,540	September 2002	10.0%
Ilijan	1,200	Nat Gas	7,833,095	June 2002	25.7%
Total	12,791,917 (equivalent to 25.71%)				

[84] Data are available via email by Philippines DOE

[85] 2007 data, 20% of the AEG_{total} thus equals to 2,552 MWh.

(c) From SET5-units and SET≥20% , the set of power units that comprises the larger annual electricity generation (SET_{sample}) is identified as SET≥20%. Dates when the power units in SET_{sample} started to supply electricity are identified the table below (all less than 10 years ago):

Sub-steps d) to f) do not apply since power units listed are all less than 10 years ago.

The Build Margin emissions factor (BM) is calculated as the generation-weighted average emission factor of the most recently built plants, using the following formula:

$$EF_{grid,BM,y} = \frac{\sum_{i,m} EG_{m,y}.EF_{EL,m,y}}{\sum_{m} EG_{m,y}}$$

Where:

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

The calculation method for BM is as same as the one for OM (refer to the table below)

Plant Name	Power generation in 2008 (GWh)	Plant Type	Default CEF (tCO_2/GJ)	$\eta_{m,y}$	EF_{EL} (tCO_2/MWh)	tCO_2
Sevilla Hydroelectric Plant	1	Hydro	0		0	
PMDP II	18	Oil based	0.0726	0.395	0.66167	11,870.55
Northern Negro Geothermal Plant	0	Geothermal	0		0.00000	-
5 MW Bunker (GBPC)	6	Oil based	0.0726	0.395	0.66167	4,272.62
12.5 MW Bunker (GBPC)	0	Oil based	0.0726	0.395	0.66167	-
20 MW Bunker (GBPC)	22	Oil based	0.0726	0.395	0.66167	14,638.89
Guimaras Power Project	7	Oil based	0.0726	0.395	0.66167	4,336.27
San Roque HE	1080	Hydro	0			-
San Lorenzo Nat Gas	3825	Nat Gas	0.0543	0.395	0.49489	1,892,711.35
Ilijan	7833	Nat Gas	0.0543	0.395	0.49489	3,876,489.88
Total	12792					5,804,319.56
					BM	**0.4537**

The build margin emission factor is therefore 0.4537 tCO_2/MWh.

STEP 6- Calculate the combined margin (CM) emissions factor

The final step in applying the tool is to calculate the combined margin emissions factor. This has been calculated as the weighted average of the emissions factor of the OM and the BM. The formula that has been used to calculate this weighted average emission factor is as follows:

$$EF_{grid,CM,y} = EF_{grid,OM,y} \times w_{OM} + EF_{grid,BM,y} \times w_{BM}$$

Where

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

Therefore, $EF_{grid,CM,y}$ = 0.5= $0.6231 \times 50\% + 0.4691 \times 50\%$*0.6296+0.5*0.4537 = **0.5416 tCO_2/MWh**

As recommended by the tool for projects other than wind and solar projects, the default values of weighted factors w_{OM} = 0.5 & w_{BM} = 0.5 are used.

The latest default values recommended in the 2006 IPCC Guidelines for National Greenhouse Gas Inventories for the fuels emissions factors and Default efficiency factors for power plants in Annex 1 of the "Tool to calculate the emission factor for an electricity system" are used to derive the OM and the BM emission factors of the grid.

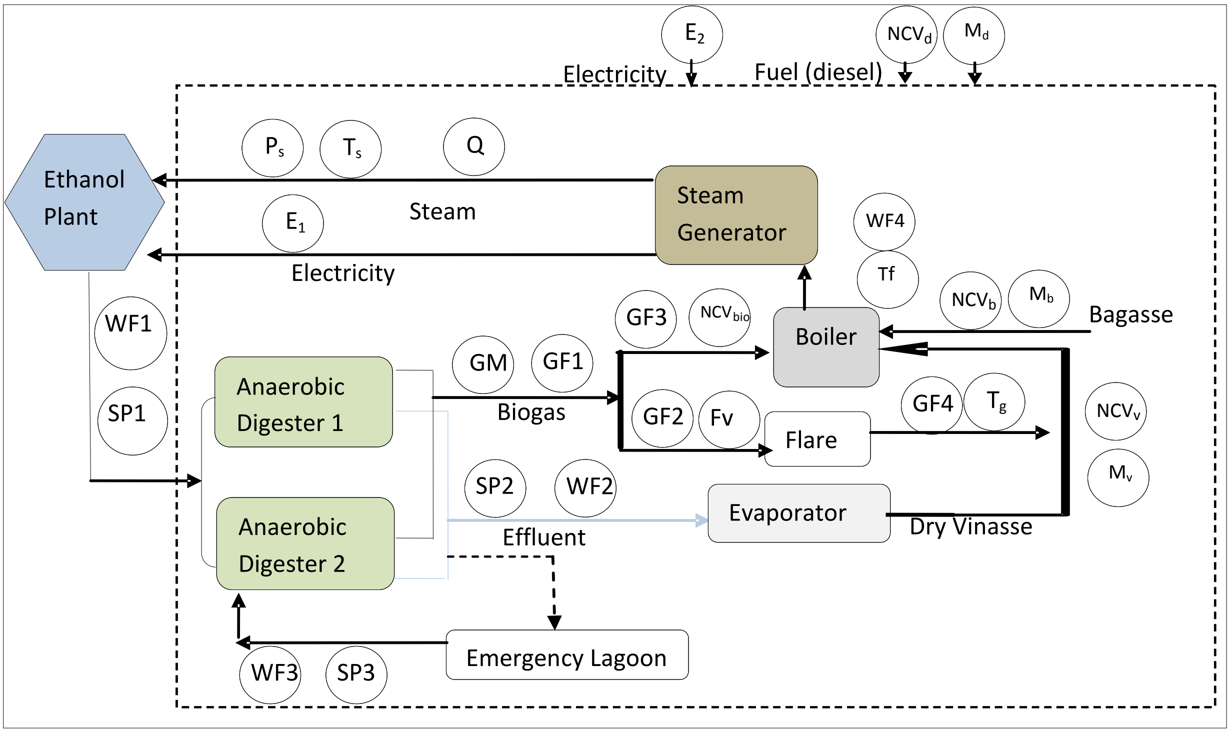
Grid emission factors computation

Designation	EF in tCO2/MWh
« Operating Margin » (OM)	
2006	0.6380
2007	0.6295
2008	0.6222
Average OM	0.6296
« Build Margin » (BM)	0.4537
Combined Margin (weighted average OM and BM)	**0.5416**

<u>Annex 4</u>

MONITORING INFORMATION

Monitoring Diagram



Monitoring Meters and Parameters

Monitoring points	Description	Monitored Parameters in the Monitoring Plan
WF1	Wastewater Flow Meter (influent)	$F_{PJ,dig,m}$
WF2	Wastewater Flow Meter (effluent from the digester)	$F_{PJ,effL,dig,m}$
WF3	Wastewater Flow Meter (effluent from the emergency lagoon)	$F_{PJ,effL,lag,m}$
WF4	Quantity of feed water in year y	$F_{feed\ water,y}$
SP1	Sample point to measure influent COD concentration	$w_{COD,\ dig,m}$
SP2	Sample point to measure effluent COD concentration from the digesters	$w_{COD,effl,dig,m}$
SP3	Sample point to measure influent COD concentration from the emergency lagoon	$w_{COD,effl,lag,m}$
GF1	Gas Flow Meter to measure gas collected from the digesters	$F_{biogas,y}$
GF2	Gas Flow Meter to measure gas sent to flare	$F_{biogas,flare,y}$
GF3	Gas Flow Meter to measure gas sent to the boilers	$F_{biogas,boiler,y}$
GF4	Gas Flow Meter to measure residue gas from flare	$FV_{RG,h}$

GM	Gas meter to measure concentration of methane in the biogas collected from the digesters	$w_{CH4,biogas,y}$
T_g	Thermometer to measure exhaust gas of flare	T_{flare}
fv	Gas analyzer to monitor the volumetric fraction of methane in biogas flared	$fv_{CH4,h}$
NCV_{bio}	Net Calorific Value of biogas consumed by the boiler	$NCV_{biogas,boiler}$
NCV_v	Net Calorific Value of dry vinasse consumed by the boiler	$NCV_{dry\ vinasse,\ boiler}$
NCV_b	Net Calorific Value of bagasse consumed by the boiler (ibid)	$NCV_{bagasse,boiler}$
NCV_d	Net Calorific Value of Diesel consumed by the ethanol plant	NCV_{diesel}
M_v	Weight of the dry vinasse consumed by the boiler	$F_{dry\ vinasse,\ boiler,y}$
M_b	Weight of the bagasse consumed by the boiler	$F_{bagasse,boiler,y}$
M_d	Weight of the diesel consumed by the ethanol plant	$FC_{diesel,y}$
E_1	Electricity generated from the turbine in year y	$E_{tot,y}$
E_2	Electricity consumed for the wastewater treatment in year y	$E_{con,\ WWT,y}$
Q	Quantity of steam generated at the turbine	$F_{steam,y}$
T_s	Temperature of the steam	$T_{steam,y}$
T_f	Temperature of the feed water in year y	$T_{feed\ water,y}$
P_s	Pressure of the steam	$P_{steam,y}$

Monitoring Parameters, Frequency, Equipment Archiving and Responsibility

In order to fully comply with the QA/QC procedures will be applied right from the source of the data itself. The data will be captured in a log. The data collection template will be use to keep record of data for each parameter to be measured in the monitoring plan as illustrate in the template below.

GENERAL INFORMATION	
FORM TYPE:	**FORM NUMBER:**
DATA TO BE MEASURED:	**CDM ID:**
DESCRIPTION OF LOCATION:	**PERSON RESPONSIBLE FOR DATA LOGGING:** **NAME: DEPARTMENT:**
INSTRUMENTATION INFORMATION	
INSTRUMENT ID:	**INSTRUMENT TYPE:**
MANUFACTURER/MODEL:	**SERIAL NUMBER:**
MEASUREMENT RANGE AND UNIT: **UPPER MEASUREMENT LIMIT:** **LOWER MEASUREMENT LIMIT:**	**INSTRUMENT CALIBRATION INFORMATION:** **LAST CALIBRATION DATE:** **NEXT CALIBRATION DATE:** **UNCERTAINTY LEVEL:**
INSTRUCTIONS REQUIRED	
MONITORING FREQUENCY:	**MAX. REPORTING UNCERTAINTY:**
BEFORE DATA READING:	**ABNORMAL SITUATION:**
AFTER DATA READING:	**SPECIAL REQUIREMENTS:**
DATA LOG	