Monitoring report form for CDM project activity

(Version 06.0)

Complete this form in accordance with the instructions attached at the end of this form.

MONITORING REPORT

Title of the project activity	Switching of fuel from coal to palm oil mill biomass waste residues at Industrial de Oleaginosas Americanas S.A. (INOLASA)	
UNFCCC reference number of the project activity	1314	
Version number of the PDD applicable to this monitoring report	Version 10	
Version number of this monitoring report	1	
Completion date of this monitoring report	18/02/2019	
Monitoring period number	First monitoring period (second crediting period)	
Duration of this monitoring period	30/11/2014 – 30/11/2018	
Monitoring report number for this monitoring report	N/A	
Project participants	1. Industrial de Oleaginosas Americanas S.A. (INOLASA)	
Host Party	Costa Rica	
Sectoral scopes	Sectoral scope: 1: Energy industries (renewable - / non-renewable sources	
Applied methodologies and standardized baselines	Applied methodology: "*Thermal energy for the user with or without electricity*", AMS-I.C, version 20, 01 June, 2014	
Amount of GHG emission reductions or net anthropogenic GHG removals achieved by the project activity in this monitoring period	Amount achieved before 1 January 2013	Amount achieved from 1 January 2013
	0	136,745
Amount of GHG emission reductions or net anthropogenic GHG removals estimated ex ante for this monitoring period in the PDD	50,710 tCO_2 per year (average for the 2nd crediting period). 185,039 tCO_2 for the first 48 months corresponding to the 2nd crediting period (i.e. for the duration of this monitoring period).	

SECTION A. Description of project activity

A.1. General description of project activity

The proposed CDM project activity comprises the installation of a biomass fuelled boiler to supply steam for internal production processes, displacing a coal-fired boiler. Coal will be replaced by palm kernel shells (PKS), empty fruit bunches (EFB) and other type of renewable biomass available in the area, saving coal consumption and consequently reducing carbon emissions. The project is estimated to reduce a total of **354,969 tCO_2** during the second crediting period.

The proposed project activity is being developed at INOLASA (Industrial de Oleaginosas Americanas S.A). INOLASA is a company established in 1986 in Costa Rica, with the objective of supplying the country and the region of Central America with high quality soybean products. The company is located in the province of Puntarenas, the district of Barranca.

Table 1

Pre-project situation	Baseline situation	Project activity
Bunker-fuelled boilers	Coal-fuelled boilers	Biomass-fuelled boiler

The present project activity involves incineration of a wide range of renewable biomass fuels, including palm oil mill residues, bagasse and wood wastes that are nowadays abandoned or disposed with no management at all. Such is the case of PKS, which is seen nowadays as a residue not considered for the heat generation systems of the NUMAR's mills. INOLASA is relying on CDM in order to make the proposed project viable.

Biomass fuel will be mainly purchased from three nearby palm oil mills, called Palo Seco, Naranjo and Coto. The first two mills are located in Quepos and the last one in Golfito, in the province of Puntarenas. Furthermore, it will be also purchased from another palm oil mill called Rio Escondido, located in Nicaragua. The palm oil mills belong to "Grupo NUMAR", a group of several companies active in the plantation, extraction, processing and production of vegetable oil. Thanks to efficiency measures being taken in the three NUMAR's boilers, a greater availability of renewable resources will be generated. Since version 03 of this PDD, bagasse and wood chips are also contemplated. In said revision, availability of cane bagasse and wood chips was demonstrated by indicating a site-specific surplus for the sources providing former as well as a country-wide surplus existence of unused wood residues for the latter.

Regarding the biomass from the palm oil plants, it will be transported using trucks with a capacity of 25-28 tons each, making approximately 3 trips per day. Daily trips will be also done to obtain the bagasse and several trips per week to obtain wood chips. During the maintenance period of the biomass boiler, bunker will be combusted for two weeks in the current boilers in order to supply the required energy.

A.2. Location of project activity

Country: Costa Rica
Province: Puntarenas
District: Barranca.

Coordinates: 454.5-459 North; 217.5-217.9 East.
Latitude of Barranca is N 09, 59', 23.5'' and longitude is W 084, 42', 36.9''. The altitude is sea level.

The project activity is located in Puntarenas, the largest province of Costa Rica. Puntarenas is an area of 11,276 km^2 and has a population of 350,000 habitants. The central part of Puntarenas has a population of 100,000 habitants and is situated 130 km from San José, the capital of Costa Rica. The project activity is situated in district eight, Barranca, in the central part of Puntarenas.

Precise coordinates for the project are 454.5-459 North; 217.5-217.9 East. Latitude of Barranca is N 09, 59', 23.5'', and longitude is W 084, 42', 36.9''. Its altitude is sea level. It has an approximate population of 38, 199 habitants.

Figure 1 - Location map of INOLASA

A.3. Parties and project participants

Parties involved	Project participants	Indicate if the Party involved wishes to be considered as project participant (Yes/No)
Costa Rica (Host)	Industrial de Oleaginosas Americanas S.A. (INOLASA).	No

A.4. Reference to applied methodologies and standardized baselines

Type I – Renewable Energy Projects

Title of baseline methodology: "*Thermal energy for the user with or without electricity"*, Type I.C in Appendix B of the Simplified Modalities and Procedures for Small-Scale CDM project activities, version 20.0 (EB79, 01 June 2014)

Tools used:

- "*Project and leakage emissions from transportation of freight*" (version 01.1.0)
- "*Tool for the demonstration and assessment of additionality*[1]" (version 2)
- "*Methodological tool – Determining the baseline efficiency of thermal or electric energy generation systems" (Version 02.0)*
- "*Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation*" (version 03)

[1] Valid at the time of the original additionality analysis.

- "*Tool to calculate the emission factor for an electricity system*" (version 06.0)
- "*Leakage in biomass small-scale project activities*" (version 04.0)

UNFCCC CDM website:
http://cdm.unfccc.int/methodologies/DB/W3TINZ7KKWCK7L8WTXFQQOFQQH4SBK

A.5. Crediting period type and duration

Type: Renewable
Second crediting period
Duration: 30 Nov 14 - 29 Nov 21

SECTION B. Implementation of project activity

B.1. Description of implemented project activity

The project is fully implemented and operational as explained in the previous verification processes and the PDD. The boiler was installed and commissioned on April 15, 2007 and April 24, 2007 respectively. The CDM project activity was registered and started the first crediting period on 30 November 2007 until 29 November 2014. During the first crediting period the project was completely implemented and operational.

The boiler installed is a bi-drum water-tube boiler with membrane design wall and a rated capacity of 35,000 kg steam per hour. It has a designed pressure of 35.0 bars, but is currently used on 12.0 bars. The overall efficiency is given up to 80%. Table 2 shows more technical specifications of the biomass boiler. The next table shows the biomass boiler's design and technical specifications:

Table 2 – Technical Design Specification of Biomass Boiler

Technical Design Specification of Biomass Boiler	
Boiler Type	Fraser II Bi-Drum Watertube Boiler, Membrane wall design
Boiler Capacity	35,000 Kg/Hr
Boiler Model	FR 16/49
Boiler working pressure	12.0 bar resp. 31.0 bar
Design pressure	35.0 bar
Steam Temperature	192°C (Saturated) resp. 275°C (40° Superheated)
Feed water temperature	120°C +/- 5% (Economizer Water outlet temperature)
Air temperature at F.D Fan	220°C to 240°C (pre-heater air outlet temperature)
Actual steam evaporation	35,000 Kg/Hr.
Draught system	Balance Draught
Burning method	Reciprocating Step Grate; water cooled; hydraulically operated; grate material with high allow content.
Fuel to be used:	Approx: 51% PK shells, 28% EFB, 17% bagasse and 4% wood chips, depending on availability.
Dust Emissions	<=100 mg/ nm³
Overall efficiency on Gross Calorific Value of Fuel	Up to 80%[2]

The boiler is used for the generation of process steam for an onsite soybean refinery plant.

[2] During actual implementation, and considering that a different biomass mix (with a higher moisture rate) was ultimately used for this project, boiler efficiency has been less than this nominal value. In terms of additionality, this implies that the baseline alternative (i.e. coal fire boiler) would have been even more desirable than the project scenario.

Biomass residues from the palm oil are used as fuel; these biomasses are empty fruit bunches and palm kernel shells. Additionally, the boilers used other types of biomass as fuel, namely, sugar cane bagasse (obtained from available sugar cane mills) and wood wastes from nearby sawmills, that are nowadays abandoned or disposed with no management at all. Sawmills provide, free of charge, wood waste accumulated from their Teak and Melina processing lines to the three suppliers that furnish the wood chips used by Inolasa.

The biomass (PK Shells, empty fruit bunches, cane bagasse and wood chips) transportation equipment type is a 'Grate Cooled Hydraulic Operated Reciprocating Step'. A reciprocating grate is a continuous ash discharge grate used for firing the biomass fuel. The reciprocating grate consists of cast iron bars mounted on shafts. Alternate shafts are connected together and oscillated by hydraulic driven mechanism. There are fixed shafts at the sides of each oscillating shaft. The bars have slots to allow for combustion air at the bottom of the grate.

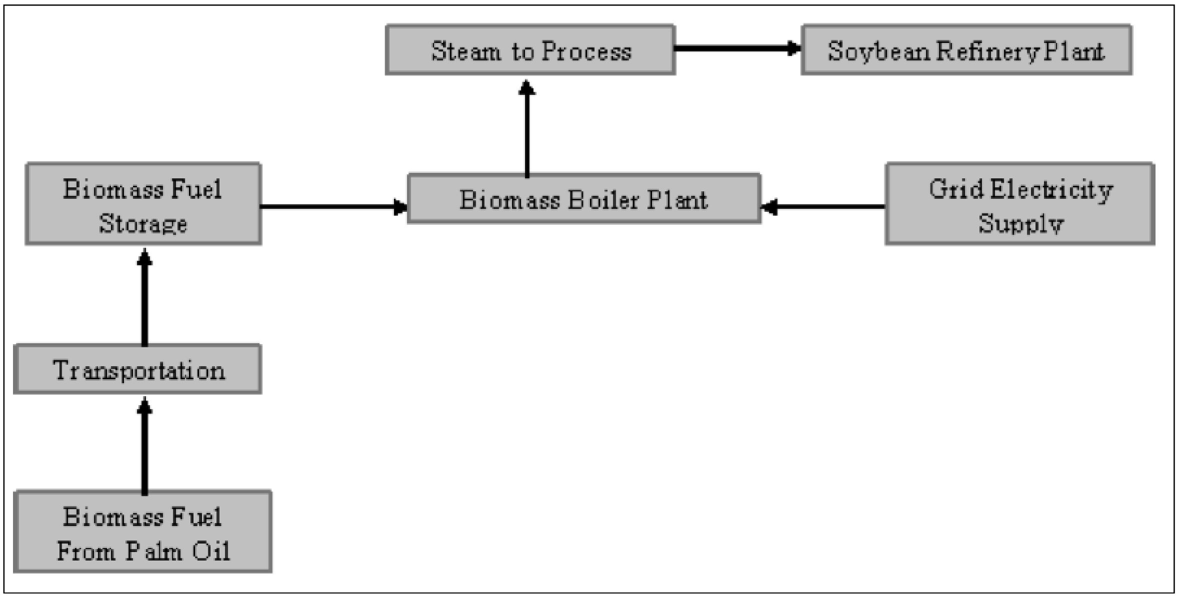
From its storage site, the biomass is transported by an elevator into a conveyor that is used to conduct the biomass unto the boiler's feed system.

The fuel is fed into the boiler by gravity at the front end of the grate. Due to the reciprocating action of the grate, the fuel moves towards the ash discharge end. The speed of the grate is set in such a way that the fuel is fully incinerated when it reaches the discharge end. This results in a continuous ash discharge.

The boiler's specifications comply with all the emission regulations of the country. There are bag filters in the boiler's chimney in order to keep dust emissions below 100 milligrams/nm^3. Compared to the baseline, no additional water consumption will take place during the project activity.

Figure 1 provides a process scheme.

Figure 2 - Process Scheme[3]



[3] Other types of biomass used are bagasse and wood chips (discussed below).

During this monitoring period the following events were recorded:

Table 3 – Event log

YEAR 2015	
Date or time frame	**Event**
06/12/14	Boiler stopped by electric power cut (10 hours)
31/12/14	The boiler stops for Christmas Celebration (10 hours)
01/01/2015 up the 04/01/2015	General plant shutdown by the star of the New Year (77,75 hours)
07/01/15	Boiler stopped due to communication problems in the Control Panels (10 hours)
09/01/15	Boiler stopped due to communication problems in the Control Panels (6,83 hours)
02/04/2015 up the 04/04/2015	Boiler stopped for holiday and electrical maintenance (59 hours)
22/05/2015 up the 31/05/2015	Boiler stopped for annual maintenance (217 hours)
01/06/2015 up the 03/06/2015	Boiler stopped for annual maintenance (67 hours)
04/10/2015 up the 08/10/2015	Boiler Stopped due to system modifications (86 hours)

YEAR 2016	
Date or time frame	**Event**
01/12/2015 up the 02/12/2015	Boiler stopped for equipment maintenance (19,16 hours)
27/01/2016 up the 28/01/2016	Boiler stopped for equipment repair (12 hours)
31/01/2016 up the 01/01/2016	Boiler stopped for equipment repair (10,33 hours)
01/02/16	Boiler stopped by repairing equipment and changing fan motors (15,67 hours)
14/02/2016 up the 18/02/2016	Boiler stopped by chimney sweep and maintenance of equipment (85,5 hours)
24/03/2016 up the 26/03/2016	Boiler stopped for a holiday enjoyment (64 hours)
22/5/2016 up the 25/5/2016	Boiler stopped for repairing the furnace and equipment (86 hours)
17/07/2016 up the 24/07/2016	Boiler stopped by chimney sweep (163 hours)
08/08/2016 up the 09/08/2016	Boiler stopped for maintenance on the induction fan (24 hours)
12/09/2016 up the 14/09/2016	Boiler stopped for repairing the oven grate (44 hours)
06/10/2016 up the 07/10/2016	Boiler stopped for maintenance on the induction fan and equipments (30,75 hours)
01/11/2016 up the 04/11/2016	Boiler stopped for equipment maintenance (74 hours)

YEAR 2017	
Date or time frame	**Event**
25/12/2016 up the 30/12/2016	Boiler stopped by chimney sweep and equipment maintenance (106 hours)
04/01/2017 up the 06/01/2017	Boiler stopped maintenance of filter sleeves (61,5 hours)
22/01/2017 up the 23/01/2017	Boiler stopped for repairing leaks in furnace pipes (16,5 hours)
01/02/2017	Boiler stopped for equipment maintenance (9,5 hours)
05/03/2017 up the 09/03/2017	Boiler stopped by chimney sweep (81,5 hours)
23/04/2017	Boiler stopped for maintenance on the induction fan (6 hours)
02/05/2017 up the 03/05/2017	Boiler stopped for repairing the furnace and equipment (30 hours)
04/06/2017 up the 14/06/2017	Boiler stopped for annual maintenance (242 hours)
18/06/2017 up the 19/06/2017	Boiler stopped for equipment repair (10,5 hours)
29/07/2017	Boiler stopped for electrical maintenance (8 hours)
30/07/2017 up the 01/08/2017	Boiler stopped for repairing the furnace and equipment (51,33 hours)
01/10/2017 up the 05/10/2017	Boiler stopped by chimney sweep and equipment maintenance (98,75 hours)
04/11/2017 up the 05/11/2017	Boiler stopped for repairing the furnace and equipment (27,25 hours)
20/11/2017 up the 22/11/2017	Boiler stopped by problems in the water pipes of the furnace (28,25 hours)

28/11/2017 up the 30/11/2017	Boiler stopped by problems in the furnace (39 hours)

YEAR 2018	
Date or time frame	**Event**
24/12/2017 up the 26/12/2017	The boiler stops for Christmas Celebration and equipment's maintenance (38 hours)
27/12/2017 up the 30/12/2017	Programmed stoppage / trial operation of new boiler
31/12/2017 up the 02/01/2018	General plant shutdown by the star of the New Year and electrical maintenance (56,5 hours)
10/01/2018 up the 17/01/2018	Boiler stopped maintenance of filter sleeves (165,5 hours)
17/02/2018	Boiler stopped due to change of bearings in the fan (8 hours)
05/03/2018 up the 10/03/2018	Boiler stopped by chimney sweep and equipment maintenance (96 hours)
15/03/2018 up the 22/03/2018	Programmed stoppage / trial operation of new boiler
29/03/2018 up the 31/03/2018	Boiler stopped for a holiday enjoyment and electrical maintenance (65 hours)
09/04/2018 up the 12/04/2018	Programmed stoppage / trial operation of new boiler
16/04/2018 up the 22/04/2018	Programmed stoppage / trial operation of new boiler
13/06/2018 up the 22/06/2018	Programmed stoppage / trial operation of new boiler
05/07/2018 up the 06/07/2018	Boiler stopped for equipment repair (20,25 hours)
17/07/2018 up the 12/08/2018	Programmed stoppage / trial operation of new boiler
31/08/2018 up the 01/09/2018	Boiler stopped for equipment repair (16,41 hours)
05/09/2018 up the 22/09/2018	Programmed stoppage / trial operation of new boiler
23/09/2018 up the 30/09/2018	Operating the two boilers
01/10/2018 up the 19/10/2018	Programmed stoppage / trial operation of new boiler
25/10/2018 up the 30/11/2018	Programmed stoppage / trial operation of new boiler

The cleaning of the biomass boiler is programmed for each one and a half months and is based on an agreement between the Costa Rican Ministry of Health and INOLASA. This maintenance, involving cleaning equipment and the boiler, it normally takes around a week.

There were no incidences or situations during the Monitoring Period, which may impact the applicability of the methodology.

B.2. Post-registration changes

B.2.1. Temporary deviations from the registered monitoring plan, applied methodologies or standardized baselines

There are no temporary deviations from the registered monitoring plan or applied methodology during this monitoring period.

B.2.2. Corrections

There are no corrections in this monitoring period.

B.2.3. Changes to the start date of the crediting period

No changes to the start date of the crediting period

B.2.4. Inclusion of monitoring plan

Not applicable

B.2.5. Permanent changes to the registered monitoring plan, or permanent deviation of monitoring from the applied methodologies, standardized baselines, or other applied standards or tools

No changes were made during this monitoring period

B.2.6. Changes to project design

(a) Changes that have been approved by the Board as applicable from the period prior to this monitoring period:

a.1 – The monitoring plan was revised and approved on 21/05/2011. During the 4th verification if was concluded that no co-incineration using coal would be possible in the future and that consequently bunker fuel would be used permanently during periods with low availability of biomass or it the equipment is out of maintenance.

a.2 - The PDD version 3 (completion date 29/11/2013) was revised and approved on 24/04/2014.

(b) No changes to the project design of the project activity has been approved or submitted with this monitoring report.

(c) No changes have been submitted with this monitoring report.

SECTION C. Description of monitoring system

The main elements of this monitoring plan can be summarized as follows[4]:

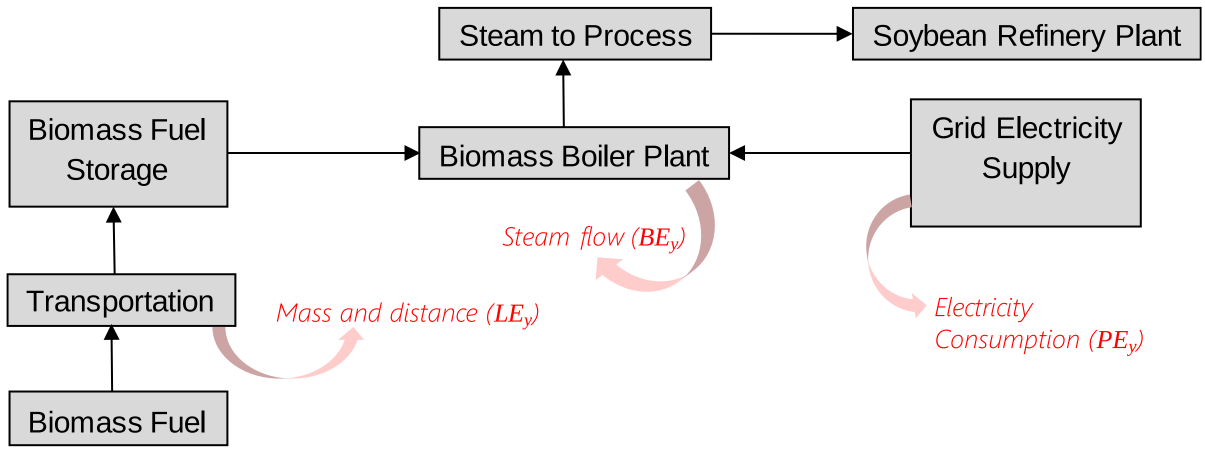
Element / requirement	BE/PE/LE	Summary of monitoring procedures
The baseline emissions from thermal energy displaced by the project activity during the year y ($BE_{thermal,CO2,y}$)	BE	Net quantity of thermal energy is calculated from the steam flow ($F_{ss,y}$) measured at the mass flow transmitter, multiplied by the change in enthalpy between the feed water and the saturated steam (equation (3)).
CO_2 emissions from electricity consumption ($PE_{EC,y}$)	PE	Electricity consumption of the biomass boiler is metered and converted into tCO_2 by means of the grid's emission factor. The result is adjusted to account for transmission/distribution losses (equation (5)).
CO_2 emissions from the transportation of biomass residues to the project site,	LE	Distance and mass transported of every shipment is recorded. A

[4] Detailed equations are provided in Section E of this monitoring report.

whenever the former are transported over a distance of 200 km or more ($LE_{TR,y}$).	default transport emission factor is used to obtain the corresponding emissions (equation (6)).

Operation of the project as well as its main monitoring points are summarized in the following scheme:

Figure 3 – Operation and monitoring scheme



Other elements in the monitoring plan include:

Roles and responsibilities:

The Project owner is Industrial de Oleaginosas Americanas S.A. (INOLASA). INOLASA is therefore responsible for the operation and the monitoring of the project activities. INOLASA has appointed one person to be responsible for monitoring, Mr. Danilo Castrillo. The operational staff, the Superintendent of Production and the Superintendent of Maintenance, report to him.

Data collection and procedures:

The Superintendent of Production collects data on a daily basis and transfers these data to weekly and final monthly reports, which are submitted to the responsible for monitoring. The Superintendent of Maintenance saves the steam flow data digitally, which he regularly crosschecks with the manual data. In addition, crosschecks of the final reports against the daily data are performed for quality assurance.

Emission reduction calculation:

The CDM spreadsheet is prepared from the original data. It comprises monthly summary sheets that contain the daily data for easy control and comparison of these against other sources. The data sheets are compiled by the person responsible for monitoring and signed by the plant manager.

Trainings:

During the crediting period internal trainings are performed. If trainings are performed during this monitoring period, receipts of these internal trainings will be available on-site.

Involvement of Third Parties:

The company Geo Ingeniería Ingenieros Consultores S.A provided support and consultancy regarding the CDM obligations. During operation, the technology provider PETRA supports the technical team of INOLASA, if necessary.

Documentation from the authorised boiler inspector during his yearly on-site visit will be available during the on-site visit.

A third-party check of the electricity meter has been performed and the documentation will be available to the DOE.

Troubleshooting procedures:

In case of unforeseen problems or failures of the data recording system, the operating staff will switch to manual readings of all meters. This procedure is well defined and trained by the staff, since manual readings as back-up for the computerised data readings have been a part of the normal operation since the starting period of this project. Furthermore, a logbook will be maintained, recording all deviations from normal operation, including observations and all other information necessary to document. In this way, jumps or periods where operating conditions are out of range can be identified and explained.

SECTION D. Data and parameters

D.1. Data and parameters fixed ex ante

Data/Parameter	$\eta_{BL,thermal}$
Unit	%
Description	Efficiency of the baseline (coal based) boiler.
Source of data	Quotation from boiler manufacturer.
Value(s) applied	78%
Choice of data or measurement methods and procedures	This is consistent with option (d) in page six of the "*Methodological tool – Determining the baseline efficiency of thermal or electric energy generation systems"* (version 02.0).
Purpose of data/parameter	Calculation of $BE_{thermal,y}$
Additional comments	-

Data/Parameter	$EF_{FF,CO2}$
Unit	tCO_2/TJ
Description	CO_2 emission factor of the fossil fuel that would have been used in the baseline plant.
Source of data	2006 IPCC Guidelines for National GHG Inventories. Vol 2 (Energy), table 1.4
Value(s) applied	77.4 tCO_2/TJ (corresponding to pre-project scenario fuel, which is residual fuel oil – see comments below).
Choice of data or measurement methods and procedures	As allowed by the methodology.
Purpose of data/parameter	Calculation of $BE_{thermal,y}$
Additional comments	Although coal is the baseline fuel, the methodology requires use of the pre-project fuel's emission factor (in this case, bunker) if the latter is more conservative than the former.

Data/Parameter	$EF_{EL,j,y}$
Unit	tCO_2/MWh
Description	Emission factor for electricity generation for source *j* in year *y* (tCO_2/MWh)
Source of data	Calculated according to the "*Tool to calculate the emission factor for an electricity system*" (version 05) using official information from the Costa Rican grid.
Value(s) applied	0.2288 tCO_2/MWh
Choice of data or measurement methods and procedures	Details provided in Appendix 4 of the PDD.
Purpose of data/parameter	Calculation of $PE_{EC,y}$
Additional comments	-

Data/Parameter	$EF_{CO2,f}$
Unit	gCO_2/t km
Description	Default CO2 emission factor for freight transportation activity *f*
Source of data	Project and leakage emissions from transportation of freight
Value(s) applied	Light vehicles: 245 gCO_2/t km Heavy vehicles: 129 gCO_2/t km
Choice of data or measurement methods and procedures	Default values as provided by the tool "*Project and leakage emissions from transportation of freight*".
Purpose of data/parameter	Calculation of $LE_{TR,y}$
Additional comments	Light vehicles are vehicles with a Gross Vehicle Mass (GVM[5]) equal or less to 26 tonnes; otherwise the vehicle is considered "Heavy".

Data/Parameter	$TDL_{j,y}$
Unit	-
Description	Average technical transmission and distribution losses for providing electricity to source *j* in year *y*
Source of data	CEPAL, Estadísticas del subsector Eléctrico 2012[6] (Central American Statistics for the electric sector compiled by UN's ECLAC)
Value(s) applied	11.6%
Choice of data or measurement methods and procedures	Default value as provided by the tool for project consumption sources
Purpose of data/parameter	Calculation of $PE_{EC,y}$
Additional comments	-

D.2. Data and parameters monitored

Data/Parameter	$EG_{thermal,y}$
Unit	TJ/period
Description	Net quantity of thermal energy supplied by the project activity during the period *y*

[5] Maximum on-road mass of the fully-loaded vehicle, consisting of its tare mass (i.e. vehicle mass) and the mass of the load (i.e. the freight).

[6] http://repositorio.cepal.org/bitstream/handle/11362/26293/1/M20130047_es.pdf (Spanish version available only)

Measured/calculated/ default	Calculated from measured data
Source of data	Calculated using equation (3) and data from the mass flow transmitter that determines steam flow ($F_{ss,y}$) and relevant temperatures / pressures of water feed and saturated steam
Value(s) of monitored parameter	1,506 TJ for the entire period
Monitoring equipment	Type: Mass Flow Transmitter Make/Model: Rosemount 3095M Accuracy class: +/-1% Serial number: 0217271 Calibration frequency: 10 years stability of +/- 0.25% according to manufacturer. The monitoring equipment was calibrated on: 26/09/2012, with validity at least until 25/09/2022. Location: The flow meter is installed in the steam output flow of the biomass boiler.
Measuring/reading/recording frequency	Continuous measurement, daily reading and monthly recording
Calculation method (if applicable)	Equation (3) in the PDD
QA/QC procedures	The meters automatically present values in mass units (i.e. the equipment internally accounts for temperature and pressure of the gas). Flow meter will be subject to a regular maintenance and testing regime to ensure accuracy.
Purpose of data/parameter	BE_y
Additional comments	In general lines, and as discussed in the original validation report[7] the general steam consumption to fulfil soy production requirements at the facility is 525 kg of saturated steam at 10 bars of pressure per each ton of soy produced. The boiler must operate always at the same pressure because the steam consuming equipment operates at a design pressure. Since the boiler is located at a distance from the plant, the operating pressure needs to be slightly higher at around 12.7 bar in order to always guarantee the supply steam at 10 bar at the plant site. The feed water temperature and pressure are the ones corresponding to the make-up / economizer, which is at 90°C and operating at atmospheric pressure. The corresponding enthalpy values are the following: Enthalpy / Value / Unit / Source Saturated steam (h_g) / 2,785.71 / kJ/kg / Saturated steam table Feed water (h_f) / 377 / kJ/kg / Steam table

Data/Parameter	$EC_{PJ,j,y}$
Unit	MWh per period
Description	Quantity of electricity consumed by the project electricity consumption source j in period y

[7] Validation report for the first crediting period, page 39.

Measured/calculated/ default	Measured
Source of data	On-site metering system
Value(s) of monitored parameter	9,465.34 MWh for the entire period
Monitoring equipment	Type: Electricity meter Make/Model: Schneider Electric CM3250 Accuracy class: IEC 687 0.5 class Serial number: 15000219 Calibration frequency: 15 years stability according to manufacturer. Date of last calibration: November 2007 Validity: At least until November 2022 Location: The electricity meter is installed in an electric substation located at the biomass boiler.
Measuring/reading/recording frequency	Measured continuously, reading daily, recorded monthly
Calculation method (if applicable)	Not applicable
QA/QC procedures	The electricity meter will be recalibrated periodically by the supplying firm
Purpose of data/parameter	PE_y
Additional comments	-

Data/Parameter	FR_y
Unit	t
Description	Total mass of freight transported to deliver biomass to the plant in period y
Measured/calculated/ default	Measured
Source of data	Transport log book
Value(s) of monitored parameter	Summary of transported biomass: (see table below)

Biomass	Transported weight (kg.)
Palm kernel shells (PKS)	105,103,790
Empty fruit bunches (EFB)	11,826,860
Wood chips	15,946,200
Cane bagasse	40,197,816
Palm kernel meal (PKM)	1,367,700
Total	174,442,366

Monitoring equipment	Type: Scale Make/Model: Rice Like 920i Accuracy class: 10 kg (smallest scale division) Serial number: 1648600087 Capacity: 60T Calibration reach: 20T Calibration frequency: Monthly Type: Scale Make/Model: Rice Like 920i Accuracy class: 10 kg (smallest scale division) Serial number: 1670300119 Capacity: 60T Calibration reach: 20T Calibration frequency: Monthly Type: Scale Make/Model: Rice Like 920i Accuracy class: 10 kg (smallest scale division) Serial number: 1767300049 Capacity: 60T Calibration reach: 20T Calibration frequency: Monthly
Measuring/reading/recording frequency	Every time a new shipment arrives
Calculation method (if applicable)	n.a.
QA/QC procedures	Values can be crosschecked with the corresponding invoices from the transportation service
Purpose of data/parameter	LE_y
Additional comments	-

Data/Parameter	$D_{f,y}$
Unit	km
Description	Round trip distance between the origin and destination of freight type f in monitoring period y
Measured/calculated/ default	Measured
Source of data	Contracted transport company
Value(s) of monitored parameter	Distances available in the ER spreadsheet
Monitoring equipment	Distance was determined by the readings of the mileage counter of a representative truck.
Measuring/reading/recording frequency	Once per each trajectory
Calculation method (if applicable)	n.a.
QA/QC procedures	Data can be double checked using invoices from transportation service provider and/or by measuring the distance on a 1:50,000 map
Purpose of data/parameter	LE_y
Additional comments	-

Data/Parameter	$B_{Biomass,y}$
Unit	Mass or volume for each biomass type

Description	Net quantity of biomass consumed in year y
Measured/calculated/ default	Measured
Source of data	See details for the parameter FR_y above
Value(s) of monitored parameter	Summary of consumed biomass: Biomass — Consumption (kg.) Palm kernel shells (PKS) — 105,756,750 Empty fruit bunches (EFB) — 11,841,894 Wood chips — 15,833,470 Cane bagasse — 40,197,816 Palm kernel meal (PKM) — 1,336,030 Total — 174,965,960
Monitoring equipment	See details for the parameter FR_y above
Measuring/reading/recording frequency	Upon arrival of each batch
Calculation method (if applicable)	n.a.
QA/QC procedures	Data can be double checked using invoices from transportation service provider
Purpose of data/parameter	This parameter is required for equation (14) in the applied methodology; however, said equation is not used for the purpose of this project's baseline emissions reductions calculation, which are instead based on actual energy measurements (equation (3)). The parameter is nonetheless monitored to evaluate the overall consistency of the energy measurements.
Additional comments	According to the energy balance, the boiler efficiency that matches the theoretical biomass energy with the measured thermal energy is 66%, which is less than the efficiency foreseen in the PDD (up to 80% for the biomass boiler[8]) for given calorific values and humidity contents. This reduced efficiency partly explains the reduction in claimed ERs.

Data/Parameter	**-**
Unit	%
Description	Moisture content of the biomass (wet basis)
Measured/calculated/ default	For each type of biomass, a specific value will be used; this can either be an ex-ante estimate, a value provided by the supplier or a value determined based on on-site measurements
Source of data	Plant records
Value(s) of monitored parameter	Values used: Biomass — Humidity % — Source Palm kernel shells (PKS) — 17% — PDD Empty fruit bunches (EFB) — 50% — PDD Wood chips — 25% — PDD Cane bagasse — 52% — PDD Palm kernel meal (PKM) — 9% — Supplier

[8] 70% was assumed in the ex-ante ER calculation in the PDD (see ex-ante ER calculation in the spreadsheet accompanying the PDD)

Monitoring equipment	-
Measuring/reading/recording frequency	-
Calculation method (if applicable)	-
QA/QC procedures	-
Purpose of data/parameter	Kindly note that the requirement stated on the methodology (monitoring frequency row for this parameter), which states that "*The moisture content of biomass of homogeneous quality shall be monitored for each batch of biomass*", applies only to the cases "where emission reductions are calculated based on biomass energy input" (AMS-I.C. ver. 20 p. 29, row "Measurement procedures (if any)" on the biomass moisture content box). These values are nonetheless used here to evaluate the overall consistency of the energy measurements.
Additional comments	-

D.3. Implementation of sampling plan

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No sampling was required in this monitoring plan.

SECTION E. Calculation of emission reductions or net anthropogenic removals

Emission reductions are calculated as follows:

(1) $$ER_y = BE_y - PE_y - LE_y$$

Where:

ER_y	Emission reductions in year *y* (tCO_2e)
BE_y	Baseline emissions in year *y* (tCO_2e)
PE_y	Project emissions in year *y* (tCO_2)
LE_y	Leakage emissions in year *y* (tCO_2)

E.1. Calculation of baseline emissions or baseline net removals

The emission reductions are realized by avoidance of emissions from the combustion of coal for the generation of steam for the internal production processes; this is the only source of GHG reductions claimed by the project (and thus $BE_y = BE_{thermal,CO2,y}$).

Paragraph 33 on AMS-I.C version 20 establishes that baseline emissions from heat production are to be estimated as:

(2) $$BE_{thermal,CO2,y} = (EG_{thermal,y}/\eta_{BL,thermal}) \cdot EF_{FF,CO2}$$

Where:

$BE_{thermal,CO_2,y}$	The baseline emissions from thermal energy displaced by the project activity during the year *y* (tCO_2)
$EG_{thermal,y}$	The net quantity of thermal energy supplied by the project activity during the year *y* (TJ). *Calculated based on the difference in enthalpy and the amount of steam supplied (see below)*

EF_{FF,CO_2}	The CO_2 emission factor of the fossil fuel that would have been used in the baseline plant obtained from reliable local or national data if available, alternatively, IPCC default emission factors can be used (tCO_2/TJ). *Although coal is the baseline fuel, the methodology requires use of the pre-project fuel's emission factor (in this case, bunker) if the latter is more conservative than the former (discussed below).*
$\eta_{BL,thermal}$	The efficiency of the plant using fossil fuel that would have been used in the absence of the project activity. *Manufacturer value is used as discussed below.*

According to page 27 of the methodology, the net amount of heat ($EG_{thermal,y}$) is determined using the difference in enthalpy, i.e. the difference in the enthalpy between the liquid entering and the steam leaving the boiler. As discussed during the validation of the project[9], the boiler has to operate at a constant, 12.7 bar pressure. Therefore, this parameter is given by:

(3) $$EG_{thermal,y} = F_{ss,y} \cdot (h_g - h_f)$$

Where:

$F_{ss,y}$	Steam flow from the biomass boiler in the period *y* (t/period)
h_g	Enthalpy of the saturated steam leaving boiler (in TJ/t)
h_f	Enthalpy of the liquid entering boiler (in TJ/t)

As the baseline for this project was determined to be the use of a coal-fired boiler[10], the efficiency provided by the manufacturer of the coal boiler was considered for the parameter $\eta_{BL,thermal}$. Regarding the remaining parameter, $EF_{FF,CO2}$, the methodology (p.9) states that "*For project activities implemented in existing facilities where the additionality is demonstrated based on a baseline scenario that is not the continuation of the current practice (e.g. continued use of the fossil fuel that was used prior to the implementation of the project activity), the baseline emission factor is chosen as lower of the two: (a) the emission factor of the fossil fuel that would have been used in the identified baseline scenario; and (b) the emission factor of the fossil fuel that was used prior to the implementation of the project activity*". Thus, the emission factors for coal (baseline) and bunker (pre-project) are compared: the emission factor for coal implicit in the original PDD[11] is 92.50 tCO_2/TJ, whereas the default IPCC emission factor[12] for residual fuel oil is 77.40 tCO_2/TJ; thus, the latter will be used.

A summary of the calculations is provided below; detailed calculations are available in the corresponding spreadsheet.

Table 4 - Parameters involved in the calculation of baseline emissions

Parameter	Value	Unit	Source
Pressure of the feed water:	1.01325	bar	book log
Temperature of feed water:	90	^{o} C	book log
Pressure of the saturated steam:	12.7	bar	book log
Enthalpy saturated steam (h_g):	2785.71	kJ/kg	Saturated steam table

[9] Validation Report, page 39.

[10] This was not the same as the pre-project scenario, consisting of a bunker-fired boiler.

[11] Resulting from the reported net calorific value of 25.73 TJ/kt and the emission factor of 2380 tCO_2/kt.

[12] IPCC 2006, Vol. 2, Chapter 1, Table 1.4.

Enthalpy feed water (h_f):		377	kJ/kg	Steam table
h_g - h_f	=	2,409	kJ/kg	Calculated
$\eta_{BL,thermal}$	=	0.78		PDD
$EF_{FF,CO2}$	=	77.4	tCO_2/TJ	PDD

Table 5 - Summary of BE calculations

Year[13]	Steam output ($F_{ss,y}$) in MT	$EG_{thermal,y}$ in TJ (eq. (3))	$BE_{thermal,CO2,y}$ in tCO_2 (eq. (2))
2014	15,872	38	3,794
2015	181,916	438	43,481
2016	185,457	447	44,328
2017	155,076	374	37,066
2018	86,797	209	20,746
Total	625,118	1,506	149,415

E.2. Calculation of project emissions or actual net removals

As per the PDD, project emissions are given by:

(4) $$PE_y = PE_{FF,j,y} + PE_{EC,y} = PE_{EC,y}$$

Where:

PE_y	Project emissions from the project activity during the year y (tCO_2/period)
$PE_{EC,y}$	Project emissions from electricity consumption in period y (tCO_2/period)

Emissions from electricity consumption, calculated as per the "*Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation*" (p. 5) are given by:

(5) $$PE_{EC,y} = \sum_j EC_{PJ,j,y}.EF_{EL,j,y} \cdot (1 + TDL_{j,y})$$

Where:

$PE_{EC,y}$	Project emissions from electricity consumption in year y (tCO_2/yr);
$EC_{PJ,j,y}$	Quantity of electricity consumed by the project electricity consumption source j in period y (MWh/yr)[14];

[13] 2014 includes December only; 2018 includes the period comprised between January and November (both months entirely included).

[14] The only process in this case is the operation of the biomass boiler.

$EF_{EL,j,y}$	Emission factor for electricity generation for source j in year y (tCO_2/MWh)[15]
$TDL_{j,y}$	Average technical transmission and distribution losses for providing electricity to source j in year y

Again, only a summary of the calculations is provided below; detailed calculations are available in the corresponding spreadsheet:

Table 6 - Parameters involved in the calculation of baseline emissions

Parameter	Value	Unit	Source
EF_{ELy}	0.2288	tCO_2/MWh	PDD
TDL_y	11.60%		PDD

Table 7 - Summary of PE calculations

Year[16]	EC_y in MWh	$PE_{EC,y}$ in tCO_2 (eq. (5))
2014	214	55
2015	2,606	665
2016	2,590	661
2017	2,314	591
2018	1,742	445
Total	9,465	2,417

E.3. Calculation of leakage emissions

Emissions from transportation of biomass from sources further than 200 km are calculated in accordance to Option B (default values) of the tool "*Project and leakage emissions from transportation of freight*" (version 01.1.0):

(6)

$$LE_y = LE_{TR,y} = \sum_f D_{f,y} \cdot FR_{f,y} \cdot EF_{CO2,f} \cdot 10^{-6}, \text{ when } D_{f,y} > 200 \text{ km;}$$

or:

$$LE_y = 0, \text{ when } D_{f,y} \leq 200 \text{ km}$$

Where:

$LE_{TR,y}$	Leakage emissions from transportation of freight monitoring period y (tCO_2);
$D_{f,y}$	Round trip distance between the origin and destination of freight transportation activity f in monitoring period y (km);

[15] Calculated according to the "Tool to calculate the emission factor for an electricity system"; details provided in the PDD's Annex.

[16] 2014 includes December only; 2018 includes the period comprised between January and November (both months entirely included).

$FR_{f,y}$	Total mass of freight transported in freight transportation activity f in monitoring period y (t)
$EF_{CO2,f}$	Default CO_2 emission factor for freight transportation activity f (gCO2/t km); *default values provided by the tool*
f	Each of the freight transportation activities conducted in the project activity and involving distances larger than 200 km in monitoring period y

The calculations are summarized as follows:

Table 8 - Parameters involved in the calculation of leakage emissions

Parameter	Value	Unit	Source
$EF_{CO2,f}$	129	gCO_2/t km	PDD

Table 9 - Summary of LE calculations[17]

Year	$LE_{TR,y}$ in tCO_2 (eq. (6))
2014	228
2015	2,525
2016	2,412
2017	2,400
2018	2,689
Total	10,253

E.4. Calculation of emission reductions or net anthropogenic removals

	Baseline GHG emissions or baseline net GHG removals (t CO_2e)	Project GHG emissions or actual net GHG removals (t CO_2e)	Leakage GHG emissions (t CO_2e)	GHG emission reductions or net anthropogenic GHG removals (t CO_2e)		
				Before 01/01/2013	From 01/01/2013	Total amount
Total	149,415	2,417	10,253		136,745	136,745

E.5. Comparison of emission reductions or net anthropogenic removals achieved with estimates in the registered PDD

Amount achieved during this monitoring period (t CO_2e)	Amount estimated ex ante (t CO_2e)
136,745	185,039

[17] Distance ($D_{f,y}$) and freight ($FR_{f,y}$) details are provided in the accompanying spreadsheet.

E.6. Remarks on increase in achieved emission reductions

This monitoring periods comprises four years, from December 2014 to November 2018 (=48 months). The first four years of this crediting period should have accrued a total of 185,039 tCO_2 in emission reductions as per the registered PDD; thus, there was no increase in the amount achieved over the ex-ante forecast.

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Document information

Version	*Date*	*Description*
06.0	7 June 2017	Revision to: • Ensure consistency with version 01.0 of the "CDM project standard for project activities" (CDM-EB93-A04-STAN); • Make editorial improvements.
05.1	4 May 2015	Editorial revision to correct version numbering.
05.0	1 April 2015	Revisions to: • Include provisions related to delayed submission of a monitoring plan; • Provisions related to the Host Party; • Remove reference to programme of activities; • Overall editorial improvement.
04.0	25 June 2014	Revisions to: • Include the Attachment: Instructions for filling out the monitoring report form (these instructions supersede the "Guideline: Completing the monitoring report form" (Version 04.0)); • Include provisions related to standardized baselines; • Add contact information on a responsible person(s)/ entity(ies) for completing the CDM-MR-FORM in A.6 and Appendix 1; • Change the reference number from *F-CDM-MR* to *CDM-MR-FORM*; • Editorial improvement.
03.2	5 November 2013	Editorial revision to correct table in page 1.
03.1	2 January 2013	Editorial revision to correct table in section E.5.
03.0	3 December 2012	Revision required to introduce a provision on reporting actual emission reductions or net GHG removals by sinks for the period up to 31 December 2012 and the period from 1 January 2013 onwards (EB 70, Annex 11).
02.0	13 March 2012	Revision required to ensure consistency with the "Guidelines for completing the monitoring report form" (EB 66, Annex 20).
01.0	28 May 2010	EB 54, Annex 34. Initial adoption.

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