PROJECT DESIGN DOCUMENT FORM
FOR SMALL-SCALE CDM PROJECT ACTIVITIES (F-CDM-SSC-PDD)
Version 04.1

PROJECT DESIGN DOCUMENT (PDD)

Title of the project activity	Energeticos Jaremar – Biogas recovery from Palm Oil Mill Effluent (POME) ponds, and heat & electricity generation, Honduras
Version number of the PDD	05
Completion date of the PDD	9/07/2012
Project participant(s)	Energeticos Jaremar, S.A. de C.V.
Host Party(ies)	Honduras
Sectoral scope and selected methodology(ies)	**Sectoral Scope 13:** Waste handling and disposal **Methodology:** “Methane recovery in wastewater treatment” following definition in AMS-III.H/Version 05_Scope 13_EB31 **Sectoral Scope 1:** Energy industries (renewable sources) **Methodology:** “Thermal energy for the user with or without electricity”, following definition in AMS-I.C./Version 11_Scope 1_EB32
Estimated amount of annual average GHG emission reductions	54,524

SECTION A. Description of project activity

A.1. Purpose and general description of project activity

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The proposed project activity involves the covering of two open anaerobic lagoons for the treatment of palm oil mill effluent (POME) at Agrotor's palm oil mill located in Honduras. The recovered biogas will be utilised on site for the production of heat and electricity.

The project reduces greenhouse gas emissions in three ways: (1) by preventing methane emission resulting from the anaerobic conversion of the POME, to the atmosphere by biogas capture, (2) by replacing residual fuel oil (bunker) with biogas and (3) by replacing electricity consumption from the grid with electricity generated from biogas.

The project is developed by Energeticos Jaremar S.A. de C.V.(from now on Energeticos Jaremar) and implemented at the Agrotor production facility. Both companies are part of the Jaremar Group, which is an agricultural business leader in the palm oil industry in Honduras.

Besides the decrease in greenhouse gas emissions the project contributes to Honduras' sustainable development as follows:

- The project reduces the dependency on fossil fuels, due to the usage of biogas for heat and electricity generation.
- The project proponent has decided to share part of the revenues from this CDM project with the community, by increasing the support given through a corporate social responsibility plan based on education programs for local communities. This is done in cooperation with the National Education Authorities.
- The project involves technology transfer to the region.
- The project will result in environmental benefits: reduced odour and pathogen and vector control.

The capture and utilisation of biogas is expected to yield 381,665 tCO_2eq over the first seven-years crediting period. The project will result in an emission reduction of approximately 54,524 tCO_2eq per year. The project is expected to be operational by 1st January 2008.

A.2. Location of project activity

A.2.1. Host Party(ies)

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Honduras

A.2.2. Region/State/Province etc.

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Atlantida Departament

A.2.3. City/Town/Community etc.

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San Alejo Village, Tela Community

A.2.4. Physical/Geographical location

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Precise coordinates for the project are N 15° 43.41' and W 87°35.4' The project is delineated by mainly African palm plantations, and the San Alejo River.

A.3. Technologies and/or measures

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The proposed CDM project activity covers the following sectoral scopes:

Sectoral Scope 13: Waste handling and disposal
Project activity: "Methane recovery in wastewater treatment" following definition in AMS-III.H/Version 05_Scope 13_EB31.

Sectoral Scope 1: Energy industries (renewable sources)
Project activity: "Thermal energy for the user with or without electricity", following definition in AMS-I.C./Version 11_Scope 1_EB32

I) Methane recovery
The proposed project activity involves the covering of two existing open anaerobic lagoons with a high-density polyethylene (HDPE), linear low-density polyethylene (LLDPE), or ethylene propylene dimonomer (EPDM) liner, which resist bad weather and provide a system to evacuate accumulated rainwater. The cover will be anchored along the edge of each lagoon to guarantee that they are hermetically sealed. This cover will prevent the release of biogas to the atmosphere. The biogas recovery system is managed by an automatic control system which establishes optimal operation conditions.

Before both the lagoons are covered they will be adapted to assure ease of maintenance and steady biological conditions through the project's lifetime. Measures under this adaptation include an increase of the treatment capacity, installation of an internal mixing system and a refurbishment of the existing sludge removal system. A piping system will be installed which serves as a by-pass in case of malfunctions or maintenance. Current pumps and piping will remain in the project situation.

Sludge management: There is no dewatering process for the complete treatment system. A sludge removal unit will be installed to avoid the progressive accumulation of sludge at the bottom of the lagoons, which could affect the methane capture capacity. Surplus sludge will be continuously circulated to the digester system and it will be occasionally removed from the recirculation cycle.
Removed sludge will be dried on dedicated fields. All the dried sludge will be managed under aerobic and controlled conditions.
The project proponent currently uses the sludge for land application to enhance the quality of the soil.

II) Biogas utilisation
The composition of the captured biogas is typically primarily methane (65%) and carbon dioxide (35%).
The biogas distribution system includes PVC piping for the biogas flow and biogas blowers to transport the gas. The piping system further includes: water condensation system (to remove water content), H_2S biological and chemical filters (eliminate impurities), biogas flow measurement, biogas analysis (CH_4, CO_2, O_2, H_2S), flare, pressure measurement devices on several points, valves and accessories, sampling points and several blowers to inject biogas into the different combustion units. For security reasons and to minimise biogas loss, the biogas pipeline is periodically checked and maintained if necessary.

The biogas will be utilised in the following priority:

1) Heat generation in the boilers: The biogas will replace bunker consumption at the refinery located near the palm oil mill:
2) Electricity production by a biogas generator system: The produced electricity will avoid electricity imports from the grid. All electricity generated will be used at the palm oil mill and the refinery.
3) Flaring: If there is an excess of biogas, it will be flared by an open candlestick flare. Most likely this occurs in the months from August to October where an enhanced biogas production is expected.

The biogas utilisation priorities can be restructured. If the grid operator Empresa Nacional de Energía Eléctrica (ENEE) cannot supply the additional electricity required for the operation of the refinery or the mill, electricity generation will be considered as the highest priority for the consumption of biogas (including the possibility to incorporate a new biogas generator). The same is applicable if heat/steam generation is considered as a highest priority.

Technical details for each utilisation unit for biogas can be found below:

<u>1) Heat generation in the boilers:</u>

The biogas will initially replace 1,477 m^3 of bunker per year. In order to utilise the captured biogas in the boilers one burner will be replaced and the other one will be adapted. The specifications of the existing boilers are:

- Boiler 1:
  - Thermal capacity: 7.36 MW_{th}
  - Model: Cleaver-Brooks peritubular boiler
  - Purpose: steam production for internal production process at the palm oil refinery.
  - Efficiency from Cleaver Brooks Manual (conservative reference on Efficiency): lower value for steam boiler with biogas (81%) and higher value for steam boiler with fuel oil N°5 and N°6 (86%). See Annex 10 of the Supporting Documentation.
- Boiler 2:
  - Thermal capacity: 1.17 MW_{th}
  - Model: HTT wtö 1.250-30-1-v (vertical). Provided by HTT Energy systems
  - Purpose: Energy System for heating thermal oil.
  - Efficiency: 85% for any fuel. The technology provider has informed that there are no efficiency differences between bunker and biogas. The characteristics of the thermal oil heater are described under Annex 11 of the Supporting Documentation.

The PDD registered on the 8th of March 2008, foresaw the installation of new thermal applications for the biogas and allowed for the implementation of such applications as the production requires it. Later, it became clearer what these additional applications were two additional boilers which were added to the project and which were included in the Monitoring Plan Revision approved on the 9th of November 2011. These new applications have the following characteristics:

- Boiler 3:
  - Thermal capacity: 9.802 MWth
  - Model: CB600-800

  - Purpose: Energy steam production for internal production process at the palm oil refinery.
  - According to "Cleaver Brooks Efficiency Facts", when testing the efficiency of a CB600-800 using fuel oil No.6 across a range of operating conditions, the highest value obtained is 87.5%. This value has been selected according to paragraph 13 (b) of the methodology comparing the efficiencies of three different providers for similar equipment.
  - The efficiency of the boiler using biogas is to be determined during the first verification for which ID.42 will be relevant.

- Boiler 4:
  - Thermal capacity: 0.93 MWth
  - Model: NUK-HP 930 from GekaKonus
  - Purpose: Energy steam production for internal production process at the palm oil refinery.
  - A default value of 100% efficiency using fuel oil No.6 was adopted during the Monitoring Plan Revision due to the lack of available information (paragraph 13 of AMS-I.C (version 11, option c). The project owner will be able to use a more realistic (lower) efficiency value if sufficient information is provided at verification to support a change.
  - The efficiency of the boiler using biogas is to be determined during the first verification for which ID.43 will be relevant.

2) Biogas generator system:
The proposed project activity involves the installation of a 0.848 MW_e biogas fuelled generator. The generator is sized based on the electricity needs of the complete refinery and palm oil mill in Agrotor and minimize the consumption from the grid. The specifications of the generator are:
  - Installed capacity: 0.848 MW_e
  - Model: Jenbacher GenSet JGC316 GS-B.L
  - Voltage: 840 Volts
  - Frequency: 60 Hz

More details are included under Annex 12 of the Supporting Documentation.

3) Flaring:
The open flare will burn the surplus biogas, to avoid any dangerous accumulation in the covered lagoon of the biogas management system. It is envisaged that only in the months from August to October there will be a surplus of biogas.

A.4. Parties and project participants

Party involved (host) indicates a host Party	Private and/or public entity(ies) project participants (as applicable)	Indicate if the Party involved wishes to be considered as project participant (Yes/No)
Honduras (host)	Energeticos Jaremar, S.A. de C.V.	No
United Kingdom of Great Britain and Northern Ireland	CF Carbon Fund II Limited	No

The Project owner is Energeticos Jaremar, S.A. de C.V., a company created by Jaremar S.A. (Jaremar Group) for the management of this project activity and other innovative projects. Jaremar Group is part of a conglomerate of companies dedicated to production and trade of agro-industrial and mass consumer products. With over 3,000 employees, the Jaremar Group is one of the five most important industrial and commercial clusters in Honduras and Panama.

Full contact information for Energeticos Jaremar S.A. de C.V. is provided in Annex 1.

Further companies involved:

- OneCarbon B.V is the CDM consultant
- Ecofys Netherlands B.V. is the PDD writer
- BIOTEC is the technology supplier.

A.5. Public funding of project activity

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The project activity obtains no public funding.

A.6. Debundling for project activity

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

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

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

SECTION B. Application of selected approved baseline and monitoring methodology

B.1. Reference of methodology

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Methane recovery

Title: Methane Recovery in Wastewater Treatment

Reference: ‘*Methane recovery in wastewater treatment’* approved small scale CDM baseline methodology III.H./Version 05_Scope 13_EB31.

Heat generation

Title: Thermal Energy for User with or without electricity

Reference ‘*Thermal energy for the user with or without electricity’* approved small scale CDM baseline methodology I.C./Version 11_Scope 1_EB32.

B.2. Project activity eligibility

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Methane recovery in wastewater treatment – Project Type III

As per the methodology, this project category comprises measures for methane recovery from wastewater treatment facilities. The emission reductions are limited to less than or equal to 60 kt CO_2 equivalent per year.

Since the emission reductions are less than 60kt CO_2 equivalent, the project is eligible for approved small scale baseline methodology III.H.

The project category *'recovery in wastewater treatment (III.H./Version 05_Scope 13_EB31.*) comprises measures that recover methane from biogenic organic matter in wastewaters by means of several options. The only suitable option for the calculation of the emission reductions achieved by the project activity is (iv) "*Introduction of methane recovery and combustion to an existing anaerobic wastewater treatment system such as anaerobic reactor, lagoon, septic tank or an on site industrial plant"*

Thermal energy for the user with or without electricity – Project Type I

For the estimation of the emission reductions from the displacement of fossil fuels, approved small scale CDM baseline methodology *Thermal Energy for user with or without electricity' (I.C/Version 11_Scope 1_EB32)* is used. This category comprises renewable energy technologies that supply individual households or users with thermal energy that displaces fossil fuels. Where generation capacity is specified by the manufacturer, it shall be less than 15MW_e.

The total installed capacity of the boilers included in the project boundary is 19.26 $MW_{thermal}$, this is below the threshold of 45 $MW_{thermal}$. The breakdown of the installed capacity can be found in table 3.

Table 3. Breakdown installed capacity boilers

Boiler number	**Name in Monitoring plan**	**Thermal capacity (MW_{th})**
Boiler 1	Cleaver Brooks	*7.36*
Boiler 2	HTT Energy System for heating thermal oil	*1.17*
Boiler 3	CB600-800	*9.80*
Boiler 4	NUK-HP 930	*0.93*
Total		*19.26*

For the estimation of the emission reduction from the displacement of grid electricity approved small scale CDM baseline methodology *Thermal Energy for user with or without electricity' (I.C/Version 11_Scope 1_EB32)* is used. This category comprises renewable generation units that supply electricity to and displace electricity from a grid. The total generation capacity to be installed as part of this project activity is of 0.848 MW_e, which is below the threshold of 15 MW_e.

If we consider a theoretical relation of 1 MW_e equivalent to 3 MW_{th} , we can estimate a new total thermal capacity summing up the boilers and the biogas generator system. This is equal to 21.80 MW_{th} which is still below the threshold of 45 $MW_{thermal.}$

B.3. Project boundary

Source		GHGs	Included?	Justification/Explanation
Baseline scenario	$BE_{methane}$	CH_4	Yes	Baseline emissions resulting from anaerobic digestion of waste water in the year "y" have been included because the wastewater treatment system captures methane to use it in different applications that otherwise would have been emitted.
	$BE_{y,thermal}$	CO_2	Yes	Baseline emissions resulting from the combustion of bunker in the year "y" have been included since the use of captured biogas for energy generation displaces the baseline's use of bunker.
	$BE_{y,power}$	CO_2	Yes	Baseline emissions resulting from grid electricity production, in the year "y" are included since the project uses captured biogas for electricity generation. In the baseline, this electricity would have been imported from the grid.
Project scenario	$PE_{y,power}$	CO_2	Yes	Emissions through electricity consumption from the biogas capture equipment in the year "y" have been considered since the project consumes electricity.
	$PE_{y,ww,treated}$	CH_4	Yes	Emissions through degradable organic carbon in treated wastewater in year "y" have been considered since there is treated wastewater.
	$PE_{y,fugitive}$	CH_4	Yes	Emissions through methane release in capture and flare systems in year "y" has been considered since the flare's efficiency is lower than 100%.
	$PE_{y,s,final}$	CH_4	No	Emissions from anaerobic decay of the final sludge produced in the year "y" have been neglected since the sludge is used for fertirrigation and there are no emissions linked to its used as soil application.
	$PE_{y,dissolved}$	CH_4	Yes	Emissions though dissolved methane in treated wastewater in year "y" have been considered to consider potential changes in the amount and characteristics of the methane dissolved in treated wastewater.

According, to approved small scale CDM baseline methodology III.H./Version 05_Scope 13_ EB31. 'Methane recovery in wastewater treatment', the project's boundary is the physical, geographical site where the wastewater treatment takes place and the methane is transported. Taking into account AMS-I.C./Version 11_Scope 1_EB32 'Thermal Energy for user with or without electricity', the project boundary is the physical, geographical site of the renewable energy generation inside the Energeticos Jaremar facility. Furthermore the project boundary also encompasses all power plants physically connected to the Honduran electricity grid (SIN), managed by the ENEE [1].

[1] www.enee.hn

The following figure shows a representation of the project boundary.

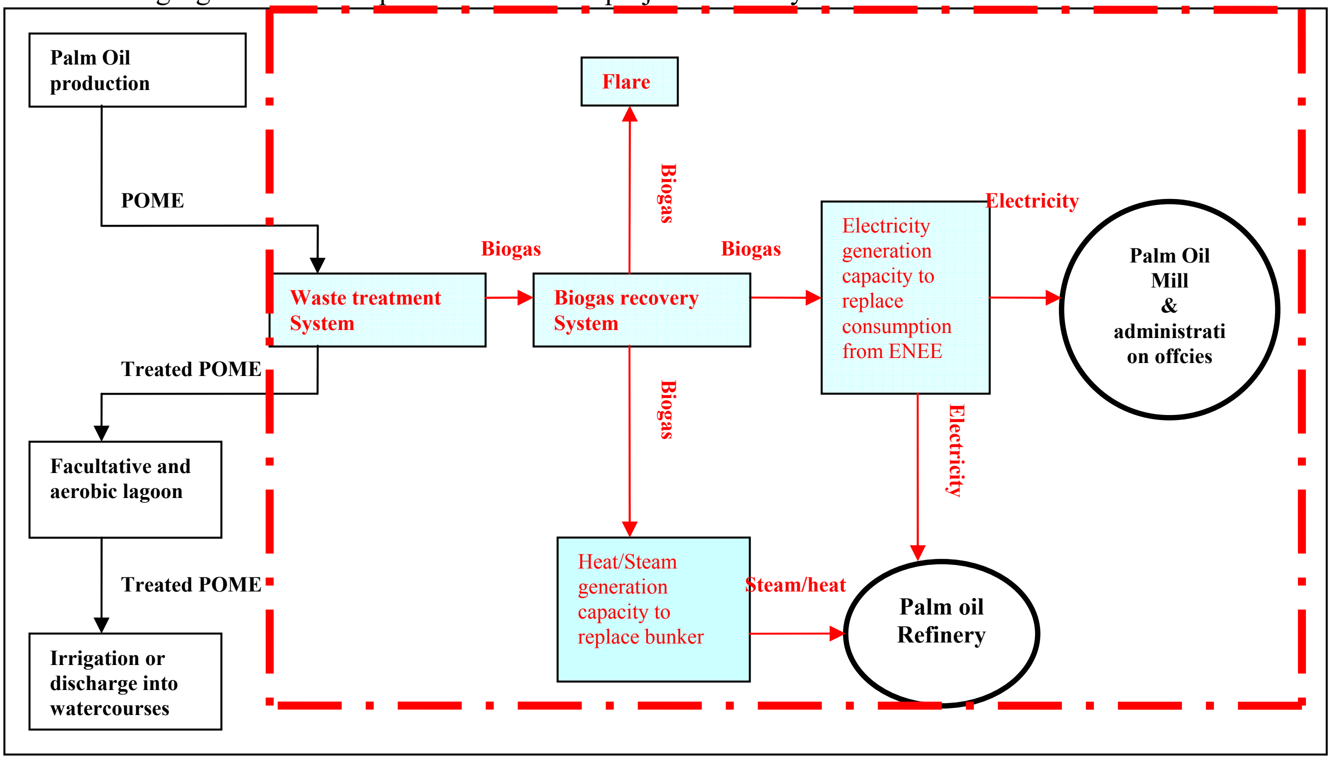

Figure 3: Graphical representation of the CDM project's boundaries[2]

B.4. Establishment and description of baseline scenario

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The project reduces greenhouse gas emissions in three ways:

(1) by methane recovery (capture) in a wastewater treatment system,
(2) by replacement of bunker used for the generation of heat and for heating thermal oil with biogas (thermal energy for user)
(3) by replacing grid electricity with electricity generated from biogas (electricity generation)

The baseline for all three processes is identified on this section.

(1) Methane recovery in wastewater treatment

The existing wastewater treatment system consists of a chain of open lagoons. Wastewater first flows into small ponds that are used to cool the wastewater and recover the oil residues. Then the effluent flows into the two anaerobic lagoons, where the organic content of the effluent is converted into biogas, which is emitted freely to the atmosphere. Afterwards the treated wastewater is diverted to storage lagoons (facultative and aerobic lagoon), from where it can be transported for use of irrigation on the fields or discharge into the San Alejo River.

The characteristics of the two existing open anaerobic lagoons (which will be covered by the project activity) are:

- Available volume: 14,000 m^3

[2] Figures and boxes with red letters represent the CDM project boundaries.

- Depth: 3.5 m

The depth is enough to create anaerobic conditions in the lagoon.

Figure 4: Existing open anaerobic lagoon at Agrotor

Honduran laws and legislation do not dictate requirements on the capture of biogas. Furthermore Energeticos Jaremar has not been requested to cover the open lagoons by the local environmental authority.

Since covering of the lagoons is not obliged by legislation, two options are available to the project participant:

1. Continuation of the current waste water treatment system with the open lagoons
2. Cover the open lagoons.

Alternative 1 does not involve any investment and has a low operational risk. Furthermore it is the common practice for wastewater treatment for the Palm Oil mill industry in Honduras. This is analysed in Table 4.

The Honduran palm oil industry is composed of private owned extractors and social cooperatives where several small palm farmers meet. The following table represents the common practice on wastewater treatment systems for all of these companies and associations.

Table 4. Wastewater treatment systems for Palm Oil Mills in Honduras[3]

	Company or association	Wastewater treatment system for POME	Biogas recovery system developed as a CDM project?
Public sector	Hondupalma	Open Anaerobic lagoon	No
	Coapalma	Direct discharge into watercourse	No
	Cooperativa Salamá	Open Anaerobic lagoon	No
Private Sector	Dinant	Open Anaerobic lagoon	No
	Agrotor	Biogas recovery system under development	Yes
	Palcasa	Biogas recovery system	Yes[4]
	Aceydesa	Open Anaerobic lagoon	No
	Indisa	Open Anaerobic lagoon	No
	Caicesa	Open Anaerobic lagoon	No
	Agropalma	Open Anaerobic lagoon	No

Alternative 2 would involve the implementation of a biogas recovery system. Without CDM revenues this type of system is typically not viable. This is evidenced by lack of biogas recovery systems at palm oil mills in Honduras. The only existing exception is Palcasa, that has registered its biogas recovery system as a CDM.

Based on the above analysis it can be concluded that the baseline scenario for the methane recovery is alternative 1, the continuation of the current wastewater treatment system (open anaerobic lagoon without methane recovery) where the generated methane is released to the atmosphere.

(2) Thermal Energy for user
The recovered biogas is used for the production of thermal energy for the refinery. Without the implementation of the methane recovery project, the thermal energy could not be produced by biogas.
As it is stated in paragraph 6 of AMS.I-C ver 11, the simplified baseline is the fuel consumption of the technologies that would have been used in the absence of the project activity times an emission coefficient for the fossil fuel displaced.
In the baseline situation, heat required by the refinery would have been generated by the use of bunker.

(3) Electricity generation for the user
The recovered biogas is used for the production of electricity. Without the implementation of the methane recovery project, the electricity could not be produced by the biogas and would have been supplied by the current cogeneration systems and the national grid of Honduras.

[3] Based on contacts from the Palm oil mill industry in Honduras (Palcasa and Agrotor/Jaremar) and confirmed by assessment from Biotec.
[4] Registered CDM project with reference number 492: http://cdm.unfccc.int/Projects/DB/TUEV-SUED1151931954.52/view.html.

In the current situation the electricity originates mainly from the national grid and is complemented by an existing biomass cogeneration system, consisting of two turbines. These turbines are not intended for dispatch to the grid and are not part of this CDM project activity.

The baseline for the produced electricity is the electricity produced by the national grid ENEE.

B.5. Demonstration of additionality

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According to Attachment A to Annex B of the simplified modalities and procedures for CDM small-scale project activities, explanation must be provided to show that the project activity would not have occurred anyway due to at least one of the following barriers: investment barrier, technological barrier, barrier due to prevailing practice and other barriers. First a check on applicable legislation is made.

The project is in line with the following legislation:

1. Technical Standards for the discharge of residual water to receiving stations and sanitary sewage system
2. Decree 85-98, Incentives for the generation of renewable energy
3. Decree 267-98 for the use of renewable and natural resources to generate electricity
4. Decree 176-99 and Decree 267-98 from the Law of Renewable Incentives
5. Decree 103-2003, concerning municipalities support for renewable energy incentive
6. National law for drinking water and improvement for sanitation
7. Framework law for the electricity sub sector
8. Rules and regulation from the electricity sub sector law

The project activity goes beyond environmental legislation since no standards exist for the recovery of biogas from wastewater treatment systems.

The proposed project activity faces the following barriers:

(a) Barriers due to prevailing practice

Biogas recovery system

Under section B.4, baseline determination an analysis has been made of the occurrence of biogas recovery systems at waste water treatment systems at palm oil mills in Honduras. Based on this analysis it can be concluded that the prevailing practice is not to recover the biogas originating from water treatment systems at palm oil mills in Honduras. The prevailing practice therefore shows a barrier for implementation of a biogas recovery system.

This barrier was overcome by development of the biogas recovery system as CDM project. The revenues from the CERs could be used to create a viable project. Energeticos Jaramar was encouraged by the project developers to implement the biogas recovery system as an innovation of their waste management practices while reducing greenhouse gas emissions.

Heat and electricity generation
The prevailing practice for electricity and heat generation is generation using fossil fuels. Fossil fuels are responsible for 65 % of all electricity generation in the interconnected electricity grid system[5]. This trend is not expected to change as the expansion plans of the national electricity company include investments in thermal generation capacity in the coming years[6].
The utilisation of biogas for the generation of heat and electricity can therefore be considered to go beyond the prevailing practice.

(b) Technological barrier:
No Honduran company can supply a biogas recovery and utilisation system for the Agrotor palm oil mill. Therefore the company relies on the technology supplier Biotec (the central office of Biotec is based in Columbia). This entails significant risks since the operation of the palm oil mill and refinery require a continuous deliverance of heat and electricity. In order to mitigate this risk Energeticos Jaremar has established a permanent partnership with Biotec to secure optimal operation of the digesters system and minimise the risks of failure of the biogas recovery system. The revenues from the CER allow Energeticos Jaremar to establish this partnership.

From Biotec experience[7] it can be concluded that that there is no skilled labourers available in Honduras Implementation of the project activity must therefore also include the training of personnel.

Finally, in order to utilise the recovered methane, the burner of one of the boilers has to be replaced and adaptations have to be made to the other boiler's burner. This involves a risk for the Palm oil refinery's production process, as the production process relies on the proper operation of these boilers.

Conclusion of the additionality assessment
From the barrier analysis it can be concluded that the project would not have occurred anyway without the support from the CDM and the additional revenues from CERs. The CDM project activity goes beyond the applicable legislation and the prevailing practices in Honduras. There are as well technological barriers that prevent the implementation of these systems. Therefore, it can be concluded that the CDM project activity faces barriers that prevent its implementation. Therefore the CDM project activity is "additional to the baseline scenario".

B.6. Emission reductions

B.6.1. Explanation of methodological choices

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The emission reductions for the methane recovery are estimated by the use of the approved small scale CDM baseline methodology *Methane recovery in wastewater treatment* III.H./Version 05_Scope 13_EB31. Baseline scenario (iv) has been chosen (see section B.2) since this scenario best represent the actual situation.

[5] This percentage has been calculated based on ENEE data for 2006, considering that: the total generation based on fossil fuels = 3,770.3 GWh and the total generation for the ENEE grid not including CDM projects = 5,804 GWh. Background information is available to the DOE.
[6] Expansion plan for ENEE grid mainly based on bunker and diesel generators under http://www.enee.hn/PDFS/PlanExpansionGen07.pdf
[7] Biotec was involved as technology supplier to the EECOPALSA CDM project, located in Palcasa palm oil mill, in Honduras

The ex-ante emission reductions resulting from the generation of heat are estimated by use of approved small scale CDM baseline methodology AMS I.C. "Thermal Energy for user with or without electricity" (Version 11_Scope 1_EB32). Option (a): *Electricity is supplied from the grid and steam/heat is produced using fossil fuel* has been selected for the calculation of the emission reductions. The estimated emission reductions from heat generation are calculated from the expected amount of bunker to be replaced.

This project has considered an ex-ante approach for the estimation of a representative grid emission factor (see Annex 13 of the Supporting Documentation). The Operating Margin as well as the Build Margin will be calculated according to methodology AMS.I-C, this methodology makes reference to approved consolidated methodology ACM0002. The operating margin is calculated as a "Simple Operating Margin". The build margin is calculated based on the power plant capacity additions in the electricity system that comprise 20% of the system generation (in GWh) and that have been built most recently.

The ex-post emission reductions are determined by measuring the amount of methane captured and fuelled or flared by the project activity during a year and by the electricity produced from the captured biogas. The total amount of methane recovered is monitored by measuring the quantity of methane used to produce thermal energy, electricity and measuring the amount that is flared. Emissions from the electricity consumption of the digesters system are subtracted from the total emission reduction estimation.

B.6.2. Data and parameters fixed ex ante

Data / Parameter	**ID. 1 / TFF_y**
Unit	Tonnes/year
Description	The expected amount of fresh fruit to be processed in year y
Source of data	Feasibility study by Biotec
Value(s) applied	From 240,000 ton/year (2008) and growing at a rate of 5,714 additional tons/year
Choice of data or Measurement methods and procedures	The feasibility study for the project gives the expected production of the palm oil mill for the coming years.
Purpose of data	BE and PE (ex-ante)
Additional comment	See Annex 3

Data / Parameter	**ID. 2 / WU**
Unit	m^3/tonnes fresh fruit
Description	The average water usage per processed ton of fresh fruit.
Source of data	This value is based on operational data on water usage from the project's operation.
Value(s) applied	1.13
Choice of data or Measurement methods and procedures	Operational data of the first 11 months of 2009 have been used to obtain this value.
Purpose of data	BE and PE (ex-ante)
Additional comment	This value was initially taken from the estimations made in the technology provider's feasibility study (Biotec's feasibility study). Since operational data show that it has changed significantly, a notification of this change has been made.

Data / Parameter	**ID. 3 / COD**
Unit	Tonnes/m^3
Description	Chemical Oxygen Demand per m^3 of water entering the lagoons
Source of data	Report from local consultant Cotecnica based on laboratory analysis and included in Biotec's feasibility study. See Annex 8 of the Supporting Documentation.
Value(s) applied	$64.2381 * 10^{-3}$
Choice of data or Measurement methods and procedures	The laboratory analysis of the wastewater provides a reliable source. A frequent analysis of sample will be conducted at in-house lab and observations will be recorded. The biogas recovery system has been designed taken into account the highest value measured for COD content, in order to operate on adequate levels and as required by Biotec.
Purpose of data	BE and PE (ex-ante)
Additional comment	

Data / Parameter	**ID. 4 / $BB1_y$**
Unit	m^3/year
Description	Amount of bunker which would have been used in boiler 1 (steam boiler) in year y
Source of data	Records from 2006 of Energeticos Jaremar for the consumption of bunker at the refinery. Value used in the Feasibility study of Biotec
Value(s) applied	1,045.45
Choice of data or Measurement methods and procedures	This is the most accurate figure available. However it is also conservative, considering that fresh fruit production increases every year.
Purpose of data	BE
Additional comment	Boiler 1: For steam generation

Data / Parameter	**ID. 5 / $BB2_y$**
Unit	m^3/year
Description	Amount of bunker which would have been used in boiler 2 in year y
Source of data	Records from 2005 of Energeticos Jaremar for the consumption of bunker at the refinery. Value used in the Feasibility study of Biotec
Value(s) applied	249.66
Choice of data or Measurement methods and procedures	This is the most accurate figure available. However it is also conservative, considering that fresh fruit production increases every year.
Purpose of data	BE
Additional comment	Boiler 2: For heating thermal oil

Data / Parameter	**ID. 6 / EF_{grid}**
Unit	Tonnes CO_2 eq/GWh
Description	Honduras grid emission factor**:** CO_2 emissions related to the consumption of 1 GWh
Source of data	ENEE.
Value(s) applied	646
Choice of data or Measurement methods and procedures	Ex-ante estimation based on calculations made on the combined margin. This has been based on the criteria established in the last version of AMS I-D, for the calculation of the representative emission factor for the grid. The combined margin has been calculated as the weighted average from the operating margin. All the calculations to estimate the grid emission factor is included in Annex 13 in Supporting Documentation. Operating margin: 678 tCO_2/GWh Build Margin: 615 tCO_2/GWh
Purpose of data	BE and PE
Additional comment	See Annex 13

Data / Parameter	**ID. 7 / B_{0ww}**
Unit	($kgCH_4$/kgCOD)
Description	Methane generation capacity of the untreated wastewater, entering the wastewater treatment system.
Source of data	Default value from AMS.III-H. version 5.
Value(s) applied	0.21
Choice of data or Measurement methods and procedures	As per methodology, the IPCC 2006 default value of 0.25 kg CH4/kg COD was corrected to take into account the uncertainties.
Purpose of data	BE and PE
Additional comment	

Data / Parameter	ID. 8 $MCF_{treatment}$
Unit	%
Description	Methane correction factor for the wastewater treatment system that will be equipped with methane recovery equipment.
Source of data	Table III.H.1. IPCC default values for Methane Correction Factor (MCF) (AMS- III.H version 5)
Value(s) applied	0.8
Choice of data or Measurement methods and procedures	Lower value of Anaerobic deep lagoon - depth more than 2 metres. As per methodology
Purpose of data	BE and PE
Additional comment	

Data / Parameter	ID 9 / $MCF_{ww,final}$
Unit	%
Description	Methane correction factor based on type of treatment and discharge pathway of the wastewater (fraction)
Source of data	Table III.H.1. IPCC default values for Methane Correction Factor (MCF) (AMS- III.H version 5)
Value(s) applied	1.0
Choice of data or Measurement methods and procedures	As per methodology
Purpose of data	PE
Additional comment	

Data / Parameter	**ID 10 / E_{COD}**
Unit	%
Description	COD removal efficiency of digester
Source of data	Based on lowest value of three comparable projects from Biotec (see Annex 6 of the Supporting documentation).
Value(s) applied	85 %
Choice of data or Measurement methods and procedures	Digesters usually have an average efficiency of 90% for COD removal in wastewater. 85 % is a conservative value.
Purpose of data	PE
Additional comment	

Data / Parameter	**ID 11 / $EFCO_2$**
Unit	tCO_2/TJ
Description	Carbon emission factor of residual fuel oil (bunker)
Source of data	Source: IPCC 2006. Chapter 2 Stationary Combustion, Table 2.2. page 16
Value(s) applied	77.4
Choice of data or Measurement methods and procedures	This is the most accurate reference available.
Purpose of data	BE
Additional comment	

Data / Parameter	ID 12/ NCV_{biogas}
Unit	TJ/Gg
Description	Energetic content of biogas/methane (net calorific value)
Source of data	Default value from IPCC 2006. Volume 2, Chapter 1, Table 1.2 From footnote 16-18 of the IPCC Guidelines: This is also methane theoretical number
Value(s) applied	50.4
Choice of data or Measurement methods and procedures	This is the most accurate reference available.
Purpose of data	BE
Additional comment	

Data / Parameter	ID 13 / NCV_b
Unit	TJ/m^3
Description	Available energy per volume of Bunker
Source of data	Specifications from bunker provider: Oleoproductos de Honduras (OLEPSA S.A.).
Value(s) applied	0.0398
Choice of data or Measurement methods and procedures	Information from the bunker provider related to the characteristics of this product has been included in Annex 9 of the Supporting Documentation file.
Purpose of data	BE
Additional comment	

Data / Parameter	**ID 14/ $[CH_4]_{y,ww,treated}$**
Unit	Tonnes/m3
Description	Dissolved methane content in the treated wastewater.
Source of data	Reference given in AMS.III-H ver.11: Value calculated using approach given by Greenfield, P.F. and Batstone, D.J. Anaerobic digestion: impact of future GHG mitigation policies on methane generation and usage. In: Proceedings of Anaerobic Digestion Congress, Montreal, Canada, 2004
Value(s) applied	10^{-4} tonnes/m3
Choice of data or Measurement methods and procedures	This is a default value based on the applicable methodology
Purpose of data	PE
Additional comment	

Data / Parameter	**ID 15 / D_{CH4}**
Unit	$kgCH_4/m^3CH_4$
Description	Density of the methane (standard value)
Source of data	Referential value for methane in standard conditions (ACM0001 version7, footnote 6, page 8)
Value(s) applied	0.7168
Choice of data or Measurement methods and procedures	The standard value for the density is derived from the standard conditions used for correction of the volume. This is determined from the average conditions of temperature and pressure. Standard temperature: 0 degree Celsius Pressure: 1,013 bar.
Purpose of data	BE
Additional comment	

Data / Parameter	**ID 16 / CFEww**
Unit	%
Description	Capture and flare efficiency of the methane recovery and combustion equipment in the wastewater treatment.
Source of data	Default value provided from AMS.III-H
Value(s) applied	0.9
Choice of data or Measurement methods and procedures	There is no other appropriate value to represent this parameter, so the default reference provided from AMS.III-H will be considered for the ex-ante calculation of this CDM project.
Purpose of data	PE
Additional comment	

Data / Parameter	**ID 17 / ηS_b**
Unit	%
Description	Efficiency of the steam boiler at the refinery using bunker.
Source of data	Based on reference from a Cleaver Brooks manual attached in Annex 10 of the Supporting Documentation.
Value(s) applied	Constant efficiency of 86%
Choice of data or Measurement methods and procedures	The reference comes from a Cleaver Brooks Manual that states a 85- 86 % for normal loads to complete loads. A value of 86% has been considered as conservative since these results in the lowest baseline emissions.
Purpose of data	BE
Additional comment	

Data / Parameter	**ID 18 / ηsp**
Unit	%
Description	Efficiency of the steam boiler at the refinery, using biogas
Source of data	Based on reference from a Cleaver Brooks manual attached in Annex 10 of the Supporting Documentation.
Value(s) applied	Constant efficiency of 81%
Choice of data or Measurement methods and procedures	The reference comes from a Cleaver Brooks Manual that states an 81-82 % for normal loads to complete loads, using natural gas. Natural gas will be considered as representative. A value of 81% has been considered as conservative.
Purpose of data	BE
Additional comment	

Data / Parameter	**ID 19 / ηth_b**
Unit	%
Description	Efficiency of the thermal oil heater using bunker
Source of data	Based on reference from the technology supplier HTT Energy systems, attached in Annex 11 of the Supporting Documentation.
Value(s) applied	Constant efficiency of 85%
Choice of data or Measurement methods and procedures	The technology provider (HTT Energy systems) has informed that there are no efficiency differences between bunker and biogas.
Purpose of data	BE
Additional comment	

Data / Parameter	**ID 20 / ηth_p**
Unit	%
Description	Efficiency of the thermal oil heater using biogas
Source of data	Based on reference from the technology supplier HTT Energy systems, attached in Annex 11 of the Supporting Documentation.
Value(s) applied	Constant efficiency of 85%
Choice of data or Measurement methods and procedures	The technology provider (HTT Energy systems) has informed that there are no efficiency differences between bunker and biogas.
Purpose of data	BE
Additional comment	

Data / Parameter	**ID 21 / η_{flare}**
Unit	%
Description	Flare efficiency
Source of data	AMS.III-H ver.11
Value(s) applied	50%
Choice of data or Measurement methods and procedures	Default value for an open candlestick flare as requested by applicable methodology, as it is not possible in this case to monitor the efficiency.
Purpose of data	BE and PE
Additional comment	

New fixed parameters added during the a Monitoring Plan revision approved the 9th of November 2011:

Data / Parameter	**ID 45 / $\eta_{3,b}$**
Unit	-
Description	The efficiency of boiler 3 using bunker that would have been used in the absence of the project activity.
Source of data	Paragraph 13. AMS-I.C (version 11), Option b. Value chosen: Cleaver Brooks Efficiency Facts, page 18. Table. Guaranteed fuel-to-steam efficiencies No.6 Oil.
Value(s) applied	87.5%
Choice of data or Measurement methods and procedures	The document "Cleaver Brooks Efficiency Facts", indicates that when testing the efficiency of a CB600-800 using fuel oil No.6 across a range of operating conditions, the highest value obtained is 87.5%. This value has been selected according to paragraph 13 (b) of the methodology comparing the efficiencies of three different providers for similar equipment.
Purpose of data	BE
Additional comment	This parameter is fixed once for each new boiler and is not monitored afterwards.

Data / Parameter	ID 46 / $\eta_{4,b}$
Unit	-
Description	The efficiency of high-pressure boiler 4 using bunker that would have been used in the absence of the project activity.
Source of data	Paragraph 13: AMS- I.C (version 11)
Value(s) applied	100%
Choice of data or Measurement methods and procedures	Since insufficient information was available at the time of submission of this request for revision of the Monitoring Plan to fulfil the requirements of options (a) and (b) paragraph 13 of AMS-I.C (version 11), a default value - option (c) – has been adopted. The project owner will be able to use a more realistic (lower) efficiency value if sufficient information is provided at verification to support a change according to the requirements of AMS- I.C (version 11), paragraph 13.
Purpose of data	BE
Additional comment	

B.6.3. Ex ante calculation of emission reductions
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This section describes the ex-ante approach used for an estimation of the emission reductions.

Baseline emissions
The baseline emissions are estimated by the sum of the baseline emissions for biogas capture, the emissions from the thermal energy displaced and the emissions from the displaced electricity, according to:

$$BE_y = BE_{y,methane} + BE_{y,thermal} + BE_{y,power} \quad (1)$$

Where:

BE_y	Baseline emissions in the year “y” in tonnes CO_2eq
$BE_{y,methane}$	Baseline emissions resulting from anaerobic digestion of waste water in the year “y” in tonnes CO_2eq
$BE_{y,thermal}$	Baseline emissions resulting from the combustion of bunker in the year “y” in tonnes CO_2eq
$BE_{y,power}$	Baseline emissions resulting from grid electricity production, in the year “y” in tonnes CO_2eq

Methane recovery

The baseline GHG emissions from methane release to the atmosphere are determined by the methane generation potential of the untreated wastewater. This is calculated according to:

$$BE_{y,methane} = MEP_{y,ww,treatment} \cdot GWP_{CH4} \quad (2)$$

Where:

$BE_{y,methane}$	Baseline emissions resulting from anaerobic digestion of waste water in the year "y" in tonnes CO_2eq
$MEP_{y,ww,treatment}$	Methane emission potential of wastewater treatment plant in the year "y" in tonnes CH_4/year.
GWP_CH_4	Global warming potential for CH_4 (value of 21 is used)

The methane emission potential is calculated with the following equation:

$$MEP_{y,ww,treatment} = Q_{y,ww} \cdot COD_{y,ww,untreated} \cdot Bo_{ww} \cdot MCF_{treatment} \quad (3)$$

Where:

$MEP_{y,ww,treatment}$	Methane emission potential of wastewater treatment plant in the year "y" in tonnes CH_4/year.
$Q_{y,ww}$	Projected volume of wastewater treated in the year "y" in m^3/year.
$COD_{y,ww,untreated}$	Chemical Oxygen Demand of the untreated wastewater in year y in tonnes/m^3
B_{0ww}	Methane generation capacity of the untreated wastewater in kgCH_4/kgCOD.
$MCF_{treatment}$	Methane correction factor for the wastewater treatment system that will be equipped with methane recovery equipment.

$Q_{y,ww}$ is calculated by:

$$Q_{y,ww} = WU \cdot TFF_y \quad (4)$$

Where:

$Q_{y,ww}$	Projected volume of wastewater treated in the year "y" in m^3/year.
WU	Average water usage per processed ton of fresh fruit in m^3/Tonnes of fresh fruit.
TFF_y	Tonnes of fresh fruit consumed as input in year y..

Thermal energy

The baseline for the GHG emissions from fossil fuel combustion in the boilers is determined by the fuel consumption in the absence of the project activity times an emission coefficient for the fossil fuel displaced, according to:

$$BE_{y,thermal} = FC_y \cdot EFCO_2 \quad (5)$$

Where:

$BE_{y,thermal}$	Baseline emissions for the production of thermal energy in year "y" in tonnesCO_2eq/year
$EFCO_2$	IPCC default value for carbon content of the bunker in tonnes CO_2 eq/TJ.
FC_y	The total bunker consumption in year y in TJ/year. Calculated through the following equation.

$$FC_y = (BB1_y + BB2_y) \cdot NCV_b \qquad (6)$$

Where:

FC_y	The total bunker consumption in year y in TJ/year.
$BB1_y$	Amount of bunker which would have been used in boiler 1 in year y in m^3/year.
$BB2_y$	Amount of bunker which would have been used in boiler 2 in year y in m^3/year
NCV_b	Net Calorific Value of bunker in TJ/m^3

Electricity

Baseline emissions for the displaced grid electricity are equal to the product of the grid's baseline emissions factor (EF in tCO_2/GWh) times the electricity generated by the project activity (EGy in GWh), as follows:

$$BE_{y,power} = EG_y \cdot EF_{grid} \qquad (7)$$

Where:

$BE_{y,power}$	Baseline emissions from displaced electricity in the year y in tonnes CO_2 eq/year.
EG_y	Electricity supplied by the project activity in GWh/yr
EF_{grid}	Emissions factor of the Honduran grid in tonnes CO_2eq/GWh. .

Project emissions

The use of biogas as fuel for heat/steam generation and electricity generation does not result in project emissions, since the combustion of biogas is CO_2-neutral. Methane emissions from surplus biogas not burned due to inefficiency of an open candlestick flare (50 % of efficiency), are considered as part of the project emissions.

The project emissions resulting from the capture of biogas are estimated by *AMS III. H. Methane recovery in wastewater treatment* (Version 05_Scope 13, 15_May 2007).

The project emissions consist of:

$$PE_y = PE_{y,power} + PE_{y,ww,treated} + PE_{y,s,final} + PE_{y,fugitive} + PE_{y,dissolved} \qquad (8)$$

Where:

PE_y	Project activity emissions in the year "y" in tonnes CO_2eq/year
$PE_{y,power}$	Emissions through electricity consumption from the biogas capture equipment in the year "y", in tonnes CO_2 eq /year
$PE_{y,ww,treated}$	Emissions through degradable organic carbon in treated wastewater in year "y" in tonnes CO_2 eq/year
$PE_{y,fugitive}$	Emissions through methane release in capture and combustion systems in year "y" in tonnes CO_2eq/year.
$PE_{y,s,final}$	Emissions from anaerobic decay of the final sludge produced in the year "y" in tonnes CO_2 eq/year. A description of the sludge management is in A.4.2.
$PE_{y,dissolved}$	Emissions though dissolved methane in treated wastewater in year "y" in tonnes CO_2 eq/year

The sludge will be applied as fertiliser to the surrounding land. This does not result in any greenhouse gas emissions; therefore $PE_{y,s,final}$ is considered as nil.

The final sludge disposal has been considered as part of the monitoring plan.

The emissions as a result of the electricity consumption in the year “y” are determined by:

$$PE_{y,power} = EF_{grid} \cdot EC_y \qquad (9)$$

Where:

PE_{ypower}	Emissions through electricity consumption from the biogas capture equipment in the year “y” in tonnes CO_2 equivalent /year
EF_{grid}	Emission factor from the Honduran electricity grid in tonnes CO_2eq/GWh. This has been established ex-ante.
EC_y	Annual electricity consumption from the biogas recovery equipment in GWh/year.

The emissions through degradable organic carbon in treated wastewater in year y are determined by:

$$PE_{y,ww,treated} = Q_{y,ww} \cdot COD_{y,ww,treated} \cdot Bo_{ww} \cdot MCF_{treatment} \cdot GWP_{CH4} \qquad (10)$$

Where:

$PE_{y,ww,treated}$	Emissions through degradable organic carbon in treated wastewater in year “y” in tonnes CO_2 equivalent /year
$Q_{y,ww}$	Projected volume of wastewater treated in the year “y” in m^3/year. See equation 4.
$COD_{y,ww,treated}$	Chemical oxygen demand of the treated wastewater in tonnes/m^3
B_{0ww}	Methane generation capacity of the untreated wastewater in $kgCH_4$/kgCOD
$MCF_{ww,final}$	methane correction factor based on type of treatment and discharge pathway of the wastewater (fraction).
GWP_CH_4	Global warming potential for CH_4 (value of 21 is used)

The ex-ante value for $COD_{y,ww,treated}$ is calculated through the following equation:

$$COD_{y,ww,treated} = (1 - E_{COD}) \cdot COD_{y,w,untreated} \qquad (11)$$

Where:

E_{COD} :	COD removal efficiency of digester (%)
$COD_{y,ww,untreated}$:	Chemical oxygen demand of the untreated wastewater in tonnes/m^3.

The emissions through methane release in capture and flare systems in year y are determined by:

$$PE_{y,fugitive} = (1 - CFE_{ww}) \cdot MEP_{y,ww,treatment} \cdot GWP_{CH4} \qquad (12)$$

Where:

$PE_{y,fugitive}$	Emissions through methane release in capture and flare systems in year “y” in tonnes CO_2 equivalent /year
CFE_{ww}	Capture and flare efficiency of the methane recovery and combustion equipment in the wastewater treatment.
$MEP_{y,ww,treatment}$	methane emission potential of wastewater treatment plant in the year “y” in tonnes CH_4/year.

GWP_CH_4	Global warming potential for CH_4 (value of 21 is used)

The emissions though dissolved methane in treated wastewater in year y are determined by:

$$PE_{y,dissolved} = Q_{y,ww} \cdot [CH_4]_{y,ww,treated} \cdot GWP_{CH4} \quad (13)$$

Where

$PE_{y,dissolved}$	Emissions though dissolved methane in treated wastewater in year "y" in tonnes CO_2 equivalent /year
$Q_{y,ww}$	Projected volume of wastewater treated in the year "y" in m^3/year. See equation 4.
$[CH_4]_{y,ww,treated}$	Dissolved methane content in the treated wastewater in tonnes $CH_4/m^{3.}$
GWP_CH_4	Global warming potential for CH_4 (value of 21 is used)

Leakage

Leakage is not taken into consideration since the used technology is not transferred from another activity. The project does not result in an increase in the transportation of fuels. Moreover the project leads to a decrease of transportation emissions since no bunker has to be transported to the Palm oil refinery. These avoided emissions are not claimed in order to follow a conservative approach.

Estimation of ex-post emission reductions

The calculation of emission reductions shall be based on the amount of methane recovered and fuelled or flared that is monitored ex-post, considering also emission reductions from power and heat generation minus the electricity consumption from the project activity.

By monitoring the above parameters the total emission reductions can be calculated ex-post according to:

$$ER_y = ER_{MD,y} + ER_{thermal,y} + ER_{power,y} \quad (14)$$

Where:

ER_y	Emission reductions in the year "y" in tonnes CO_2 equivalent /year.
ER_{MDy}	Emission reductions from the CH_4 consumed as fuel and flared in year "y" in tonnes CO_2 equivalent /year.
$ER_{,thermal,y}$	Emission reductions due displacement of bunker fuel for the generation of heat, in the year "y" in tonnes CO_2 equivalent /year .
$ER_{,power,y}$	Emission reductions due to displacement of electricity in the year "y" in tonnes CO_2 equivalent /year

I- Ex-post determination of methane consumed.

The amount of methane consumed (and destroyed) is determined by summation of the amount of methane fed into the boilers, the generator and the flare minus the amount of emission resulting from incomplete combustion at the flare as follows:

$$ER_{MD\,y} = (\sum_i MD_{boiler,i,y} + \sum_i MD_{generator,i,y} + MD_{flared,y}) \cdot GWP_{CH4} \quad (15)$$

Where:

ER_{MD_y}	Amount of CH_4 fuelled and flared in year “y” in tonnes of CH_4/year.
$MD_{boiler\_i,y}$	Amount of CH_4 consumed by boiler i in year “y” in tonnes of CH_4/year.
$MD_{generator\_i,y}$	Amount of CH_4 consumed by generator i in year “y” in tonnes of CH_4/year.
MD_{flared_y}	Amount of CH_4 consumed by flare in year “y” in tonnes of CH_4/year
GWP_{CH4}	Global warming potential for CH_4 (value of 21 is used)

The amount of CH_4 consumed by the boiler i is calculated according to:

$$MD_{boiler,i,y} = BG_{boiler,i,y} \cdot w_{CH4,y} \cdot D_{CH4} \qquad (16)$$

Where:

$MD_{bioler,i,y}$	Amount of CH_4 consumed by boiler *i* in year “y” in tonnes CH_4/year.
$BG_{boiler,i,y}$	The quantity of biogas fed into boiler *i* in year “y” in Nm^3/year.
$w_{CH4,y}$	The average CH_4 fraction of the biogas as measured during the year “y” and expressed as a fraction in m³ CH_4/m³ BG.
D_{CH4}	The CH_4 density in tonnes CH_4/m^3CH_4.

The amount of CH_4 consumed by the biogas generator i is calculated according to:

$$MD_{generator,i,y} = BG_{generator,i,y} \cdot w_{CH4,y} \cdot D_{CH4} \qquad (16)$$

Where

$MD_{generator,i,y}$	Amount of CH_4 consumed by generator i in year “y” in tonnes CH_4/year.
$BG_{generator,i,y}$	The quantity of biogas fed into the generator i in year “y” in Nm^3/year.
$w_{CH4,y}$	The average CH_4 fraction of the biogas as measured during the year “y” and expressed as a fraction in m³ CH_4/m³ BG
D_{CH4}	The CH_4 density in tonnes CH_4/m^3CH_4.

The amount of CH_4 consumed by the flare is calculated according to:

$$MD_{flared,y} = BG_{flare,y} \cdot w_{CH4,y} \cdot D_{CH4} \cdot \eta_{flare} \qquad (17)$$

Where:

$MD_{flared,y}$	Amount of CH_4 consumed by the flare in year “y” in tonnes CH_4/year.
$BG_{flare,y}$	The quantity of biogas fed into the flare in year “y” in Nm^3/year.
$w_{CH4,y}$	The average CH_4 fraction of the biogas as measured during the year “y” and expressed as a fraction in m³ CH_4/m³ BG
D_{CH4}	The CH_4 density in tonnes CH_4/m^3CH_4.
η_{flare}	Flare efficiency (open flare, 50%).

The only emissions due to incomplete combustion of biogas occur at the flare. The project uses an open flare, and therefore 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 used, as requested by the applicable small scale methodology.

II- Ex-post emission reduction from heat generation

The following equations are included to estimate the thermal energy delivered and the emission reductions from the replacement of bunker. The energy delivered is first estimated using the amount of biogas fed into the boilers, followed by a comparison of this value with the actual measured delivered thermal energy. The lower value is then used in the emission reduction calculation.

Evaluation of supplied thermal energy using methane destroyed:

For the steam boiler (boiler 1):

$$HG_{1,y} = MD_{boiler,1,y} \cdot NCV_{biogas} \cdot \eta_{s,p} \cdot \frac{1}{1000} \qquad (18)$$

$HG_{1,y}$	The net quantity of biogas associated thermal energy supplied by the steam boiler to the process in the project activity during the year y in TJ/year.
$\eta_{s,p}$	The efficiency of the steam boiler using biogas.
$MD_{boiler,1,y}$	Amount of CH_4 consumed by the steam boiler in year "y" in tonnes CH_4/year
NCV_{biogas}:	Calorific value of biogas in TJ/Gg.

For the Thermal oil heater (boiler 2):

$$HG_{2,y} = MD_{boiler,2,y} \cdot NCV_{biogas} \cdot \eta_{th,p} \cdot \frac{1}{1000} \qquad (19)$$

Where:

$HG_{2,y}$	The net quantity of biogas associated thermal energy supplied by the thermal oil heater to the process in the project activity during the year y in TJ/year.
$\eta_{th,p}$	The efficiency of the thermal oil heater using biogas.
$MD_{boiler,2,y}$	Amount of CH_4 consumed in year "y" by boiler 2 in tonnes CH_4/year
NCV_{biogas}:	Calorific value of biogas in TJ/Gg.

For the steam boiler 3:

$$HG_{3,y} = MD_{boiler,3,y} \cdot NCV_{biogas} \cdot \eta_{3,p} \cdot \frac{1}{1000} \qquad (20)$$

Where:

$HG_{3,y}$	The net quantity of biogas associated thermal energy supplied by the steam boiler to the process during the year y in TJ/year.
$\eta_{3,p}$	The efficiency of the steam generation unit using biogas.
$MD_{boiler,3,y}$	Amount of CH_4 consumed in year "y" by boiler i in tonnes CH_4/year.
NCV_{biogas}:	Calorific value of biogas in TJ/Gg.

For the high pressure steam boiler 4:

$$HG_{4,y} = MD_{boiler,4,y} \cdot NCV_{biogas} \cdot \eta_{4,p} \cdot \frac{1}{1000} \qquad (21)$$

Where:

$HG_{4,y}$	The net quantity of biogas associated thermal energy supplied by the high pressure steam boiler to the process during the year y in TJ/year.
$\eta_{4,p}$	The efficiency of the steam generation unit using biogas.
$MD_{boiler,4,y}$	Amount of CH_4 consumed in year “y” by boiler i in tonnes CH_4/year.
NCV_{biogas}	Calorific value of biogas in TJ/Gg.

The use of bunker as an auxiliary fuel does not need to be monitored or subtracted from total emission reductions, since emission reductions from heat generation will be based on biogas flow and not in the total heat generation.

<u>Comparison of estimated with measured thermal energy:</u>

For the all boilers the heat generation estimation using biogas inflow will be compared to the measured heat generated by the boiler, and the lower value will be used for the calculations:

$$HG_{\min,i,y} = \min(HG_{i,y}, HG_{measured,i,y} - \frac{FF_{i,y}}{SFC_i}) \qquad (22)$$

Where:

$HG_{min,i,y}$	The conservative quantity of biogas associated thermal energy supplied by boiler i to the process in the project activity during the year y in TJ/year.
$HG_{i,y}$	The net quantity of biogas associated thermal energy supplied by boiler i during the year y in TJ/year.
$HG_{measured,i,y}$	The directly measured total quantity of thermal energy supplied by boiler i during the year y in TJ/year.
$FF_{i,y}$	The amount of fossil fuel used in boiler i in Gg/y
SFC_i	Specific fuel consumption for fossil fuel in boiler i in Gg/TJ

Where:

$$SFC_i = \frac{1}{NCV_{FF} \cdot \eta_{i,p}}$$

NCV_{FF}	Calorific value of the fossil fuel in TJ/Gg.
$\eta_{i,p}$	Efficiency of project boiler i.

<u>Emission reduction for thermal energy generation:</u>

The emission reductions related to the heat/steam generation component are calculated as follows:

$$ER_{thermal,y} = \left(\frac{HG_{\min,1,y}}{\eta_{s,b}} + \frac{HG_{\min,2,y}}{\eta_{th,b}} + \frac{HG_{\min,3,y}}{\eta_{3,b}} + \frac{HG_{\min,4,y}}{\eta_{4,b}}\right) \cdot EFCO_2 \quad (23)$$

Where:

$ER_{thermal,y}$	The total baseline emissions from steam/heat displaced by the project activity during the year y in tonnes CO_2 eq/year.
$HG_{min,1,y}$	The conservative quantity of biogas associated thermal energy supplied by the steam boiler 1 to the process in the project activity during the year y in TJ/year.
$HG_{min,2,y}$	The conservative quantity of biogas associated thermal energy supplied by the thermal oil heater 2 to the process in the project activity during the year y in TJ/year.
$HG_{min,3,y}$	The conservative quantity of biogas associated thermal energy supplied by the steam boiler 3 to the process in the project activity during the year y in TJ/year.
$HG_{min,4,y}$	The conservative quantity of biogas associated thermal energy supplied by the high pressure steam boiler 4 to the process in the project activity during the year y in TJ/year.
$EFCO_2$	The CO_2 emission factor per unit of energy of bunker that would have been used in the baseline plant in tonnes CO_2 / TJ.
$\eta_{s,b}$	The efficiency of the steam boiler using bunker that would have been used in the absence of the project activity.
$\eta_{th,b}$	The efficiency of the thermal oil heater using bunker that would have been used in the absence of the project activity.
$\eta_{3,b}$	The efficiency of steam boiler 3 using bunker that would have been used in the absence of the project activity.
$\eta_{4,b}$	The efficiency of high pressure steam boiler 4 using bunker that would have been used in the absence of the project activity.

III- Ex-post emission reductions from electricity generation

The emission reductions can be calculated by multiplying the amount of net electricity produced with the emission factor of the Honduran grid. According to:

-

$$ER_{power,y} = (EG_y - EC_y) \cdot EF_{grid} \quad (24)$$

Where:

$ER_{power,y}$	Emission reduction resulting from the production of electricity in tonnesCO_2eq/year
EG_y	Net amount of electricity produced by the project activity in GWh/year.
EC_y	Electricity consumption of the project activity in year “y” inGWh/year.
EF_{grid}	Emission factor of the Honduran grid, determined ex ante in tonnes $CO_{2\,eq}$/GWh.

The net amount of electricity generated should include the electricity delivered by the 0.848 MW_e generator plus any future installed generator which operates on the captured biogas.

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

Year	Baseline emissions (t CO_2e)	Project emissions (t CO_2e)	Leakage (t CO_2e)	Emission reductions (t CO_2e)
2008	66,530	15,997	-	50,533
2009	68,624	16,376	-	52,248
2010	70,180	16,755	-	53,424
2011	71,735	17,135	-	54,600
2012	73,291	17,514	-	55,777
2013	74,846	17,894	-	56,953
2014	76,402	18,273	-	58,129
Total	**501,608**	**119,943**	**0**	381,665
Total number of crediting years	7			
Annual average over the crediting period	71,658	17,135	0	54,524

B.7. Monitoring plan

B.7.1. Data and parameters to be monitored

Data / Parameter	ID 22 / $w_{CH4,y}$
Unit	m^3 CH4/m^3 BG
Description	Fraction of methane in the biogas in the year "y"
Source of data	Monitoring system.
Value(s) applied	0.65. This ex-ante value is based on similar Palm oil mill effluent treatment systems designed by Biotec.
Measurement methods and procedures	The methane fraction will be measured and registered periodically using an electronic gas analyser. This measurement will be performed with a frequency to satisfy statistical 95%/10% confidence level/ precision[8] and at least quarterly. A high level of accuracy of the measurements will be achieved due to the use of high-precision equipment. The data will be stored in the monitoring system's interface, named SCADA (Supervisory Control And Data Acquisition). The security of the system is guaranteed by a password.
Monitoring frequency	To satisfy a 95%/10% confidence level and at least quarterly.
QA/QC procedures	QA: The device will be recalibrated according to the instructions (schedules, procedures) for QA of the technology provider. QC: There will be strict compliance to maintenance schedule recommended by the technology provider.
Purpose of data	BE
Additional comment	

[8] According to the general guidelines for sampling and surveys for small scale CDM project activities, EB50, Annex 30

Data / Parameter	ID 23 / $BG_{total,y}$
Unit	Nm3/year
Description	Flow of the total biogas recovered in year ‘y”.
Source of data	Monitoring system.
Value(s) applied	4,412,314 Nm^3/year in 2008 (see Annex 3)
Measurement methods and procedures	The biogas flow will be continuously measured with mass flow meters, which are not affected by changes in temperature or pressure. The monitored flow of biogas is automatically converted by the measuring equipment to gas volumes at standard conditions (STP). A high level of accuracy of the measurements will be achieved due to the use of high-precision equipment. The monitored data is automatically recorded and stored in the monitoring system’s interface, SCADA (Supervisory Control And Data Acquisition). The security of the system is guaranteed by a password.
Monitoring frequency	Continuously
QA/QC procedures	QA: The device will be recalibrated according to the instructions (schedules, procedures) for QA of the technology provider. Cross checks of the sum of all sub flow meters will be made with the total biogas recovered. QC: There will be strict compliance to maintenance schedule recommended by the technology provider.
Purpose of data	BE
Additional comment	See also the explanation below regarding the connections and the priorities of the different mass flow meters.

Data / Parameter	ID 24 / $BG_{boiler1,y}$
Unit	Nm3/year
Description	The flow of biogas consumed in boiler 1 in year 'y".
Source of data	Monitoring system.
Value(s) applied	1,972,659 Nm^3/year (See annex 3)
Measurement methods and procedures	The biogas flow will be continuously measured with mass flow meters, which are not affected by changes in temperature or pressure. The monitored flow of biogas is automatically converted by the measuring equipment to gas volumes at standard conditions (STP). A high level of accuracy of the measurements will be achieved due to the use of high-precision equipment. The monitored data is automatically recorded and stored in the monitoring system's interface, SCADA (Supervisory Control And Data Acquisition). The security of the system is guaranteed by a password.
Monitoring frequency	Continuously
QA/QC procedures	QA: The device will be recalibrated according to the instructions (schedules, procedures) for QA of the technology provider. Cross checks of the sum of all sub flow meters will be made with the total biogas recovered. QC: There will be strict compliance to maintenance schedule recommended by the technology provider.
Purpose of data	BE
Additional comment	See also the explanation below regarding the connections and the priorities of the different mass flow meters.

Data / Parameter	ID 25 / $BG_{boiler2,y}$
Unit	Nm3/year
Description	The flow of biogas consumed in boiler 2 in year “y”.
Source of data	Monitoring system.
Value(s) applied	443,694 Nm^3/year (See annex 3)
Measurement methods and procedures	The biogas flow will be continuously measured with mass flow meters, which are not affected by changes in temperature or pressure. The monitored flow of biogas is automatically converted by the measuring equipment to gas volumes at standard conditions (STP). A high level of accuracy of the measurements will be achieved due to the use of high-precision equipment. The monitored data is automatically recorded and stored in the monitoring system’s interface, SCADA (Supervisory Control And Data Acquisition). The security of the system is guaranteed by a password.
Monitoring frequency	Continuously
QA/QC procedures	QA: The device will be recalibrated according to the instructions (schedules, procedures) for QA of the technology provider. Cross checks of the sum of all sub flow meters will be made with the total biogas recovered. QC: There will be strict compliance to maintenance schedule recommended by the technology provider.
Purpose of data	BE
Additional comment	See also the explanation below regarding the connections and the priorities of the different mass flow meters.

Data / Parameter	ID 26 / $BG_{generator,y}$
Unit	Nm3/year
Description	The flow of biogas consumed in the generator in year "y"
Source of data	Monitoring system.
Value(s) applied	682,241 Nm3/year for 2008. Estimated maximum of 1,374,228 Nm3/year for year 2014. (See annex 3)
Measurement methods and procedures	The biogas flow will be continuously measured with mass flow meters, which are not affected by changes in temperature or pressure. The monitored flow of biogas is automatically converted by the measuring equipment to gas volumes at standard conditions (STP). A high level of accuracy of the measurements will be achieved due to the use of high-precision equipment. The monitored data is automatically recorded and stored in the monitoring system's interface, SCADA (Supervisory Control And Data Acquisition). The security of the system is guaranteed by a password.
Monitoring frequency	Continuously
QA/QC procedures	QA: The device will be recalibrated according to the instructions (schedules, procedures) for QA of the technology provider. Cross checks of the sum of all sub flow meters will be made with the total biogas recovered. QC: There will be strict compliance to maintenance schedule recommended by the technology provider.
Purpose of data	BE
Additional comment	See also the explanation below regarding the connections and the priorities of the different mass flow meters.

Data / Parameter	ID 27 / $BG_{flared,y}$
Unit	Nm3/year
Description	The flow of biogas consumed in the flare in year "y"
Source of data	Monitoring system.
Value(s) applied	Estimated maximum of 1,313,719 Nm3/year for 2008 mainly because the generator will not be implemented at the beginning of the year (See annex 3)
Measurement methods and procedures	The biogas flow will be continuously measured with mass flow meters, which are not affected by changes in temperature or pressure. The monitored flow of biogas is automatically converted by the measuring equipment to gas volumes at standard conditions (STP). A high level of accuracy of the measurements will be achieved due to the use of high-precision equipment. The monitored data is automatically recorded and stored in the monitoring system's interface, SCADA (Supervisory Control And Data Acquisition). The security of the system is guaranteed by a password.
Monitoring frequency	Continuously
QA/QC procedures	QA: The device will be recalibrated according to the instructions (schedules, procedures) for QA of the technology provider. Cross checks of the sum of all sub flow meters will be made with the total biogas recovered. QC: There will be strict compliance to maintenance schedule recommended by the technology provider.
Purpose of data	BE
Additional comment	See also the explanation below regarding the connections and the priorities of the different mass flow meters.

Data / Parameter	**ID 28 / $BG_{boiler3,y}$**
Unit	Nm3/year
Description	The flow of biogas consumed in boiler 3 in year "y"
Source of data	Monitoring system.
Value(s) applied	0 Nm3/year (for ex-ante calculations)
Measurement methods and procedures	The biogas flow will be continuously measured with a mass flow meter, which is not affected by changes in temperature or pressure. The monitored flow of biogas is automatically converted by the measuring equipment to gas volumes at standard conditions (STP). A high level of accuracy of the measurements will be achieved due to the use of high-precision equipment. The monitored data is automatically. The monitored data is automatically and continuously recorded and stored in a Programmable Logic Controller (PLC). The monitoring values are automatically and continuously recorded and stored in the PLC's memory unit. The content of this unit will be regularly transferred to the control room's computer.
Monitoring frequency	Continuously
QA/QC procedures	QA: The device will be recalibrated according to the instructions (schedules, procedures) for QA of the technology provider. Cross checks of the sum of all sub flow meters will be made with the total biogas recovered. QC: There will be strict compliance to maintenance schedule recommended by the technology provider.
Purpose of data	BE
Additional comment	See also the explanation below regarding the connections and the priorities of the different mass flow meters.

Data / Parameter	ID 29 / $BG_{boiler4,y}$
Unit	Nm3/year
Description	The flow of biogas consumed high pressure boiler 4 in year "y"
Source of data	Monitoring system.
Value(s) applied	0 Nm3/year (for ex-ante calculations)
Measurement methods and procedures	The biogas flow will be continuously measured with a mass flow meter, which are not affected by changes in temperature or pressure. The monitored flow of biogas is automatically converted by the measuring equipment to gas volumes at standard conditions (STP). A high level of accuracy of the measurements will be achieved due to the use of high-precision equipment. The monitored data is automatically and continuously recorded and stored in a Programmable Logic Controller (PLC). The monitoring values are automatically and continuously recorded and stored in the PLC's memory unit. The content of this unit will be regularly transferred to the control room's computer.
Monitoring frequency	Continuously
QA/QC procedures	QA: The device will be recalibrated according to the instructions (schedules, procedures) for QA of the technology provider. Cross checks of the sum of all sub flow meters will be made with the total biogas recovered. QC: There will be strict compliance to maintenance schedule recommended by the technology provider.
Purpose of data	BE
Additional comment	See also the explanation below regarding the connections and the priorities of the different mass flow meters.

Data / Parameter	ID 30 / T_{flare}
Unit	° Celsius
Description	Temperature in the exhaust gas of the flare
Source of data	Monitoring system
Value(s) applied	> 300°C [9]
Measurement methods and procedures	The temperature is measured continuously with a thermocouple sensor to demonstrate that the flare is operational. A high level of accuracy of the measurements will be achieved due to the use of high-precision equipment. The monitored data is automatically recorded and stored in the monitoring system's interface, SCADA (Supervisory Control And Data Acquisition). The security of the system is guaranteed by a password.
Monitoring frequency	Continuously
QA/QC procedures	QA: The flare has a back up thermocouple sensor in case of failure. The device will be recalibrated according to the instructions (schedules, procedures) for QA of the technology provider. QC: There will be strict compliance to maintenance schedule recommended by the technology provider.
Purpose of data	BE and PE
Additional comment	The flare is deemed to be operational when the temperature measured is higher than the above-mentioned temperature.

[9] According to Request for Clarification 199 of the SSC-WG and the statement of the technology provider

Data / Parameter	ID 31 / EC_y
Unit	GWh/year
Description	Electricity consumption of the project activity in year “y”
Source of data	Electricity meter/s
Value(s) applied	0.095 GWh/year (ex-ante value from BIOTEC technical feasibility study).
Measurement methods and procedures	This measurement will be carried out during the whole monitoring period. The measurement includes the electricity consumption of the complete biogas recovery equipment, pumps, compressors and lightning of the gas handling area. It does not include electricity consumption from previous wastewater treatment system (baseline). The frequency for reading the parameter value is at least weekly and relies on accumulated values of electricity consumption, which are continuously measured. A high level of accuracy of the measurements will be achieved due to the use of high-precision equipment.
Monitoring frequency	Continuously
QA/QC procedures	QA: The device will be recalibrated according to the instructions (schedules, procedures) for QA of the technology provider. QC: There will be strict compliance to maintenance schedule recommended by the technology provider.
Purpose of data	PE
Additional comment	The emissions resulting from the electricity consumption of the pumps located in the lagoons for sludge management can be neglected during the whole crediting period since they represent an insignificant share of the total emission reductions. This will be demonstrated at verification stage, using the monitoring records of the hours of the pumps’ operation and their maximal power consumption per hour.

Data / Parameter	ID 32 / EG_y
Unit	GWh/yr
Description	Net electricity production by the project activity
Source of data	Monitoring system (ex-ante values from BIOTEC technical feasibility study)
Value(s) applied	1.7 GWh for May 2008 until Dec 2008, and 3.5 GWh for year 2015. Increasing with 0.143 GWh per year. See Annex 3
Measurement methods and procedures	The net electricity production will be measured continuously. A high level of accuracy of the measurements will be achieved due to the use of high-precision equipment. The monitored data is automatically recorded and stored in the monitoring system's interface, SCADA (Supervisory Control And Data Acquisition). The security of the system is guaranteed by a password.
Monitoring frequency	Continuously
QA/QC procedures	QA: The device will be recalibrated according to the instructions (schedules, procedures) for QA of the technology provider. QC: There will be strict compliance to maintenance schedule recommended by the technology provider.
Purpose of data	BE
Additional comment	The generation capacity to be installed as part of this project activity is 0.848 MWe. This installed capacity may increase in the future in order to optimize the use of biogas .

Data / Parameter	ID 33/ End use of final sludge
Unit	Use of sludge
Description	end use of the final sludge in year "y"
Source of data	N/A
Value(s) applied	Form of final sludge use applied
Measurement methods and procedures	Sludge removed from the system will be dried on dedicated fields or directly be applied as fertilizer to the surrounding land. The procedure used will be recorded and included in the monitoring system by the team responsible of the implementation of the monitoring plan. All the dried sludge will be managed under aerobic and controlled conditions. Unexpected deviations from the procedures will be recorded and reported as well.
Monitoring frequency	Every time sludge is removed
QA/QC procedures	N/A
Purpose of data	PE
Additional comment	The purpose of monitoring this variable is to assure that an appropriate aerobic management practice is given.

Data / Parameter	ID 34 / $HG_{measured,1,y}$
Unit	TJ/yr
Description	The directly measured total quantity of thermal energy supplied by steam boiler 1 during the year y
Source of data	N/A
Value(s) applied	N/A
Measurement methods and procedures	The amount of the generated steam will be measured with a specialised mass flow meter. The operation conditions of the boilers are known, so that the mass flow can converted to energy using standard steam tables.
Monitoring frequency	Continuously
QA/QC procedures	QA: The device will be subject to regular maintenance and calibration according to the technology provider. QC: The value used to cross check HG_1, calculated according to equation 18, will be the thermal energy generation prediction calculated using the amount of biogas combusted. The lower of these two values is used in the ER calculation, as the methodology requires.
Purpose of data	BE
Additional comment	

Data / Parameter	ID 35 / $HG_{measured,2,y}$
Unit	TJ/yr
Description	The directly measured total quantity of thermal energy supplied by thermal oil heater (boiler 2) during the year y
Source of data	N/A
Value(s) applied	N/A
Measurement methods and procedures	The enthalpy of the generated energy will be calculated using measurement of the temperature gain and the flow properties: HGmeasured,2,y= ΔTt boiler,2·Flow·Heat capacity The Heat capacity is taken from the data sheet of the heat carrier, the official information from the supplier.
Monitoring frequency	Calculated
QA/QC procedures	QA: The device will be subject to regular maintenance and calibration according to the technology provider. QC: The value will be used to cross check HG_2, calculated according to equation 19, which is calculated using the amount of methane destroyed. The lower of these two values is used in the ER calculation, as the methodology requires.
Purpose of data	BE
Additional comment	

Data / Parameter	ID 36 / $HG_{measured,3,y}$
Unit	TJ/yr
Description	The directly measured total quantity of thermal energy supplied by steam boiler 3 during the year y
Source of data	N/A
Value(s) applied	N/A
Measurement methods and procedures	The amount of the generated steam will be measured with a specialised mass flow meter. The operation conditions of the boilers are known, so that the mass flow can converted to energy using standard steam tables.
Monitoring frequency	Continuously
QA/QC procedures	QA: The device will be subject to regular maintenance and calibration according to the technology provider. QC: The value will be used to cross check HG_3, calculated according to equation 20, which is calculated using the amount of methane destroyed. The lower of these two values is used in the ER calculation, as the methodology requires.
Purpose of data	BE
Additional comment	

Data / Parameter	ID 37 / $HG_{measured,4,y}$
Unit	TJ/yr
Description	The directly measured total quantity of thermal energy supplied by high pressure boiler 4 during the year y
Source of data	N/A
Value(s) applied	N/A
Measurement methods and procedures	The volume of the generated steam will be measured with a specialised steam meter. The operation conditions of the boilers are pre-set by the refinery process and known, so that the temperature, pressure, composition and density of the steam are know, and the volume flow is converted to energy using this information and standard steam tables.
Monitoring frequency	Continuously
QA/QC procedures	QC: The device will be subject to regular maintenance and calibration according to the technology provider. QA: The value will be used to cross check HG_4, calculated according to equation 21, which is calculated using the amount of methane destroyed. The lower of these two values is used in the ER calculation, as the methodology requires.
Purpose of data	BE
Additional comment	

Data / Parameter	**ID 38 / $FF_{boiler,1}$**
Unit	Gg/y
Description	Bunker fuel consumption by boiler 1
Source of data	Volume flow meter
Value(s) applied	N/A
Measurement methods and procedures	The volume of bunker used will be continuously monitored. The mass of the consumed fuel will be determined by using the volume flow measured and multiplying it by the density of bunker. There will be at least monthly recording of the volume consumed. The volume data will be archived electronically.
Monitoring frequency	Continuously
QA/QC procedures	The measurement equipment used will be of high quality. The measurements will be logged and documented. The result will be used, together with the thermal energy produced, to crosscheck the biogas consumption. The device's calibration and maintenance schedules will strictly follow the technical provider's specifications and the General Guidelines to SSC CDM methodologies. Its monitoring will be integrated in the plant's operational procedures. If the volume flow meter data are temporarily unavailable for technical reasons, internal fuel inventories will be used to calculate the fuel consumed. In such a case, internal inventories' procedures will be detailed in the monitoring report.
Purpose of data	PE
Additional comment	

Data / Parameter	**ID 39 / $FF_{boiler,2}$**
Unit	Gg/y
Description	Bunker consumption by boiler 2
Source of data	Volume flow meter
Value(s) applied	N/A
Measurement methods and procedures	The volume of bunker used will be continuously monitored. The mass of the consumed fuel will be determined by using the volume flow measured and multiplying it by the density of bunker. There will be at least monthly recording of the volume consumed. The volume data will be archived electronically.
Monitoring frequency	Continuously
QA/QC procedures	The measurement equipment used will be of high quality. The measurements will be logged and documented. The result will be used, together with the thermal energy produced, to crosscheck the biogas consumption. The device's calibration and maintenance schedules will strictly follow the technical provider's specifications and the General Guidelines to SSC CDM methodologies. Its monitoring will be integrated in the plant's operational procedures. If the volume flow meter data are temporarily unavailable for technical reasons, internal fuel inventories will be used to calculate the fuel consumed. In such a case, internal inventories' procedures will be detailed in the monitoring report.
Purpose of data	PE
Additional comment	

Data / Parameter	ID 40 / $FF_{boiler,3}$
Unit	Gg/y
Description	Bunker consumption by boiler 3
Source of data	Volume flow meter
Value(s) applied	N/A
Measurement methods and procedures	The volume of bunker used will be continuously monitored. The mass of the consumed fuel will be determined by using the volume flow measured and multiplying it by the density of bunker. There will be at least monthly recording of the volume consumed. The volume data will be archived electronically.
Monitoring frequency	Continuously
QA/QC procedures	The measurement equipment used will be of high quality. The measurements will be logged and documented. The result will be used, together with the thermal energy produced, to crosscheck the biogas consumption. The device's calibration and maintenance schedules will strictly follow the technical provider's specifications and the General Guidelines to SSC CDM methodologies. Its monitoring will be integrated in the plant's operational procedures. If the volume flow meter data are temporarily unavailable for technical reasons, internal fuel inventories will be used to calculate the fuel consumed. In such a case, internal inventories' procedures will be detailed in the monitoring report.
Purpose of data	PE
Additional comment	

Data / Parameter	ID 41 / $FF_{boiler,4}$
Unit	Gg/y
Description	Bunker consumption by boiler 4
Source of data	Volume flow meter
Value(s) applied	N/A
Measurement methods and procedures	The volume of bunker used will be continuously monitored. The mass of the consumed fuel will be determined by using the volume flow measured and multiplying it by the density of bunker. There will be at least monthly recording of the volume consumed. The volume data will be archived electronically.
Monitoring frequency	Continuously
QA/QC procedures	The measurement equipment used will be of high quality. The measurements will be logged and documented. The result will be used, together with the thermal energy produced, to crosscheck the biogas consumption. The device's calibration and maintenance schedules will strictly follow the technical provider's specifications and the General Guidelines to SSC CDM methodologies. Its monitoring will be integrated in the plant's operational procedures. If the volume flow meter data are temporarily unavailable for technical reasons, internal fuel inventories will be used to calculate the fuel consumed. In such a case, internal inventories' procedures will be detailed in the monitoring report.
Purpose of data	PE
Additional comment	

Data / Parameter	ID 42 / $\eta_{3,p}$
Unit	-
Description	The efficiency of boiler 3 using biogas.
Source of data	N/A
Value(s) applied	N/A
Measurement methods and procedures	This parameter will be determined only once the new boiler/application is added to the project. In the first verification for which this variable will be relevant, the project owner will provide a solid estimate of the efficiency of the boiler using biogas in line with relvant CDM regulation (i.e. AMS-I.C version 11 and the Tool to determine the baseline efficiency of thermal or electric energy generation systems). This parameter will be fixed at the relevant verification and will not be monitored afterwards.
Monitoring frequency	Once at the first relevant verification after the start date of operation of the boiler
QA/QC procedures	N/A
Purpose of data	BE
Additional comment	

Data / Parameter	ID 43 / $\eta_{4,p}$
Unit	-
Description	The efficiency of high-pressure boiler 4 using biogas.
Source of data	N/A
Value(s) applied	N/A
Measurement methods and procedures	This parameter will be determined only once as the new boiler/application is added to the project. In the first verification for which this variable will be relevant, the project owner will provide a solid estimate of the efficiency of the boiler using biogas in line with relevant CDM regulation (i.e. AMS-I.C version 11 and the Tool to determine the baseline efficiency of thermal or electric energy generation systems). This parameter will be fixed at the relevant verification and will not be monitored afterwards.
Monitoring frequency	Once at the first relevant verification after the start date of operation of the boiler
QA/QC procedures	N/A
Purpose of data	BE
Additional comment	

Data / Parameter	**ID 44 / $\rho_{fuel\ oil\ 6}$**
Unit	kg /m3
Description	Density of fossil fuel no.6 (bunker)
Source of data	Maximum density of the different local providers used
Value(s) applied	N/A
Measurement methods and procedures	At each monitoring period, Jaremar's fossil fuel suppliers will be asked to provide the specifications of the bunker provided. The maximum density among the values provided will be chosen to ensure conservativeness.
Monitoring frequency	Once per verification
QA/QC procedures	N/A
Purpose of data	PE
Additional comment	

The total amount of biogas generated from the recovery system and fed to the different applications is measured additional to the different sub-portions of biogas fed to the different applications. This additional measurement of the total amount of biogas will be carried out to achieve a higher level of accuracy and security. The values from this total biogas meter will be used in case of missing values from the sub-meters before the boilers, the generator and the flare. If one sub-meter fails the appropriate value will be calculated by subtracting the biogas flow of the remaining meters from the total biogas meter. If substantial differences between the total amount of biogas and the sum of the sub biogas flows occur for a certain period, maintenance of the meters will be carried out. If each sub-meter delivers reliable values the measured total amount of biogas will not be used for the emission reduction calculation as described below.

B.7.2. Sampling plan

>>

N/A

B.7.3. Other elements of monitoring plan

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The monitoring plan for the project activity can be found in the figure below.

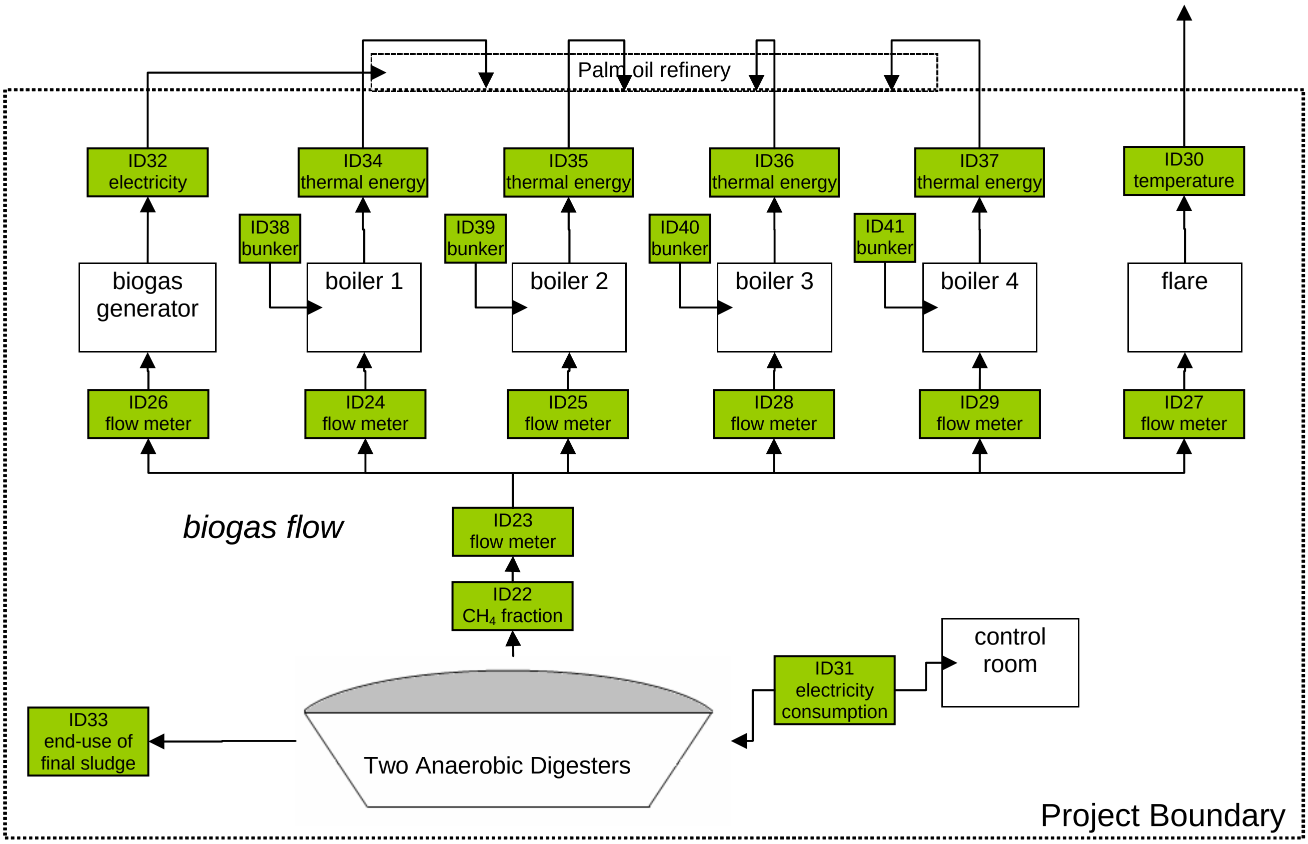

Figure 5: Monitoring plan of Energeticos Jaremar

The monitored data is read by the PLC (programmable logic controllers) and stored in a data management system directly connected to the PLC which is called SCADA. SCADA is the main interface of the monitoring system, although the data stored will be also kept in a external hard drive which will work as a back up. This system will permit to graphically represent the collected data. Every week a copy of this information will be stored on an external hard drive as a compilation of the variables of the monitoring plan and as backup.
There are two exceptions for the above-mentioned SCADA interface. One exception is the parameters related to the additional boilers, boilers 3 and 4, which due to the physical distance to the control room, which will have independent PLCs which will register data continuously, data which will be regularly transferred to the control room computer. The second exception is the bunker consumption measurements which are not digitalised, and will be regularly manually recorded. Both these procedures are detailed in the operation procedures.
The above-mentioned exceptions might be, in time, improved to enable remote and/or improved monitoring.

Responsibilities for the implementation of the monitoring plan	
Activity	**Responsible**
Implementation and accomplishment of the monitoring plan during the first year	Biotec
Definition of a team that will be trained for the correct operation and monitoring of the wastewater treatment system and the biogas utilization units.	Energeticos Jaremar
Implementation of the monitoring plan after the first year of operation	Energeticos Jaremar

Supervision and guidance for the implementation of the monitoring plan, after the first year of operation	Biotec
Records of the monitoring plan kept at least two years after the crediting period, permitting any future auditing of the values.	Energeticos Jaremar
The historical records for the operation of this project, including all the variables for the monitoring plan, will be initially kept in a data management system directly connected to the PLC, called SCADA.	Biotec & Energeticos Jaremar
If any of the measuring devices show signs of malfunction, it will be fixed by the respective technology supplier. There will be an auxiliary mass flowmeter on stock to serve as a backup for these cases.	Biotec for the first year and Energeticos Jaremar for the next years
Frequent internal audits through experienced engineers coming regularly from the main engineering office.	Biotec
Assistance in the implementation of the CDM monitoring plan and close follow up of the monitoring process.	OneCarbon / Orbeo (CDM project consultant)

Responsibilities for the installation, operation and maintenance of the project	
Activity	**Responsible**
Make available on site Operation and maintenance manuals	Biotec
Responsible for the startup and first year of operation of the system, with possibility of extension	Biotec.
Operation and administration of the wastewater treatment system after Biotec	Energeticos Jaremar
Operation and maintenance costs of the following units: o lagoons, o biogas recovery unit and o boilers and generator.	Energeticos Jaremar
Design and supervision of the project's operation.	Biotec
Installation of the equipment	Biotec
Fill in log of activities including identifying malfunctions and maintenance performed to the system.	Biotec for the first year and Energeticos Jaremar for the next years

Responsibilities for training	
Activity	**Responsible**
Capacity building to the team within Jaremar that will operate the wastewater treatment system.	Biotec
A Jenbacher expert, supplier of the power generation system, will train the same team on operation and maintenance of the generator set.	Jenbacher expert

Biotec has developed a training school to provide training to its personnel. Operators will receive training in biogas handling and operation of the generating system. Also training in instrumentation and monitoring system has been provided through Biotec experienced engineers. These conditions are stated under the contract of Biotec as a service provider for Energeticos Jaremar.

Troubleshooting procedures:
Equipment maintenance manuals are available on-site but in general system troubles are classified as follows:

- Troubles with lagoon covers: operators check continuously the lagoons covers and if some damage is presented, there is a local service supplier that is capable to fix any lagoons cover damage. Service valves are available to cut gas flow to the blowers in case of a cover rupture to avoid air entrance to the system.
- Biogas conduction: plant operators will have enough technical skills and can repair any damage in the gas conduction system.

Monitoring system is supported by a UPS (5 KVA) that has autonomy during four hours to assure all the system data.

SECTION C. Duration and crediting period

C.1. Duration of project activity

C.1.1. Start date of project activity

>>
1st of January 2008

C.1.2. Expected operational lifetime of project activity

>>
25 years

C.2. Crediting period of project activity

C.2.1. Type of crediting period

>>
Renewable

C.2.2. Start date of crediting period

>>
08/03/08[10]

C.2.3. Length of crediting period

>>
7 years

SECTION D. Environmental impacts

D.1. Analysis of environmental impacts

>>
The project activity has succesfully completed an environmental impact diagnostic, obtaining the environmental license Nº 047-2007 on 11/06/2007, from the Ministry of the Environment (Secretaria de Recursos Naturales y Ambiente).

[10] This date is the realized crediting period starting date, not the one included in the originally registered PDD which was the 21/01/08.

The environmental impact diagnostic of the Energeticos Jaremar project, concluded that the social and environmental benefits of this project would go beyond the impacts resulting from construction of the project.. The following benefits of the project have been summarised as additional benefits (apart from the reduction of greenhouse gases):

- Reduced odour, by covering the open anaerobic lagoons.
- Pathogen and vector control
- Effective treatment of wastewater. In the project situation the effluent has a lower organic matter content which will minimise potential risk of groundwater or river contamination.
- Technology transfers to the region.
- Reduced fossil fuel dependency.
- Contribution to several social projects at the region, as explained in section A.2.
- Creation of new jobs at the region during the construction and operation of the project[11].

All these statements are confirmed by the project endorsement letter given by the Designated National Authority. The DNA reviewed all the different environmental permits related to the project and found them to be in accordance with all national environmental regulations.

It has been recognized by the local environmental authority that the project has several environmental benefits related to greenhouse gas mitigation, odour mitigation and local emission reductions from fuel replacement. Therefore a successful environmental licence has been obtained from the Ministry of the Environment (Secretaria de Recursos Naturales y Ambiente).

Most of the environmental impacts of the project will occur during the construction phase. This is mostly due to the heavy machines used for construction.

The project will take the following measures to mitigate any environmental impact of the project on:
Soil pollution

Impact: The volume of the lagoons will be increased. During construction, fuel or oil can leak from machines.

Measure: In accordance with the environmental management plan, presented in the environmental declaration. If fuel is spilled, the soil will be removed with a minimum depth of 10cm.

Impact: Solid Waste Management

Measure: in accordance with the official contract with SERNA for mitigation measures, the project will guarantee appropriate storage of all solid waste generated from the project. Appropriate management will be given before its transport for final disposal on an authorized landfill.

Water Quality

Impact: percolation of hazardous waste by bad hazardous waste management or bad sludge management.

Measure: All fossil products for the operation of the machinery have to be stored in a designated area. In case of leakage this has to be cleaned with special equipment. There will be a special area

[11] A total of 12 workers and one supervisor will be continuously working in the mounting of the system, for a period of 7 months. Further employment is expected for approximately 20 local employees over the course of 4 months to assist in the construction of the project activity. A total of ten full time positions for the yearly maintenance and operation of the facility will also be created.

for disposal of fossil products; this area will be sealed to stop percolation. All the machinery will be regularly checked on leakage. It is forbidden to wash the machinery near the river.
A periodic follow up of the effluent's quality will be done in order to assure the appropriate efficiency of the wastewater treatment facility. Finally, any sludge generated from the waste treatment process will be appropriately managed under aerobic conditions and in compliance with the regulatory requirements.
Impact: Sediment accumulation in the San Alejo River.
Measure: in accordance with the official contract with SERNA for mitigation measures, the project will implement a rainwater conveyance system to drain all rainwater to the San Alejo River.
Impact: percolation of wastewater from palm oil mill
Measure: The project considers the impermeabilization of the new civil works in the lagoons
Impact: Dark brown color in final effluent
Measure: the project considers the implementation of a wastewater clarification stage

Air Quality

Impact: Air quality could be influenced by exhaust gases from the construction machinery (small particles) and by dust from the digging activities.
Measure: To avoid small particles the machinery will be regularly maintained. To prevent dust the area will be sprinkled with water.

Health and Safety

Impact: after construction the degradation process in the lagoons must be initiated, this will be done by inserting donkey dung (which includes the necessary bacteria) in the lagoons.
Measure: The worker is obliged to wear protective clothing (mask, gloves)

SECTION E. Local stakeholder consultation

E.1. Solicitation of comments from local stakeholders

>>

The public consultation was organised on the 21st of March, 2007. The meeting took place at the installations of the Jaremar association, located at km 15, in the village San Alejo, in Tela, Atlántida where the biogas project was officially presented through a small summary (handout) and a PowerPoint presentation. A site visit was offered to the participants in attendance.

The stakeholders invited through personal invitation and newspaper adverts (local newspaper "La Prensa", 15.03.07 and 16.03.07) were:

- Residents from the local communities of the region
- NGOs like the WWF
- The National Association of Palms Oil producers (FENAPALMAH)
- National and local Governments
- Others stakeholders (A list with all the attendants to this meeting has been included in Annex 7 of the Supporting documentation).

Seventy persons were present at the meeting. During the meeting the participants had the opportunity to present themselves, get an in-depth understanding of the project and give their comments on the project. The stakeholder consultation was held close to the site where the project will be realised. The discussions

were held in Spanish, the local language. All relevant material and information about the project was shared with the participants in a transparent manner.

This stakeholder consultation was documented with photo and video. A summary of the exact procedure was written and after controlling signed by Ing. José Vásquez, director of WWF-Honduras who participated as an independent external supervisor. All direct invitations were signed be the recipients. All original documents were archived at the Jaremar facilities in Honduras.

One week after the stakeholder consultation the stakeholders were informed by mail and newspaper advert (local newspaper "La Prensa", 26.03.04) about the results of the meeting and they were invited to check all related documents.

E.2. Summary of comments received

>>

Participant	**Comment**
Victoriano Cerilla, Aldea Morejen	The stakeholder requested a detailed explanation of the benefits. The project owner explained in detail the social and environmental benefits, especially for the local community.
Gabriel Cruz, Aldea Citronela and Ing. Suyapa Diaz Agrotor	The stakeholders asked what would happen to the residues of the fabric during the construction phase of the project. The project owner answered that during the construction of the project a backup solution will assure a wastewater treatment according to legal and environmental requirements.
Nery Menjivar, Vice-Alcalde Municipal de Tela	The stakeholder required a participation of the local environmental authorities. The project owner explained that this cooperation was already in place.
Enrique Sorto, Aldea Villafranca	The stakeholder asked if there were any risks for the local communities in relation with the biogas. The project developer explained how risks will be avoided with proven technique and security measures.
Miguel López Aldea Procón	The stakeholder asked if the smell of the current system can be reduced by the project. The project developer pointed out that the bad smells of the current waste water treatment system can be reduced significantly by the project.
Eduardo Cole Recarte FENAPALMAH	The stakeholder asked if additional biogas can be bottled. The Project owner explained that it could be possible, but it is financially not feasible.
Ramon Echeverria Aldea Buenos Aires	The stakeholder asked about the responsible for the project. The project owner explained the responsibility of Biotec for the adaptation of the lagoons and the general responsibility of Agrotor and Energéticos Jaremar for the environmental integrity of the project.
Jacqueline Espinal Escuela 3 de Octubre	The stakeholder asked if it would be possible to show the project to pupils/schools of the region. The project owner pointed out that it is one of the objectives of the project to receive students at the sight in an adequate manner to explain and spread the technical knowledge gained with this project.

Comments related to the company (Energeticos Jaremar)

Participant	**Comment**
Marcio David Galo, Villafranca, Centro Educativo Básico	The stakeholder asked if the Project owner could contribute to improve the educational situation of region. The project developer mentioned that his company currently helps in several aspects and that it is open to receive requests for additional programmes.

No negative comments were received. In all consultation rounds, the project was very welcome by the stakeholders since it will solve an existing environmental problem.

E.3. Report on consideration of comments received

>>
Since no negative comments were received, no action was taken on the comments that were received.

SECTION F. Approval and authorization

>>

The LoA from the host country (Honduras) was received on the 22/10/ 2007.

The LoA from the Annex I country was received on the 05/11/2010.

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Appendix 1: Contact information of project participants

Organization name	Energéticos Jaremar S.A. de C.V.
Street/P.O. Box	
Building	
City	San Alejo, Distrito de Tela
State/Region	Departamento de Atlántida
Postcode	1092
Country	Honduras
Telephone	504-429-0013
Fax	504-429-0010
E-mail	
Website	
Contact person	
Title	Managing Director
Salutation	Mr.
Last name	GABRIE
Middle name	
First name	DANNY
Department	
Mobile	
Direct fax	504-429-0010
Direct tel.	504-429-0013
Personal e-mail	dgabrie@jaremar.com

Appendix 2: Affirmation regarding public funding

Not applicable since the project obtains no capital support from public funding.

Appendix 3: Applicability of selected methodology

AMS-III.H (version 5) is applicable.

- The project comprises the measures described in Option IV: Introduction of methane recovery and combustion to an existing anaerobic wastewater treatment system such as anaerobic reactor, lagoon, septic tank or an on-site industrial plant. (paragraph 1 of AMS III.H v.5).
- The recovered methane continues is used for heat and electricity generation and that component of the project activity is considered under the corresponding category under type I (paragraph 2 of AMS III.H v.5).
- The number of annual emission reductions per year is c.54kt CO_2e; which is well below the 60 kt CO_2e annually (paragraph 3 of AMS III.H v.5).

AMS-I.C (version 11)'s applicability is not affected.

- The project comprises renewable energy technology that supplies thermal energy that displaces fossil fuels (paragraph 1 of AMS I.C v.11).
- The total thermal generation capacity of the installed units is below 45 MW (paragraphs 2 and 3 of AMS I.C v.11).
- The project is not an addition of renewable energy units to an existing renewable energy facility so paragraph 4 of AMS I.C v.11 does not apply.

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

I) Expected production data and estimated volume of wastewater at the palm oil mill

	Units	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	***Source***
Fresh Fruit used for production	*TFF/year*	240,000	245,714	251,429	257,143	262,857	268,571	274,286	Feasibility study
water usage	*m3/TFF*	1.13	1.13	1.13	1.13	1.13	1.13	1.13	Monitoring data 2009 (Jan-Nov)
Qy,ww (volume of wastewater)	*m3/year*	151,200	154,800	158,400	162,000	165,600	169,200	172,800	

II) Expected production of biogas

	Unit	2008	2009	2010	2011	2012	2013	2014	Source
Fresh Fruit used for production	*TFF/year*	240,000	245,714	251,429	257,143	262,857	268,571	274,286	Information provided from feasibility study and based on Jaremar's production
Total Bunker consumption	m3/year	1,295.11	1,295.11	1,295.11	1,295.11	1,295.11	1,295.11	1,295.11	Last report from Refinery 2006
Bunker consumption replaced by the biogas project in the Thermal oil heater	m3/year	249.66	249.66	249.66	249.66	249.66	249.66	249.66	
equivalent biogas for Thermal oil heater	Nm3/year	443,694	443,694	443,694	443,694	443,694	443,694	443,694	
Bunker consumption replaced by the biogas project in the steam boiler	m3/year	1,045.45	1,045.45	1,045.45	1,045.45	1,045.45	1,045.45	1,045.45	
equivalent biogas for Steam boiler	Nm3/year	1,972,659	1,972,659	1,972,659	1,972,659	1,972,659	1,972,659	1,972,659	
Electricity generation (MWh)	MWh/yr	1,667	2,643	2,786	2,929	3,071	3,214	3,357	Biotec
Equivalent in biogas for electricity generation	m3/year	682,241	1,081,839	1,140,317	1,198,794	1,257,272	1,315,750	1,374,228	

Name of variable	Value	Unit	Source
Percentage for thermal oil heater from the total bunker consumption	19	%	BIOTEC Feasibility study,
Percentage for steam boiler from the total bunker consumption	81	%	BIOTEC Feasibility study,
Bunker NCV	39,809	MJ/m3	Specifications from bunker provider: OLEOPRODUCTOS DE HONDURAS (OLEPSA S.A.)
Available biogas	25.59	m3 CH_4/TFF (tons of fresh fruit)	Monitoring data 2009 (Jan-Nov)
Electricity generation from Available biogas	2.44	KWh/m^3	based on the first Monitoring Report of EECOPALSA
Expected electricity generation for 2008 (from May)	1,667	MWh/yr	Biotec
Expected electricity generation for a whole year	2500	MWh/yr	Biotec
Rate of increase until 2015	142.86	MWh/yr	Biotec

Calculation of emission factor for the Honduran grid

The data required to calculate the grid emission factor is based on historic data. This project has considered an ex-ante approach for emission reductions estimation.
The baseline scenario consists on the electricity that would have otherwise been generated by the operation of the grid-connected power plants and by the addition of new generation sources.
For the calculation of the emission factor, the Combined Margin (CM) approach is applied. This Combined Margin is divided in two parts, the Operating Margin (OM) and the Build Margin (BM).
For the calculation of these two terms (BM and OM), the information used has been provided directly by *ENEE (National Company for Electric Energy).*
The Operating Margin as well as the Build Margin will be calculated according to methodology AMS.I-C, where reference is made to approved consolidated methodology ACM0002

Step1. Calculate the Operating Margin emission factor (OM)
The Operating Margin refers to actual generation mix by sources installed in Honduras. According to ACM0002, there are four criteria to represent this emission factor. Although this methodology gives priority for the dispatch analysis method, lack of data from the Honduras grid prevented the application of this option. For this CDM project activity the “Simple Operating Margin” is applied, as more than 50% of the energy available for the grid exists from fossil fuel sources that are not low-cost must run. The “simple operating margin” is the weighted average emissions (in tonCO2/GWh) of all generating sources serving the system, excluding hydro, geothermal, wind, low-cost biomass, nuclear and solar generation.

For calculating the Simple Operating Margin (tonCO2/GWh) for a specific year y, of all generating sources serving the system excluding the low-cost/must run generation units, the following formula is applied:

$$EF_{OM,y} = \frac{\sum_{i,j} F_{i,j,y} \cdot COEF_i}{\sum_{i,j} GEN_{i,j,y}} \qquad (1)$$

Where:

$EF_{OM,y}$	Emission factor representative for the operating margin, in year y (tCO2e/GWh).
$F_{i,j,y}$	The amount of fuel i (in a mass or volume unit) consumed by relevant power sources j in year(s) y, and *j* generating sources serving the system excluding the low-cost/must run generation units.
$COEF_{i,j}$	The CO_2 emission coefficient of fuel i (tCO_2/mass or volume unit of the fuel), taking into account the carbon content of the fuels used by relevant power sources j and the percent oxidation of the fuel in year(s) y.
$GEN_{i,j,y}$	The electricity in GWh delivered to the grid by the j source (excluding low cost must run resources), with fuel i, and in year y.

The calculation of the Simple OM was done using the most recent numbers for Honduras' national interconnected system obtained from the national dispatch center. Data comprising the electricity generation for the 2004-2006 period was considered. Non-low-cost/must-run resources in Honduras' national interconnected system are plants using diesel or bunker. Registered CDM project activities have not taken into account as part of the grid's mix.

$COEF_{i,j,y}$ is obtained as:

$$COEF_{i,j} = EF_{CO2i} \cdot NCV_i \cdot OXID_i \qquad \textbf{(2)}$$

Where variables and parameters used are:

$\boldsymbol{EF_{CO2,i}}$;	is the emission factor for fuel i, obtained from the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, in tCO_2/TJ.
$\boldsymbol{NCV_i}$	The net calorific value of fuel i, obtained from the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, in TJ/Gg.
$\boldsymbol{OXID_i}$	is the oxidation factor of fuel i. The default emission factors for each type of fuel obtained from the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, assume that the carbon oxidation factor is equal to 1 (See Volume 2 of the 2006 IPCC Guidelines, page 2.11).

For two power plants **Elcatex** and **Ampac**, information on the fuel consumption is not available. For these cases plant emission factors have been estimated separately based on average specific fuel consumption of power plants connected to the same grid and using the same fuels (following approach 3 c of footnote 4 in ACM0002). ENEE has provided representative information on specific fuel consumptions:

For these two cases, $F_{i,j,y}$· is obtained as:

$$F_{i,j,y} = GEN_{i,j,y} \cdot SFC_j \cdot D_i \qquad \textbf{(3)}$$

Where variables and parameters used are:

$\boldsymbol{SFC_j}$	Specific fuel consumption for plant j (Elcatex or Ampac). Obtained from the National Dispatch Center in m^3/GWh, Honduras National Commission of Energy and ENEE.
$\boldsymbol{D_i}$	density for fuel i (kg/m^3). Source: IEA 2006 Oil Information 2007/ pg.21[12]

Part of the electricity consumed in Honduras is imported from other Central American countries: Nicaragua, Costa Rica, Panama, El Salvador and Guatemala.

[12] http://wds.iea.org/pdf/doc_oil.pdf

Table I: Imports for Honduras' grid (source: ENEE)

2006	
Energy GWh	**% of total grid generation**
7.3	0.1%

These imports have been taken into account with an emission factor of 0 tCO_2e/GWh.

The following results of the Operating Margin Emission Factor have been calculated, upon each reference year (2004, 2005, and 2006), representing the first crediting period:

Table II: Results of the Operating margin emission factor.

ton CO_2e/MWh	2004	2005	2006	Average
$EF_{OM,y}$	708	657	668	**678**

Step 2. Calculate the Build Margin emission factor (EF_{BM},)

The Build Margin emission factor EF_{BM}, will be calculated on an ex-ante basis, using the most recent information available on plants already built.
The "build margin" is the weighted average emissions (in tCO2e/GWh) of the most recent capacity additions to the system, based on the most recent information available on plants already built for sample group *m* at the time of PDD submission. The sample group *m* has been calculated based on the power plant capacity additions in the electricity system that comprise 20% of the system generation (in GWh) and that have been built most recently.

The following equation is applied to calculate the build margin.

$$EF_{BM} = \frac{\sum_{i,m} F_{i,m,2006} \cdot COEF_{i,m}}{\sum_{m} GEN_{m,2006}} \qquad \textbf{(4)}$$

where

EF_{BM}	Emission factor representative for the build margin, in year 2006 (tCO2e/GWh).
$\Sigma GEN_{m,2006}$	sum of electricity from m power plants, in GWh for year 2006. This obtained from the ENEE statistics.
$F_{i,m,2006}$	is the amount of fuel i (in a mass or volume unit) consumed by relevant power sources m in year 2006. The only power generation sources that consume fossil fuels and that are part of the sample group m are Laeisz NACO and Lufussa III.

$COEF_{im}$ The CO_2 emission coefficient of fuel i (tCO_2 / mass or volume unit of the fuel), taking into account the carbon content of the fuels used by relevant power sources m and the percent oxidation of the fuel in year 2006.

Registered CDM project activities have not taken into account as part of the grid's mix.

The following result of the Build Margin Emission Factor has been calculated, upon each reference year 2006, representing the first crediting period:

Table III: Result of the Build margin emission factor.

ton CO_2e/GWh	2006
EF_{BM}	615

The combined margin has been estimated as an average between both values of build and operating margin (the 50% weight of each term is by default):

$$EF = EF_{OM} \cdot 0.5 + EF_{BM} \cdot 0.5 \qquad \textbf{(5)}$$

Where:

EF Resultant combined margin for the grid, based on ex-ante estimations (ton CO_2/GWh).

EF_{OM} Average emission factor for the operating margin at the grid (tonCO_2/GWh)

EF_{BM} Emission factor for the Build margin at the grid (tonCO_2/GWh)

Following ex-ante estimations, we have the following resultant combined margin:

Table IV: Result of the combined margin emission factor.

Combined Margin	
EF (ton CO2eq/GWh)	**646**

This ex-ante emission factor is the basis for calculating the emission factors through all the years in the crediting period (from 2008).

This ex-ante emission factor is the basis for calculating the emission factors through all the years in the crediting period (from 2008).

Energy Generation for 2004-2006 and order of power plants for the calculation of the Build Margin

	Technology	Fuel	Year online	Energy 2006GWh/year	Energy 2005GWh/year	Energy 2004GWh/year	CDM reference number of registration
Cuyamapa	**Hydro reservoir**	**Renewable**	**2006**	**14**	**0**	**0**	**45**
Zacapa	**Hydro reservoir**	**Renewable**	**Dec-05**	**3**	**0.5**	**0.008**	**235**
Cahsa	Biomass	Renewable	Feb-05	27.1	18.2		under review (1035)
Azunosa (empresa azucarera del norte)	**Biomass**	**Renewable**	**Feb-05**	**10.1**	**7**		**1034**
Yojoa	**Hydro reservoir**	**Renewable**	Jan-05	**1.3**	**1.1**		**157**
Cececapa	**Hydro reservoir**	**Renewable**	**2005**	**18.9**	**1.6**		**156**
Rio Blanco	**Hydro reservoir**	**Renewable**	Sep-04	**38.4**	**33.3**	**9.2**	**28**
Laeisz NACO	Diesel motors	bunker	Aug-04	30.9	27.3	7.6	
Lufussa III	Diesel motors	bunker	Aug-04	1805.3	1842.2	407.2	
Elcatex	Diesel motors	bunker	Jun-04	13.3	42	60.38	
Babilonia	Hydro reservoir		May-04	30.6	29.9	17.6	
Tres Valles	**Biomass**		Abr-04	**26.5**	**21.4**	**5.04**	**1066**
Enersa	Diesel motors	bunker	Mar-04	1379.2	1165.9	534.4	
La Esperanza	**Hydro reservoir**		**Jun-04**	**23.8**	**3.6**	**1.9**	**9**
Laeisz TO	Diesel motors	bunker	Feb-04	0	0	15.41	
Nacional de Ing	Diesel motors	bunker	2002	0.3	11.9	276.9	

Laeisz	Diesel motors	bunker	2002	0	0.005	132.91	
Aysa	biomass		2002	0.3	1.6	1.3	
Aguan	Biomass		2002	0	0	1.8	
La Grecia	Biomass		2002	35.9	28	36.8	under review (1056)
Lean	Biomass		2002	0	0	2	
La nieve	Hydro reservoir		2002	1.5	1.4	1.2	
Nacaome	Hydro reservoir		2002	32.4	50	16.2	
Cemcol La Puerta	Diesel motors	bunker	2002	0	16.4	270.2	
El Coyolar	Hydro reservoir		2000	0	0	0	
EMCE II (choloma)	Diesel motors	bunker	1999	145.9	180.6	380.7	
Lufussa II	Diesel motors	bunker	1999	154.6	189.7	460.9	
Eda	Biomass		1998		0	0	
La puerta Mexicana	Gas Turbine	diesel	1994	0.3	0	3.47	
Lufussa I	Gas Turbine	diesel	1995	8.3	20.5	66.6	
Ampac	Diesel motors	bunker	1994	0	0.2	0.095	
Elcosa	Diesel motors	bunker	1994	168.3	129.6	422	
Santa Fe	Diesel motors	bunker	1994	0	-0.2	1.5	
Santa Maria	Hydro reservoir		1986	3.8	4.8	6	
El Cajon-Francisco	Hydro reservoir		1985	1038.6	1004.3	702.39	
El Nispero	Hydro reservoir		1982	91.3	83.7	29.6	
EMCE I (Alsthom/Sulzer/Ceiba	Diesel motors	bunker	1980/1984/1974	63.1	68.8	470.9	
Rio Lindo	Hydro reservoir		1971	586.3	383	467.49	

La Puerta	Gas Turbine	diesel	1970	0.8	6.6	7.79	
Canaveral	Hydro reservoir		1964	185.9	120.8	149.82	
Imports = have been considered as a nil emission factor value							
nicaragua						12.1	
costa rica					218.9	26	
panamá						62.3	
El Salvador				2.9	12.9	37.6	
Guatemala				1.1	0	5.9	
otros mercados				3.3	19.4	55.4	
SUM of energy (GWh)				**5804**	**5427**	**4951**	
20 % generation from the most recent power plants		**GWh**	**1160.8**				
Total generation from most recent power plants		**GWh**	**1836.2**				

The shaded power sources are the most recently built power plants that represent at least the 20% of the total energy generation for the grid. Registered CDM project activities have been clearly identified, and these are not being taken into account as part of the grid emission factor calculation.
The only power generation sources that consume fossil fuels and that are part of the sample group m are Laeisz NACO and Lufussa III.

Non-low cost must run power sources, fuel consumption and energy generation for the calculation of the Simple Operating Margin

	fuel	Energy 2006 GWh/year	fuel consumption (lt) 2006	Emissions 2006 (tCO2eq/year)	Energy 2005GWh /year	fuel consumption (lt) 2005	Emissions 2005(tCO2 eq/year)	Energy 2004GWh/year	fuel consumption (lt) 2004	Emissions 2004(tCO2eq/year)
Laeisz NACO	Diesel	30.9	8,764,671	23,570	27.3	7,621,299	20,495	7.6	2,145,110	5,769
Lufussa III	bunker	1805.3	374,478,374	1,105,404	1842.2	377,185,788	1,113,396	407.2	82,698,696	244,114
Lufussa III	Diesel		13,113,125	35,264		341,164	917		824,837	2,218
Elcatex	bunker	13.3		9,645.4	42		30,459	60.38		43,789
Enersa	bunker	1379.2	307,354,161	907,263	1165.9	257,724,859	760,765	534.4	120,698,342	356,283
Enersa	Diesel		692,568	1,862		1,310,135	3,523		334,982	901
Laeisz TO	Diesel	0	-	-	0	1,291	3.47	15.41	37,157,229	99,925
Nacional de Ing	Diesel	0.3	87,719	236	11.9	3,379,873	9,089	276.9	41,077,167	110,466
Laeisz	Diesel	0	-	-	0.005	1,291	3.47	132.91	37,157,229	99,925
Cemcol - La Puerta	Diesel	0	-	-	16.4	4,626,038	12,441	270.2	75,462,514	202,937
EMCE II (choloma)	bunker	145.9	32,311,982	95,380	180.6	38,713,768	114,277	380.7	84,139,780	248,368
EMCE II (choloma)	Diesel		1,520,543	4,089		2,157,234	5,801		1,425,268	3,833
Lufussa II	bunker	154.6			189.7			460.9		

			35,502,993	104,800		43,409,2 73	128,138		102,883,7 24	303,697
Lufussa II	Diesel		73,914	199		631,869	1,699		93,848	252
La puerta Mexicana	Diesel	0.3	166,221.23	447	0	-	-	3.47	1,755,318 .26	4,720
Lufussa I	Diesel	8.3	2,527,618	6,797	20.5	5,950,01 7	16,001	66.6	18,642,75 3	50,135
Ampac	Diesel	0			0.2		197	0.095		94
Elcosa	bunker	168.3	58,364,262	172,283	129.6	51,141,1 58	150,961	422	118,769,6 45	350,590
Elcosa	Diesel		8,563	23	0	10,857	29	1.5	30,416	82
Santa Fe	bunker	0	7,457	22		-	-	1.5	557,856	1,647
EMCE I (Alsthom/S ulzer/Ceiba)	bunker	63.1	16,212,579	47,857.10	68.8	17,181,3 04	50,716.64	470.9	116,286,9 86	343,261.77
EMCE I (Alsthom/S ulzer/Ceiba)	Diesel		728,881	1,960.13	6.6	1,628,40 9	4,379.18		3,905,750	10,503.49
La Puerta	Diesel	0.8	500,727	1,347	0	2,990,35 4	8,042	7.79	3,409,025	9,168
TOTAL		**3,770**		**2,518,449**	**3,702**		**2,431,335**	**3,520.5**		**2,492,677**

Power generation plants with no participation on the grid during these years, have not been included,
Fuel consumption info is provided by ENEE.

As it is explained on this PDD, the fuel consumption from Ampac and Elcatex is not easily available. Emissions from these power plants have been calculated based on referential values of specific fuel consumption for this type of power plants.

	Fuel	Specific fuel consumption (lt/MWh)	Energy 2006GWh/year	Emissions 2006 (tCO2eq/year)	Energy 2005GWh/year	Emissions 2005(tCO2eq/year)	Energy 2004GWh/year	Emissions 2004(tCO2eq/year)
Elcatex	bunker	246	13.3	9,645	42	30,459	60.38	43,789
Ampac	diesel	367	0	-	0.2	197	0.095	94

<u>Referential values of specific fuel consumption</u>

Power generation station	Fuel type	Specific fuel consumption (lt/MWh)	Efficiency (percentage)
La Puerta		435	23%
Lufusa I	Diesel	272	36%
Santa Fe		335	28%
Elcosa		237	40%
Alsthorn		247	38%
Suizer		249	38%
La Ceiba		274	34%
EMCE II		227	42%
Enersa		208	45%
Lufusa II		225	42%
Lufusa III 210MW	Bunker	208	45%

Reference: based on information developed by the ENEE

Power generation station	Fuel type	Specific fuel consumption (lt/MWh)	Efficiency (percentage)
La Puerta		416	24%
Mexicana Bermejo		435	23%
Mexicana La Puerta	Diesel	523	19%

Reference: 2002/ Guía para Desarrolladores de Proyectos de Generación de Energía Eléctrica utilizando Recursos Renovables en Honduras (BUN-CA)

Power generation station	**Fuel type**	**Specific fuel consumption (lt/MWh)**	**Efficiency (percentage)**
Laeiz NACO		284	35%
Nacional de Ing		284	35%
Cemcol La puerta	Diesel	284	35%

Reference: 2006/ Statistics on ENEE

		Specific fuel consumption (lt/MWh)	**Efficiency (percentage)**
Average diesel		367	29%
Average bunker		246	39%

Default values use on the calculation of the grid emission factor

	tc02/tj (ipcc 2006)	Density (kg/m3)* (OECD/IEA 2006)	Net Calorific Value (TJ/Gg) (ipcc 2006)
Diesel Motors/Bunker	77.4	944	40.4
Gas Turbine/Diesel	74.1	844	43

Appendix 5: Further background information on monitoring plan

Not applicable.

Summary of post registration changes

1. **9th of November 2011:** Approval of a Monitoring Plan Revision.

2. **2012:** Notification of Changes in the ex-ante parameter ID. 2 *Average water usage per processed ton of fresh fruit* which increased due to the process needs in the palm oil mill.

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History of the document

Version	**Date**	**Nature of revision**
04.1	11 April 2012	Editorial revision to change history box by adding EB meeting and annex numbers in the Date column.
04.0	EB 66 13 March 2012	Revision required to ensure consistency with the “Guidelines for completing the project design document form for small-scale CDM project activities” (EB 66, Annex 9).
03	EB 28, Annex 34 15 December 2006	• The Board agreed to revise the CDM project design document for small-scale activities (CDM-SSC-PDD), taking into account CDM-PDD and CDM-NM.
02	EB 20, Annex 14 08 July 2005	• The Board agreed to revise the CDM SSC PDD to reflect guidance and clarifications provided by the Board since version 01 of this document. • As a consequence, the guidelines for completing CDM SSC PDD have been revised accordingly to version 2. The latest version can be found at <http://cdm.unfccc.int/Reference/Documents>.
01	EB 07, Annex 05 21 January 2003	Initial adoption.
Decision Class: Regulatory **Document Type:** Form **Business Function:** Registration		