Revised Monitoring Plan:

1st revision of the Monitoring Plan. Version 5 of 18/10/2011

Project title: ENERGETICOS JAREMAR – BIOGAS RECOVERY FROM PALM OIL EFFLUENT (POME) PONDS AND HEAT & ELECTRICITY GENERATION, HONDURAS
Project number: 1483

The following changes were implemented in this revision:

1) Concerning ID 28: The PDD foresees the installation of new thermal applications for the biogas and allows for the implementation of such applications as the production requires it. At this stage of the project, it is clearer what these additional applications are: two additional boilers will be added to the project. To reflect these changes, ID 28 has been modified and new ID 29 has been added. The additionality is not affected if two additional boilers utilise biogas since optimised biogas utilisation does not affect the barriers the project faces.
2) Following point (1), the efficiency of the additional applications, for both baseline and project scenario, were added to the monitoring plan, and the ex-post calculations were modified to reflect this. The documentation regarding these efficiencies was given to the DOE involved in this revision and was checked during the on-site visit associated with the project's second periodic verification.
3) Concerning ID 31 (ID 30 in the original PDD): The "Any comment" box has been revised to clarify its content as requested in the Clarifications Requested on the Request for revision of the monitoring plan on the 6th of October 2011.
4) New parameters were added according to the EB request[1], to comply with the requirement of AMS.I.C. The new parameters are ID 34 through ID 46. These parameters serve to measure the biogas associated thermal energy delivered by the various boilers. Additionally, the baseline emissions calculation was modified to use these new parameters and to compare the thus measured thermal energy with the thermal energy generation prediction using the amount of biogas combusted. The lower of these two values is used in the ER calculation, as the methodology requires.

[1] http://cdm.unfccc.int/EB/053/eb53rep.pdf paragraph 87(c)

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

B.7.1	**Data and parameters monitored:**

Data / Parameter:	**ID 22 / $w_{CH4,y}$**
Data unit:	m³ CH_4/m³ BG
Description:	Fraction of methane in the biogas in the year "y"
Source of data to be used:	Monitoring system.
Value of data	0.65. This ex-ante value is based on similar Palm oil mill effluent treatment systems designed by Biotec.
Description of measurement methods and procedures to be applied:	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[2] 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.
QA/QC procedures to be applied:	*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.
Any comment:	

Data / Parameter:	**ID 23 / $BG_{total,y}$**
Data unit:	Nm^3/year
Description:	Flow of the total biogas recovered in year 'y".
Source of data to be used:	Monitoring system.
Value of data	4,412,314 Nm³/year in 2008 (see Annex 3)
Description of measurement methods and procedures to be applied:	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.
QA/QC procedures to be applied:	*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.
Any comment:	See also the explanation below regarding the connections and the priorities of the different mass flow meters.

Data / Parameter:	**ID 24 / $BG_{boiler1,y}$**
Data unit:	Nm^3/year
Description:	The flow of biogas consumed in boiler 1 in year 'y".
Source of data to be used:	Monitoring system.
Value of data	1,972,659 Nm³/year (See annex 3)
Description of measurement methods and procedures to be applied:	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

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

	stored in the monitoring system's interface, SCADA (Supervisory Control And Data Acquisition). The security of the system is guaranteed by a password.
QA/QC procedures to be applied:	*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.
Any comment:	See also the explanation below regarding the connections and the priorities of the different mass flow meters.

Data / Parameter:	**ID 25 / $BG_{boiler2,y}$**
Data unit:	Nm^3/year
Description:	The flow of biogas consumed in boiler 2 in year "y".
Source of data to be used:	Monitoring system.
Value of data	443,694 Nm^3/year (See annex 3)
Description of measurement methods and procedures to be applied:	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.
QA/QC procedures to be applied:	*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.
Any comment:	See also the explanation below regarding the connections and the priorities of the different mass flow meters.

Data / Parameter:	**ID 26 / $BG_{generator,y}$**
Data unit:	Nm^3/year
Description:	The flow of biogas consumed in the generator in year "y"
Source of data to be used:	Monitoring system.
Value of data	682,241 Nm^3/year for 2008. Estimated maximum of 1,374,228 Nm^3/year for year 2014. (See annex 3)
Description of measurement methods and procedures to be applied:	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.
QA/QC procedures to be applied:	*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.
Any comment:	See also the explanation below regarding the connections and the priorities of the different mass flow meters.

Data / Parameter:	**ID 27 / $BG_{flared,y}$**
Data unit:	Nm^3/year
Description:	The flow of biogas consumed in the flare in year "y"
Source of data to be used:	Monitoring system.
Value of data	Estimated maximum of 1,313,719 Nm^3/year for 2008 mainly because the generator will not be implemented at the beginning of the year (See annex 3)
Description of measurement methods	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

and procedures to be applied:	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.
QA/QC procedures to be applied:	*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.
Any comment:	See also the explanation below regarding the connections and the priorities of the different mass flow meters.

Data / Parameter:	**ID 28 / $BG_{boiler3,y}$**
Data unit:	Nm^3/year
Description:	The flow of biogas consumed in boiler 3 in year "y"
Source of data to be used:	Monitoring system.
Value of data	0 Nm^3/year (for ex-ante calculations)
Description of measurement methods and procedures to be applied:	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.
QA/QC procedures to be applied:	*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.
Any comment:	See also the explanation below regarding the connections and the priorities of the different mass flow meters. Parameters 28 and 29 were one parameter ($BG_{i,y}$) in the original PDD.

Data / Parameter:	**ID 29 / $BG_{boiler4,y}$**
Data unit:	Nm^3/year
Description:	The flow of biogas consumed high pressure boiler 4 in year "y"
Source of data to be used:	Monitoring system.
Value of data	0 Nm^3/year (for ex-ante calculations)
Description of measurement methods and procedures to be applied:	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.
QA/QC procedures to be applied:	*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.
Any comment:	See also the explanation below regarding the connections and the priorities of the different mass flow meters. Parameters 28 and 29 were one parameter ($BG_{i,y}$) in the original PDD.

Data / Parameter:	**ID 30 / T_{flare}**
Data unit:	° Celsius
Description:	Temperature in the exhaust gas of the flare
Source of data to be used:	Monitoring system
Value of data	> 300[3] °C
Description of measurement methods and procedures to be applied:	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.
QA/QC procedures to be applied:	*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.
Any comment:	The flare is deemed to be operational when the temperature measured is higher than the above-mentioned temperature.

Data / Parameter:	**ID 31 / ECy**
Data unit:	GWh/year
Description:	Electricity consumption of the project activity in year "y"
Source of data to be used:	Electricity meter/s
Value of data	0.095 GWh/year (ex-ante value from BIOTEC technical feasibility study).
Description of measurement methods and procedures to be applied:	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.
QA/QC procedures to be applied:	*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.
Any 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 / EGy**
Data unit:	GWh/yr
Description:	Net electricity production by the project activity
Source of data to be used:	Monitoring system (ex-ante values from BIOTEC technical feasibility study)
Value of data	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
Description of measurement methods and procedures to be applied:	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.
QA/QC procedures to be applied:	*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

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

	technology provider.
Any comment:	The generation capacity to be installed as part of this project activity is 0.848 MW_e. This installed capacity may increase in the future in order to optimize the use of biogas (See ID 28).

Data / Parameter:	**ID 33**/ End use of final sludge
Data unit:	Use of sludge
Description:	end use of the final sludge in year "y"
Source of data to be used:	N/A
Value of data	Form of final sludge use applied
Description of measurement methods and procedures to be applied:	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.
QA/QC procedures to be applied:	N/A
Any comment:	The purpose of monitoring this variable is to assure that an appropriate aerobic management practice is given.

Data / Parameter:	**ID 34 / $HG_{measured,1,y}$**
Data unit:	TJ/yr
Description:	The directly measured total quantity of thermal energy supplied by steam boiler 1 during the year y
Source of data to be used:	N/A
Value of data	N/A
Description of measurement methods and procedures to be applied:	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.
QA/QC procedures to be applied:	*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.
Any comment:	

Data / Parameter:	**ID 35 / $HG_{measured,2,y}$**
Data 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 to be used:	N/A
Value of data	N/A
Description of measurement methods and procedures to be applied:	The enthalpy of the generated energy will be calculated using measurement of the temperature gain and the flow properties: $HG_{measured,2,y} = \Delta T_{t\ boiler,2} \cdot Flow \cdot Heat\ capacity$ The Heat capacity is taken from the data sheet of the heat carrier, the official information from the supplier.
QA/QC procedures to be applied:	*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.

Any comment:	

Data / Parameter:	**ID 36 / $HG_{measured,3,y}$**
Data unit:	TJ/yr
Description:	The directly measured total quantity of thermal energy supplied by steam boiler 3 during the year y
Source of data to be used:	N/A
Value of data	N/A
Description of measurement methods and procedures to be applied:	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.
QA/QC procedures to be applied:	*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.
Any comment:	

Data / Parameter:	**ID 37 / $HG_{measured,4,y}$**
Data 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 to be used:	N/A
Value of data	N/A
Description of measurement methods and procedures to be applied:	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.
QA/QC procedures to be applied:	*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.
Any comment:	

Data / Parameter:	**ID 38 / $FF_{boiler,1}$**
Data unit:	Gg/y
Description:	Bunker fuel consumption by boiler 1
Source of data to be used:	Volume flow meter
Value of data	N/A
Description of measurement methods and procedures to be applied:	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.
QA/QC procedures to be applied:	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.
Any comment:	

Data / Parameter:	**ID 39 / $FF_{boiler,2}$**
Data unit:	Gg/y
Description:	Bunker consumption by boiler 2
Source of data to be used:	Volume flow meter
Value of data	N/A
Description of measurement methods and procedures to be applied:	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.
QA/QC procedures to be applied:	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.
Any comment:	

Data / Parameter:	**ID 40 / $FF_{boiler,3}$**
Data unit:	Gg/y
Description:	Bunker consumption by boiler 3
Source of data to be used:	Volume flow meter
Value of data	N/A
Description of measurement methods and procedures to be applied:	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.
QA/QC procedures to be applied:	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.
Any comment:	

Data / Parameter:	**ID 41 / $FF_{boiler,4}$**
Data unit:	Gg/y
Description:	Bunker consumption by boiler 4
Source of data to be used:	Volume flow meter
Value of data	N/A
Description of	The volume of bunker used will be continuously monitored. The mass of the consumed

measurement methods and procedures to be applied:	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.
QA/QC procedures to be applied:	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.
Any comment:	

Data / Parameter:	**ID 42 / $\eta_{3,p}$**
Data unit:	-
Description:	The efficiency of boiler 3 using biogas.
Source of data to be used:	N/A
Value of data	N/A
Description of measurement methods and procedures to be applied:	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.
QA/QC procedures to be applied:	N/A
Any comment:	

Data / Parameter:	**ID 43 / $\eta_{4,p}$**
Data unit:	-
Description:	The efficiency of high-pressure boiler 4 using biogas.
Source of data to be used:	N/A
Value of data	N/A
Description of measurement methods and procedures to be applied:	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.
QA/QC procedures to be applied:	N/A
Any comment:	This parameter is fixed once for each new boiler and is not monitored afterwards.

Data / Parameter:	**ID 44 / $\rho_{fuel\ oil\ 6}$**
Data unit:	kg /m3
Description:	Density of fossil fuel no.6 (bunker)
Source of data used:	Maximum density of the different local providers used
Value applied:	N/A
Justification of the choice	At each monitoring period, Jaremar's fossil fuel suppliers will be asked to provide the

of data or description of measurement methods and procedures actually applied :	specifications of the bunker provided. The maximum density among the values provided will be chosen to ensure conservativeness.
Any comment:	

New fixed parameters:

Data / Parameter:	**ID 45 / $\eta_{3,b}$**
Data unit:	-
Description:	The efficiency of boiler 3 using bunker that would have been used in the absence of the project activity.
Source of data to be used:	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 of data	87.5%
Description of measurement methods and procedures to be applied:	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.
QA/QC procedures to be applied:	N/A
Any comment:	This parameter is fixed once for each new boiler and is not monitored afterwards.

Data / Parameter:	**ID 46 / $\eta_{4,b}$**
Data 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 to be used:	Paragraph 13: AMS- I.C (version 11)
Value of data	100%
Description of measurement methods and procedures to be applied:	‘ 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.
QA/QC procedures to be applied:	N/A
Any comment:	

Connections and priorities of the different mass flow meters
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.

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:

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

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 two boilers, the generator and the flare minus the amount of emission resulting from incomplete combustion at the flare as follows:

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

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 m^3 CH_4/m^3 BG.
D_{CH4}	The CH_4 density in tonnes CH_4/$m^3 CH_4$.

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 $CH_4/m^3 CH_4$.

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 $CH_4/m^3 CH_4$.
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 thesteam boiler boiler 3:

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

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:

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

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:

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

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.

Emission reduction for thermal energy generation:

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

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

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.7.2 Description of the monitoring plan:

>>

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

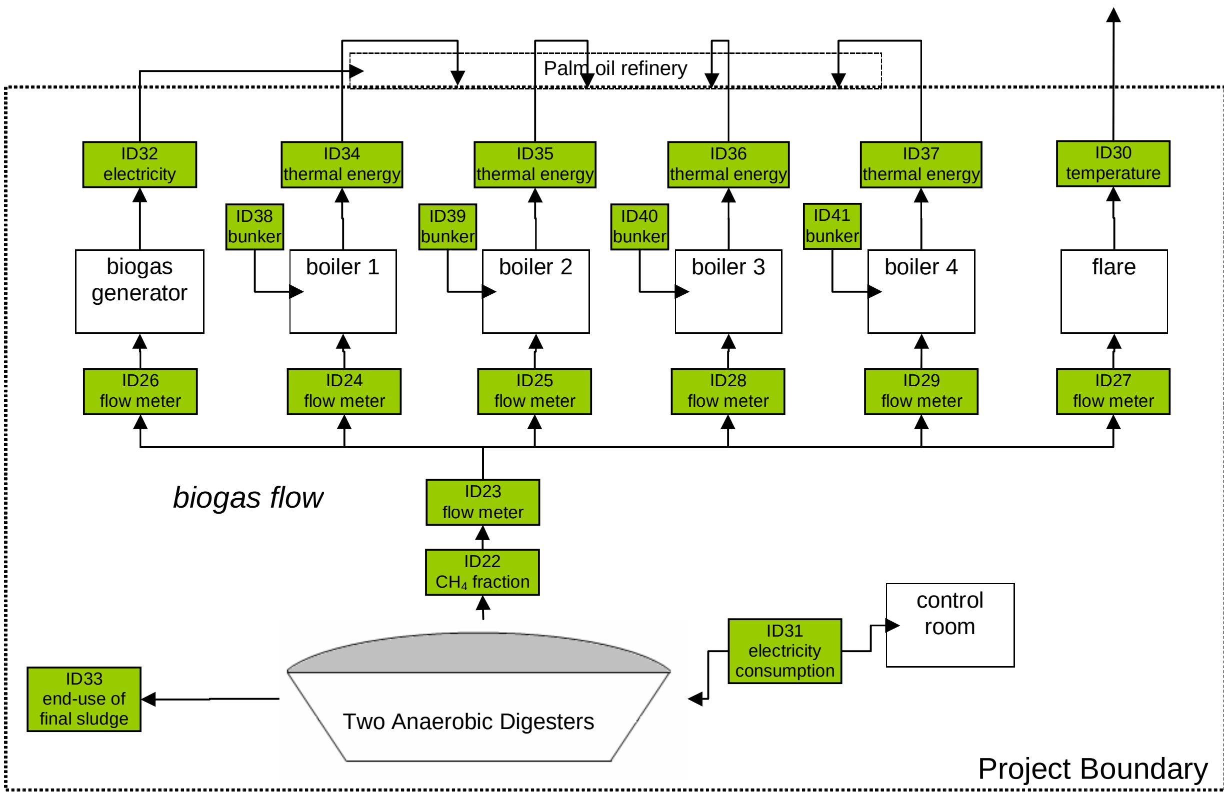

Figure 5: Monitoring plan of Energeticos Jaremar

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,	Biotec & Energeticos Jaremar

including all the variables for the monitoring plan, will be initially kept in a data management system directly connected to the PLC, called SCADA.	
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.

Annex 4

MONITORING INFORMATION

- - - - -