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

PROJECT DESIGN DOCUMENT (PDD)

Title of the project activity	Vinasse Anaerobic Treatment Project - Compañía Licorera de Nicaragua, S. A. (CLNSA)
Version number of the PDD	7
Completion date of the PDD	31/01/2014
Project participant(s)	- Compañía Licorera de Nicaragua, S. A. (CLNSA) - Corporación Andina de Fomento (CAF) * (acting as intermediary for the benefit of the State of the Netherlands for the purchase of Emission Reductions)
Host Party(ies)	Nicaragua
Sectoral scope and selected methodology(ies)	Sectoral scopes: - 13: Waste handling and disposal Methodology: - AM0013 Version 03 - “Avoided methane emissions from organic waste-water treatment”
Estimated amount of annual average GHG emission reductions	116,524 tCO_2/yr

SECTION A. Description of project activity

A.1. Purpose and general description of project activity

>>

The purpose of the project is to treat the wastewater generated in the production of alcohol (vinasse) and to use the organic matter removed from the wastewater to produce clean, renewable energy. It consists of a wastewater treatment facility as well as a co-generating facility, and it involves the design, construction, installation, start-up and operation of the wastewater treatment and co-generating facility.

The project consists of two biodigesters for the anaerobic treatment of the wastewater generated in the production of alcohol from sugar molasses. The methane generated from the anaerobic treatment of the vinasse will be captured and combusted to produce energy. This energy will substitute the consumption of fuel oil and electricity used in the alcohol production process (in the storing of molasses, the fermentation process, the distillation process and bottling). The project will substantially reduce CLNSA´s use of fuel oil and grid-supplied electricity. It is not projected at this point that electricity will be generated to allow export to the grid. The mitigation potential of the project arises from: i) the capture of methane, which would be released otherwise from the current settlement lagoon used throughout the year, and ii) from the displacement of fuel oil and grid-fed electricity by combusting the recovered methane to produce energy. The project will be implemented in four Stages. In Stages 1, 2 and 3 the project will substantially reduce the volume of wastewater sent directly to the lagoon without treatment. It is expected that by stage 4 most of, if not all, of the process' wastewater will be treated in the biodigestors prior to sending it to the lagoon. The existing lagoon has an average depth of one and a half (1.5) meters and measures two hundred and fifty (250) meters long by one hundred and forty (140) meters wide.

Figure 1: **Facultative lagoon at actual conditions July 2006, without wastewater**

The following diagrams show the project configurations at each stage including the baseline scenario.

Figure 2: Project Baseline

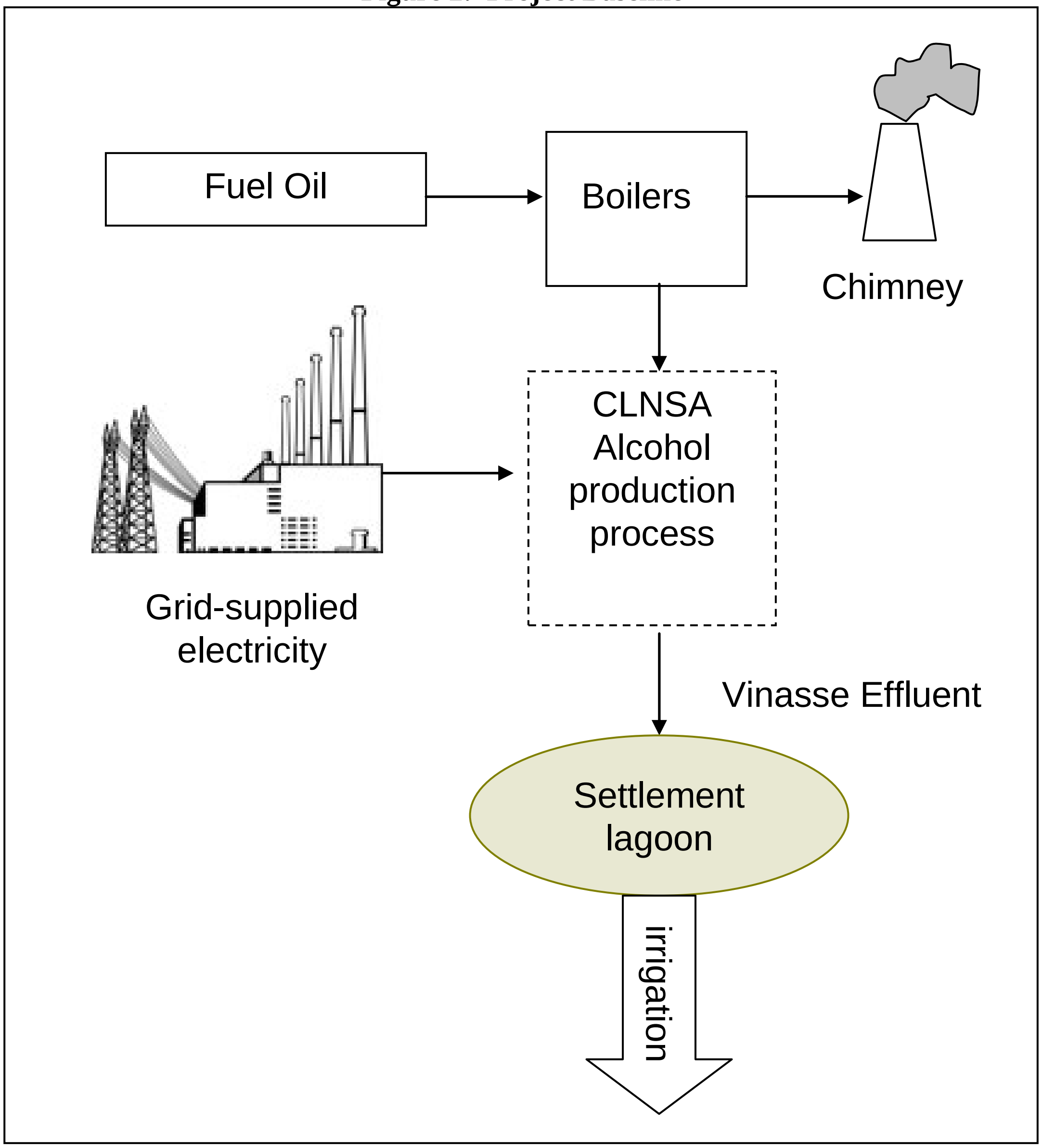
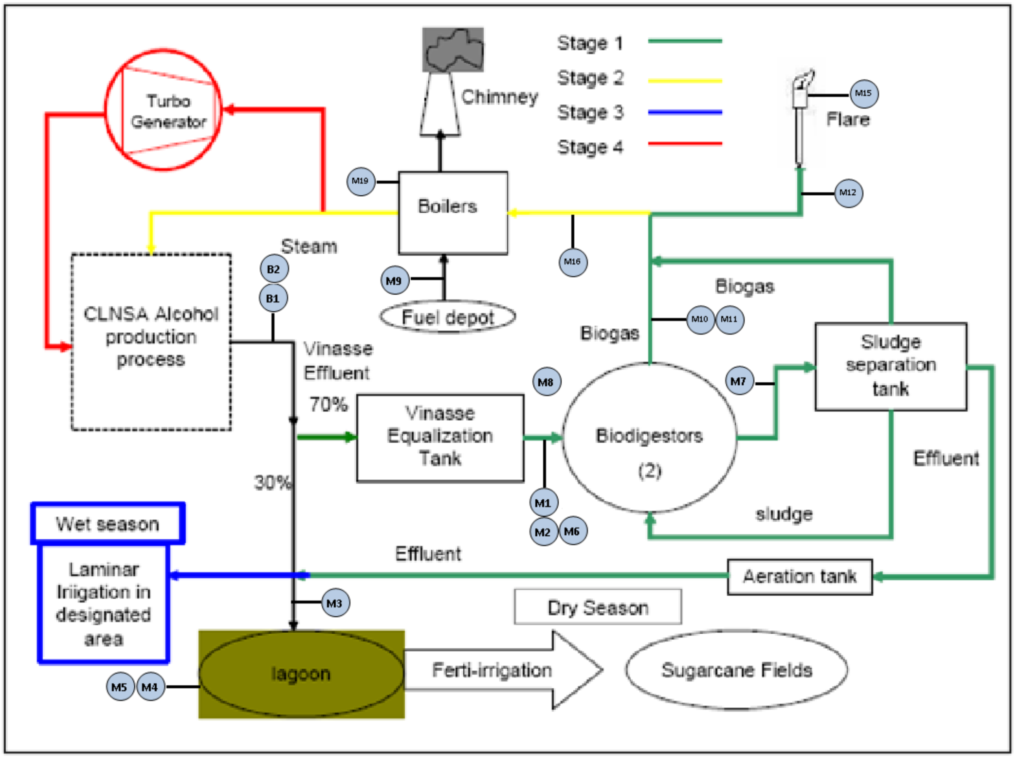


Figure 3: Description of Project Activity



Stage 1 (June 2003): Anaerobic Treatment System (ATS) – Consisted in the installation of two biodigesters that anaerobically treat the vinasse generated in the production of alcohol from sugar molasses. The anaerobic process will produce biogas from the organic material in the wastewater, which will then be used first to generate steam (stage 2) and in a later phase (stage 4) to generate energy required for the alcohol production process.

The components of the ATS will be: 2 heat exchangers, 1 cooling tower, 1 equalization tank, 2 biodigester tanks, 2 degasifying tanks, 2 foam separator tanks, 2 sludge separators tanks, 1 aeration tank, 3 compressors, and 3 blowers. The system treated initially only 60% of the vinasse due to process limitations and the other 40% of the vinasse was sent directly to the existing lagoon. Presently, the system is treating in average 70% of the vinasse since the process has been stabilized and the performance enhanced. During dry season the vinasse is used for the ferti-irrigation of the cane fields, and for laminar irrigation during the wet season (Stage 3). The effluent from the installed biodigesters is also sent to the existing lagoon (Figure 3). The Chemical Oxygen Demand (COD) of the vinasse measured at the entry of the biodigestors has been used to calculate the methane emissions of the baseline scenario before the implementation of this stage. The reason is that formerly the company didn't perform any analysis of the distillery's effluent going to the baseline lagoon. The reason was that the wastewater in the settlement lagoon (baseline lagoon) was later on used for ferti-irrigation and was not directly discharged to a water body (i.e. rivers, lakes or sea). The environmental laws in Nicaragua didn't

address the use of wastewater for ferti-irrigation. Therefore, the company was not obliged to carry out water quality analyses of the effluent.

Stage 2 (August 2003): Heat-Generation System - After the entire anaerobic treatment system was in place, the biogas has been used since then (August 2003) to generate heat in 3 existing boilers that were adapted for this purpose. The low-pressure boilers generate 15,000 Kg of steam per hour at 120 - _150 psi and 175ºC (375ºF). Usually the steam generation is achieved with 2 of the 3 boilers. The steam produced covers almost all of the distillery's heat requirements. It is instructive to note that this stage does not include installation of additional biodigesting capacity. Therefore, it remains that only 70% of the vinasse is sent to the biodigester and the rest is sent to the lagoon as described in stage 1.

Stage 3 (May 2005): Laminar irrigation as a methane avoidance and fertilization procedure – This stage consisted in the implementation of a new practice called laminar irrigation where the vinasse is applied constantly and uniformly in very thin layers over an area during the wet season. The addition of this practice means that the vinasse is sent to the lagoon only during the dry season, thus leaving it empty for the rest of the year (wet season). The designated area is itself divided into 6 sub-areas and each sub area is irrigated every 3 days. On the first day, a water film is applied, which is left to evaporate and percolate to the ground on the second day. On the third day, the soil is revolved, and on the fourth day another film of water is applied (starting the cycle again). The vinasse would not reach the settlement lagoon (or base line project lagoon), instead will be used now to fertilize a 25 hectare area with the addition of this new process, during the wet season, which runs generally from June through December. The precise number of days referred as wet season, will be determined through the monitoring variable (M5) in the project Monitoring Plan reflecting the exact number of days that the lagoon is full.

After the implementation of this stage, the settlement lagoon will not serve anymore as part of a wastewater treatment process, and just will be used if the laminar irrigation system is broke down or undergoing reparations. This type of eventuality will be also registered through the monitoring variable (M5) mentioned in the paragraph above. It is instructive to note that the vinasse streams and COD concentrations are identical in this stage as they were in Stage 1 and 2. Thus, the biodigesters treat approximately 70% of the vinasse and send the effluent, along with the remaining 30% of untreated vinasse to the lagoon. So the net COD value is drastically reduced.

During the dry season, the vinasse continues to be used for both fertilizing and irrigation purposes in an old practice called ferti-irrigation (continuation of ferti-irrigation). This process has been used for over 100 years (ever since the company was founded). The precise number of days referred as dry season, will be calculated through the monitoring variable (M5) in the project Monitoring.

Stage 4 (January 2008): Co-Generation System (CGS) – This stage requires the design, construction, and installation of: i) a high-pressure boiler that would substitute the previous three; and ii) a turbo generator. The electricity produced will be used to meet the distillery's power requirements, and the excess, if any, will be sold to the National Power Grid. It is instructive to note that this stage does not include installation of additional biodigesting capacity. Therefore, in this scenario almost all the vinasse will be sent to the biodigester in order to obtain all the possible energy.

The project contributes greatly to sustainable development for several reasons:

- It treats one of the by products from CLNSA (which was already being reused as a fertilizer) and turns it into a better fertilizer, while taking advantage of its organic content to produce energy.
- It will allow the company to eliminate the use of 5,500 gallons of fuel oil per day.
- The local air quality will be improved due to the fact that emissions from flaring biogas are much less harmful than emissions from burning fuel oil in the boilers. Specifically, emissions of particulate matter and hydrogen sulfide will be reduced significantly.
- By reducing the use of fuel oil and substituting it with methane, CLNSA is replacing fossil fuel with clean and renewable fuel, therefore contributing to the conservation of non-renewable resources while also reducing greenhouse emissions.
- Most of the methane originally emitted to the environment from the settlement lagoon will not be released anymore because laminar irrigation. Since it's the first project of this kind and scale in Nicaragua, it will be a milestone for future CDM projects that would impact in the same ways the socio-economic life in the region and other Latin-American countries. The project has already received the technical visit of other industrial facilities interested to apply these environmental solutions and renewable energy technologies

The proposed project activity aims to reduce an annual average of 116,524 tCO_2/yr.

A.2. Location of project activity

A.2.1. Host Party(ies)

>>

Nicaragua

A.2.2. Region/State/Province etc.

>>

Chinandega

A.2.3. City/Town/Community etc.

>>

Chichigalpa

A.2.4. Physical/Geographical location

>>

The Compañia Licorera de Nicaragua (CLNSA) is located near the village of Chichigalpa,a small city located in the North-western side of the country, 130 Km away from Managua, Nicaragua's capital (Figure 4). It is part of the department (state) of Chinandega. The department is 222 Km^2 and its population is 50,000 inhabitants. The area is known for the very fertile soils it posses as a result of volcanic activity which has made it possible to become a very important sugar cane and quality rums producing region.

Figure 4: Geographical position of the city of Chichigalpa

A.3. Technologies and/or measures

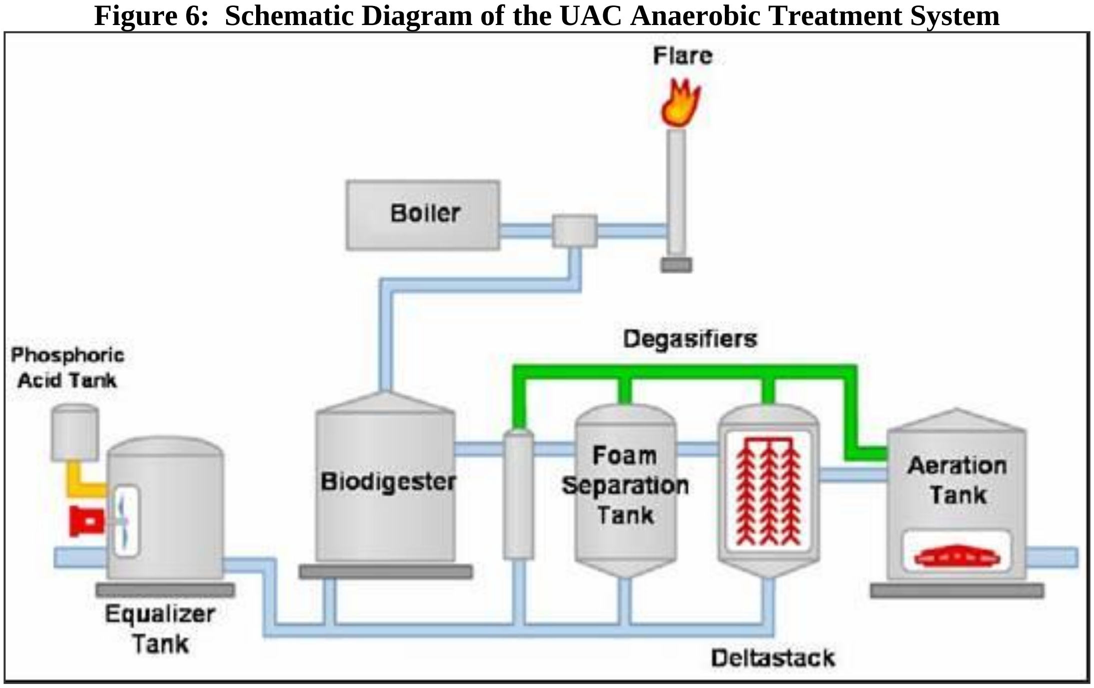
>>

The anaerobic digestion is a bacterial fermentation of organic material that will now occur in a controlled way in the two installed biodigesters at CLNSA's plant. As a result of this fermentation the biodigestors will produce biogas, which is typically made up of about 55% to 60% methane and 40% to 45% carbon dioxide, with traces of nitrogen, sulphur compounds, volatile organic compounds and ammonia. It is estimated that between 40% and 60% of the organic matter present in biodigesters can be converted to biogas. One of the by products of anaerobic digestion is sludge that is known to posses excellent characteristics as a soil conditioner and fertilizer. During the base case, sludge was being produced in the lagoon rather than in biodigesters and it was removed only when necessary as to maintain a desirable water depth.

The anaerobic digestion technology used at CLNSA''s plant is known as Up-flow Anaerobic Contact (UAC) (See Figure 6). In addition the treatment system has a sludge separator, suitable for wastewater with high solids content.

Figure 5: Aerial view of actual biodigester

Figure 6: Schematic Diagram of the UAC Anaerobic Treatment System



The CLNSA biogas project involves four sequential phases of implementation (See Figure 3). It consists of a transition from the basic wastewater treatment facility, to a methane co-generating facility. Stage 1 was implemented in 2003 and consisted in installing two anaerobic digesters for treatment of the vinasse and biogas generation, which has been used as fuel for industrial steam boilers, thus displacing fuel oil. Each biodigester is 12 meters high and has a diameter of 33.6

meters. The two biodigesters produce about 22,821 Nm3 of biogas per day (net of physical leakage of biogas from the digesters). The vinasse comes from the distillery, and depending on its organic load, it may be used directly or may need dilution. A heat exchanger is required to reduce the temperature of the vinasse from 90°C to a temperature of 38°C. The water is then cooled for recycling. The vinasse is transported to an equalization tank, where sodium hydroxide is added to increase its alkalinity (an increase from pH 5 to 6.8 - 7.5). Phosphorous is also added to increase the efficiency of decomposition in the biodigesters. The effluent flows to the biodigesters, where it is retained for 14 days, and then it passes to the degasifiers to separate out the last quantities of gas from the effluent. The effluent from each biodigester flows to a foam separation tank, where the foam containing sludge is separated from the effluent.

Then, the sludge continues to a sludge separator tank, where the remaining sludge is separated from the effluent; both the foam and the sludge are reinjected into the biodigester to maintain the required level of anaerobes. The excess sludge flows to a storage tank for mixing with the aerobically-treated effluent and then this stream is sent to the lagoon where it is further on used for irrigation purposes. The biogas generated goes to the boilers where the methane is converted to energy. In cases where the boilers go offline, an atmospheric flare (figure 7) burns the methane, so that at no point is methane released to the atmosphere, except for normal system leakage which has been monitored in situ and reaches a maximum of only about 5% of total biogas production.

Figure 7: Flare at CLNSA's plant in operation

For a period of time right after the biodigestors' installation, only 60% of the total vinasse flowing out of the industrial process was being treated in the UAC system. The remaining 40% of the vinasse continued to be sent to the lagoon as in the Baseline scenario. Presently, the biodigestors treat in average 70% of the vinasse being produced by the industrial process.

Project design, engineering, equipment supply, installation, supervision, start-up, and training for the UAC system was supplied by Uni-Systems, which is associated with EnviroAsia and Biotecs. All three companies have vast experience in the treatment of industrial wastewaters. The engineering per se is still property of the suppliers, which means that CLNSA will not be capable of reproducing this plant without their supervision. However, the know-how for operating the plant is being transferred through training, both on and off site. Regarding off-site training,

CLNSA operators traveled to Brazil for two weeks of training at one of the existing plants, and the project manager spent an additional week in Colombia observing the start-up of a new plant. Regarding on-site training, several experts from the supplying companies have visited the project on several occasions, remaining in Chichigalpa for periods that ranged from a week to a month, to make sure that CLNSA is operating the plant properly and that the project manager and other operators are well trained. This technology has been implemented by the project partners primarily in the Philippines, as well as Brazil for industries ranging from fish canning to orange juice production to alcohol production.

Stage 2 was implemented in August 2003 when the existing boilers had to be adapted to utilize biogas for producing 15,000 kg/hour low-pressure steam at 150 psi (figure 8). The generated thermal energy leaving the boilers has been used to serve the thermal loads of the industrial process thus displacing fuel oil.

Figure 8: One of the 3 adapted boiler for burning biogas / Fuel oil deposits.

Stage 3 was implemented in May 2005, and it involved the direct use of the wastewater during the wet season (6 months) for a laminar irrigation system. Note that this process is additional to the ferti-irrigation process that was already being carried out in stage 1. The laminar irrigation system comprises the spreading of both vinasse that had not been treated by the digesters and effluent from the digesters onto a field, where the wastewater both evaporates and percolates into the ground. After five years of laminar treatment, the field will have become well-fertilized and will thus be ready to be replanted with cane. At that time, another field will receive five years of laminar treatment. The implementation of this stage implied that the lagoon remains empty for approximately 6 months while the laminar irrigation is performed.

Figure 9: Designated area for laminar irrigation

Stage 4, will be implemented in 2008 when a new high pressure boiler and a turbogenerator that converts steam into electricity are installed. The three original boilers will be uninstalled and substituted by the new high pressure one. The electricity generated will be consumed by CLNSA's own industrial process. According to preliminary calculations, there will be no remaining electricity for grid supply. Thus, at stage 4 the project activity will co-generate thermal energy and electricity, displacing both fuel oil and grid-supplied electricity. On-site electrical generation will produce approximately 1.6 MW of power.

A.4. Parties and project participants

Party involved (host) indicates a host Party	Private and/or public entity(ies) project participants (as applicable)	Indicate if the Party involved wishes to be considered as project participant (Yes/No)
Nicaragua (host)	Compañía Licorera de Nicaragua, S. A. (CLNSA) (Private)	No
The Netherlands	Corporación Andina de Fomento (CAF) * (acting as intermediary for the benefit of the State of the Netherlands for the purchase of Emission Reductions)	Yes

* multilateral financial institution based in Caracas, Venezuela

A.5. Public funding of project activity

>>

There is no public funding involved in the CLNSA project. The investment made in the project was financed by "Banco Agrícola Comercial de El Salvador". In spite of that, there is an advanced negotiation with The State of Netherlands acting through the Ministry of Housing, Spatial Planning and the Environment for purchasing the Certified Emission Reductions (CERs) generated by the CLNSA project through the Corporación Andina de Fomento (CAF) and its Latin-American Carbon Program (PLAC)

SECTION B. Application of selected approved baseline and monitoring methodology

B.1. Reference of methodology

>>

The methodology applied to the CLNSA project is AM0013 Version 03 - “Avoided methane emissions from organic waste-water treatment”.

B.2. Applicability of methodology

>>

AM0013 Version 03 is applicable to this project because it explicitly addresses emission reductions produced by the substitution of the open facultative lagoon (figure 10) as a wastewater treatment alternative with a closed biodigester system. The installed anaerobic biodigesters will extract a higher quantity of methane through ensuring total anoxic conditions and high biodegradation efficiency. At initial project stages the gas was only flared but then it has been used for fueling the adapted boilers. The vision of the project concept is to utilize all of the produced biogas for heat and electricity generation. Moreover the project will produce emission reductions resulting from displacing grid-supplied electricity used on-site. Specifically, the methodology is applicable since:

- The project is an industrial organic wastewater treatment plant;
- The existing wastewater treatment operation is an open lagoon with an active anaerobic condition with more than one meter depth; sludge residing in the lagoon for at least one year; and ambient average temperature is always above 24°C.
- The project includes forced CH4 extraction through a closed tank digester;
- Captured methane is used to generate electricity, avoiding emission due to displaced electricity in a well-defined grid; and
- Electricity capacity is lower than 15MW.
- The sludge and the waste water leaving the digesters are used on land fertilization applications, ensuring a good oxidation (aerobic conditions) for the organic matter that could not be treated.

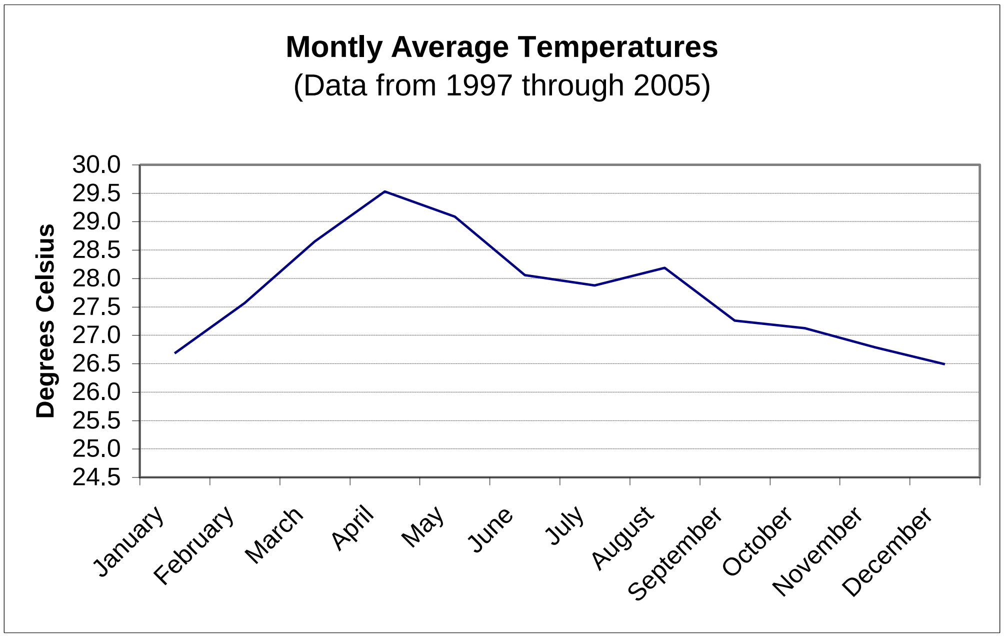
Figure 10: Facultative lagoon with wastewater previous project implementation

The AM0013 VERSION 03 applicability criterion specifying residence time of at least 30 days for the organic mater is fulfilled, considering that the average inflow to the lagoon is 57 (m^3/h)

and the volume is equal to 52,500 m^3 then the resulting hydraulic retention time is 58 days. The earlier allows for the fully development of methanogenic conditions in the lagoon at the base line scenario.

Regarding the criterion of temperature, the graph below (Figure 11) presents average measured temperatures for Chichigalpa, which demonstrates that the climatic environment of the region (above 10^{o}C) ensures anaerobic activity in the CLNSA's lagoon.

Figure 11: Average Dry Bulb Temperature for Managua, Nicaragua



B.3. Project boundary

Source		GHGs	Included?	Justification/Explanation
Baseline scenario	Wastewater settlement lagoon	CH_4	Included	The major source of emissions in the baseline
		N_2O	Excluded	Excluded for simplification. This is conservative
		CO_2	Excluded	CO_2 emissions from decomposition of organic waste are not accounted
	Fuel oil for boilers	CO_2	Included	The thermal energy that would be consumed in the absence of the project activity
		CH_4	Excluded	Excluded for simplification. This is conservative
		N_2O	Excluded	Excluded for simplification. This is conservative
	Grid supplied electricity	CO_2	Included	Emissions from the grid supplied electricity
		CH_4	Excluded	Excluded for simplification. This is conservative
		N_2O	Excluded	Excluded for simplification. This is conservative
Project scenario	Remaining wastewater flowing into settlement lagoon	N_2O	Excluded	Excluded for simplification. Not an important emission source
		CO_2	Excluded	CO_2 emissions from decomposition of organic waste are not accounted
		CH_4	Included	The emission from uncombusted methane
	Stack emissions from flare and energy generation	CO_2	Included	From emissions from electricity consumption
		CH_4	Included	The emission from uncombusted methane
		N_2O	Excluded	Excluded for simplification. This is conservative
	Start up / auxiliary fuel use	CO_2	Excluded	Excluded for simplification. This emission sources is assumed to be very small
		CH_4	Excluded	Excluded for simplification. This is conservative
		N_2O	Excluded	Excluded for simplification. This emission sources is assumed to be very small

Table 1: Emissions by source and according to scenario

The project boundary according to the baseline methodology consists of all the equipment related to the wastewater treatment systems and steam/power generation. It also includes the cultivation area where irrigation activities are performed. Electricity from the grid is also taken into account for the purpose of emission reductions. This boundary is applied to the project activity by considering:

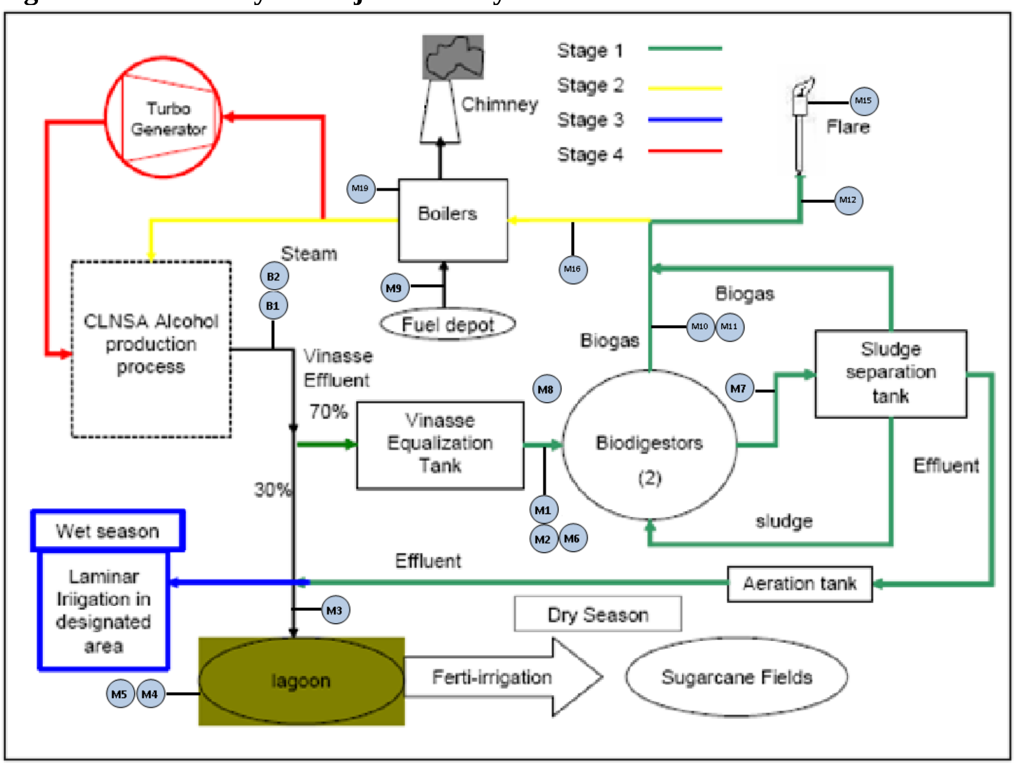
- Reduction of emissions from thermal plants supplying the electric grid.
- Reduction of emissions from substituting biogas for fuel oil burned in industrial steam boilers.
- Reduction of methane emissions from the wastewater stabilization lagoon.
- Methane emissions due to physical leakage from the biodigesters.
- Leakage emissions due to electrical accessories needed to operate the project activity processes.

Thus, the project boundary includes effects at the project site, in addition to some off-site effects. The project boundary is defined as follows:

- ***Electric grid:*** The project boundary includes the grid system to which the project delivers electricity.

- ***Project site:*** The project boundary includes the entire project site where the project activity will be implemented, including all digesters, digester pumps, electricity generation equipment, condenser, condenser pumps, steam boilers, and wastewater storage lagoon.

Figure 12: Boundary of Project Activity



- - - - - - Project Boundary

Any effect of transmission and distribution (T&D) losses from the lines, transformers, and other downstream components in the boundaries of the baseline and the project activity are excluded. It is assumed that the project activity neither increases nor decreases T&D losses to a significant degree. This assumption can be justified by the fact that the project is neither demand-side,

which would diminish the current T&D losses, nor is it predictable whether the T&D losses from the project site to the end consumer are greater or smaller than the losses from the generation that would happen otherwise.

Emissions sources at the baseline scenario included within the project boundary produce both direct emissions and indirect emissions as described below:

a. Direct methane emissions from the wastewater settlement lagoon.
b. Direct CO2 emissions from the combustion of fuel oil by the steam boilers.
c. Indirect CO2 emissions associated with the consumption of grid-supplied electricity that is generated from fossil fuel.

Emissions sources at the project case included within the project boundary produce both direct emissions and indirect emissions as described below.

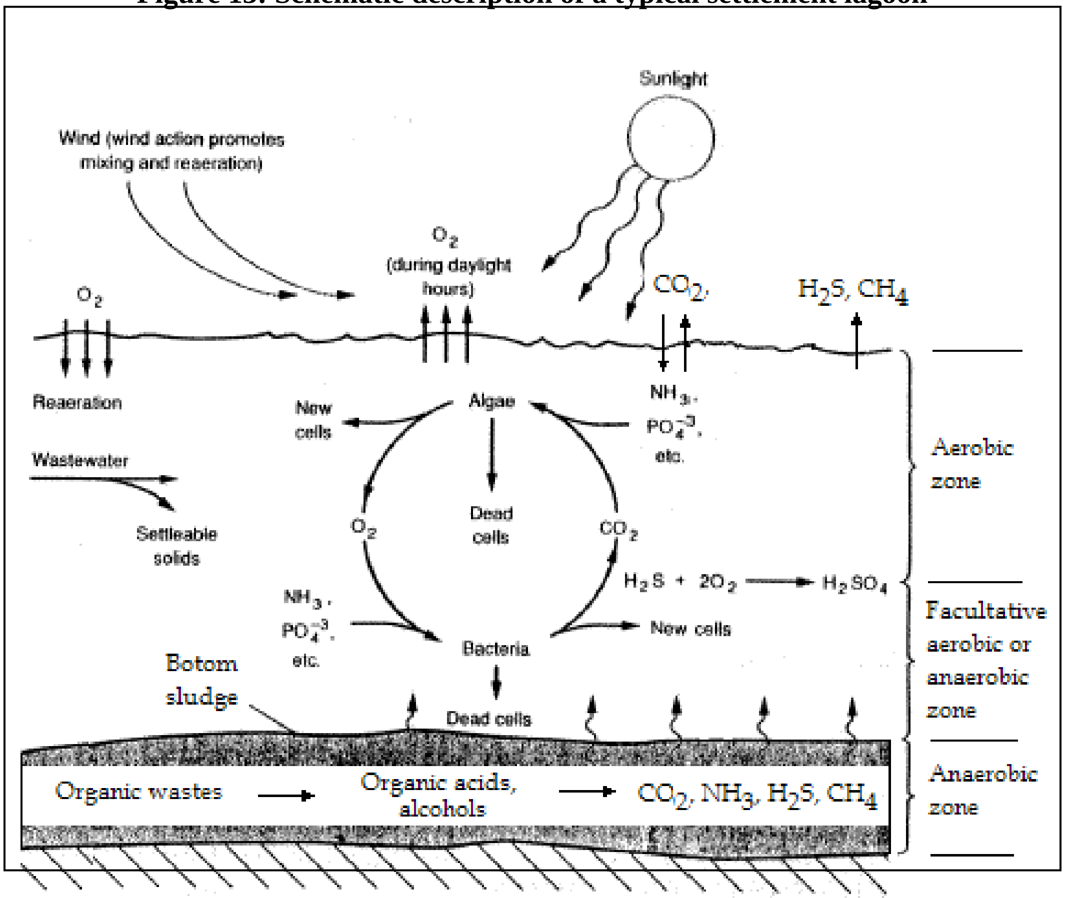
a. Methane emissions from the wastewater that still flows to the settlement lagoon.
b. Stack emissions from flare and energy generation.
c. Emissions from start up / auxiliary fuel use

B.4. Establishment and description of baseline scenario
>>
The initial condition (baseline) of the project included a facultative wastewater pond, where the decomposition of the organic matter occurred naturally (without aeration equipment), thus the oxidation rate was rather low. Normally, only the upper layers of facultative ponds are under aerobic condition, due to re-aeration trough the surface. Most of the oxygen is supplied by algae photosynthetic activity during day hours and mixed by wind action and heat. Commonly, at depths of more than one meter dissolved oxygen could decay just above cero but in upper layers oxygen is also very low. Under those anoxic conditions the anaerobic digestion or bacterial fermentation of organic material will produce biogas.

The CLNSA Biogas Project will reduce anthropogenic GHG emissions in three ways: 1) By reducing direct methane emissions from the settlement lagoon, 2) by reducing fossil fuel consumption by on-site industrial steam boilers, and 3) by displacing grid-supplied electricity with carbon-neutral electricity generated from biogas.

Uncontrolled methane emissions: The wastewater from the distillery process was sent to a settlement lagoon that is 250 meters long by 140 meters wide and 1.5 meters deep. The area and the temperature of the lagoon represent ideal conditions for anaerobic digestion. During the dry season, the wastewater is kept and applied in agricultural land as a method of ferti-irrigation. Not all water could be drained so the sludge and the methanogenic conditions persisted in the lagoon all year. The sludge remained in the lagoon for more than one year and the common practice was to remove it only every two or three years when its accumulation reduced significantly the available capacity of the lagoon. Because, the anaerobic conditions and consequently methane generation occurs in the sludge, the methanogenic conditions were not significantly affected by the patterns of wastewater discharge. In any case, the Bo and MCF factors would contemplate those small variations in the conditions (Figure 10).

Figure 13: Schematic description of a typical settlement lagoon



Source: Wastewater engineering, Metcalf & Eddy

Fossil fuel combustion: Prior to the installation of the biodigesters, fuel oil was solely used to generate process heat in steam boilers for the distillation of alcohol. Following the biodigester installation, fuel oil will be displaced by biogas.

Grid-supplied electricity: In the base case and during Stages 1, 2 and 3 of the project, grid-fed electricity is used to power the alcohol production process. The grid-supplied electricity will be displaced by on-site generation in Stage 4, equivalent to the electricity generated by the steam turbine, minus the electricity consumed by the digester auxiliary equipment, and by the on-site electric generating system auxiliary equipment.

The existence of the CLNSA Biogas Project will decrease the consumption of energy supplied from the grid. Currently, the Nicaraguan National Electric Generation System is formed by hydro, geothermal, and thermal generating sources (83.3% thermal, 5.7% geothermal, 1.4% biomass and 9.6% hydro, on a generation basis).

The regulatory framework establishes the operation of generation plants on a merit-order dispatch basis, according to the generation cost. The fact that a biogas plant has a low cost for energy production means that biogas facilities will have a higher dispatch priority rather than

thermal generators. Thus, the increase of low-cost biogas energy availability will reduce the use of higher-cost energy produced by fossil fuel[1] fired power plants.

As a result, without the CLNSA Biogas project, an increase in demand would sooner occur in residual fuel oil plants coming online and then diesel generation. During peak hours, the CLNSA project will offset these more expensive residual fuel oil and diesel units (this is because the dispatch system wants to keep the electricity price low and therefore prioritizes low cost production over more expensive units)[2]. Therefore, net GHG emissions will be reduced by the resulting reduction in the marginal operation of thermal power plants.

It is likely that any new thermal generating capacity added to the system would use the lowest installed cost technology – simple cycle combustion turbines, internal combustion engines, or combined cycle combustion turbines.

The methodology has been applied in the context of the Compañia Licorera Nicaragua industrial process and treatment of the vinasse. The project activity comprises anaerobic digesters treating wastewater (vinasse) from an alcohol distillation process. The digesters generate and capture biogas that is used to cogenerate industrial steam and electricity. In the baseline case, all electricity consumed by the distillery is purchased from the national electricity grid, and all steam is produced by combustion of Bunker C oil in the boilers.

B.5. Demonstration of additionality

>>

Project additionality is established by using the Tool for the demonstration and assessment of additionality” developed by the Executive Board (Annex 1 of EB16). The detailed process is described below:

Step 0. Preliminary screening based on the starting date of the project activity

CLNSA made the decision to invest in the project in 2001, and began construction (using internal resources) in April, 2002. Financing for the project was secured in July, 2002. Operations began in June, 2003. CLNSA explicitly contemplated carbon finance in the preparation of the project, and in November, 2001, the company initiated discussions with EcoSecurities to undertake the development of a comprehensive baseline for the project[3]. The project is not yet registered. At its meeting of July 2001, the Board of Directors approved the decision to proceed with the project activity[4].

0 Eligibility of projects already started		***Yes***	***No***
	Has construction started?	Y	
	Was construction begun before 1/1/2000?		N
	Was construction before (i) registration date and (ii) registration of a CDM activity?	Y	

[1] Thermal generation facilities run on distillate or residual fuels; natural gas is currently unavailable in the market and there are no specific plans to make it available to Nicaragua, at least for the foreseeable future.
[2] The production costs are expressed in variable costs mainly determined by fuel costs.
[3] Reference document: CLNSACLNSA 1999-2000 Annual Report (before adoption of the decision to proceed with the project).
[4] CLNSACLNSA Annual Board of Directors Meeting Report, 2001.

	Was CDM considered from early stages of development?	Y	
	Is there documentation to this effect?	Y	

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

1a Define alternatives to the project activity.

CLNSA considered several alternatives to the project, including: business-as-usual (which would leave CLNSA in compliance with applicable law, as noted below); management of the vinasse through application of the waste liquids in the cane fields; or implementation of a conventional aerobic biological treatment of the vinasse, yielding a biomass sludge for use as fertilizer. An analysis of each of these two options, as well as the project case, appears in the Pollutech report prepared for CLNSA in 1998, and in this analysis they are referred to as the "spray irrigation" option and the "aerobic biological treatment" option, respectively.[5]

None of the alternatives would have been as ambitious as the project, for they would not allow CLNSA to generate power while treating the vinasse, and accordingly they would not deliver additional emissions reductions from displacement of fossil energy generation. One possibility that would have freed up some energy production capacity would have involved efficiency measures on the boilers and steam system for the facility – likely with similar returns as the project, but at a lower investment cost. The Project was the most costly option considered. For the purposes of this discussion, the business-as-usual case will be labeled Option A, while the spray irrigation scheme will be labeled Option B, while construction of a conventional aerobic biological treatment facility is Option C. Finally, the implementation of efficiency measures is designated Option D. It is possible that efficiency measure might have involved the installation of a cogeneration facility utilizing the existing boiler fuel, but as such this would have been an altogether different installation than the cogeneration component included in the project case.

The project itself as implemented, it should be noticed, utilizes two of the approaches cited above. Specifically, the final project design incorporates the "spray irrigation" component as a follow-on step to the biodigestion process, followed by the cogeneration facility.

1b Enforcement of applicable laws and regulations.

Executive Decree 33-95[6] contains the regulations mandating controls on wastewater pollution. The decree is designed to establish the maximum permissible values or ranges of values for characteristics of the liquid discharges from domestic, industrial, and agricultural activities that discharge into the sewage system or receptors (defined as bodies of water that may be reached directly or indirectly by wastewaters, such as natural drainage systems, lakes, lagoons, rivers, the ocean). The decree does not contain any specific issues related to liquid or sludge by-products generated by domestic, industrial, and agricultural activities that are discharged into plantations or land preparation and used for fertilization, and hence is not applicable to the CLNSA's case.

[5] "Preliminary investigation of wastewater management alternatives," Pollutech, April, 1998, pp. 7-17.

[6] Decreto No. 33-95, Gaceta No. 118 (1996) Disposiciones para el control de la Contaminación proveniente de las descargas de aguas residuales, domesticas, industriales y agropecuarias, http://legislacion.asamblea.gob.ni/Normaweb.nsf/164aa15ba012e567062568a2005b564b/e54ddcf6f41b69b006256a76006cb0d5?OpenDocument&Highlight=2,ambiental

CLNSA's biodigester project goes above and beyond existing environmental requirements because the treatment and disposal methods (settlement lagoon and further land application) weren't regulated by any law or norm.

Therefore, both the project itself as well as the alternatives involving pre-treatment of the wastewater using conventional technologies such as the biodigestors and land application would have been additional to any legal requirement.

Step 2. Investment analysis.

2a, b. Determine appropriate analysis method. (option I, II, or III).

The most appropriate analytical option is the presentation of financial indicators (ROI calculations) for the project compared other investment options, including alternative capital investments as well as benchmark financial returns in Nicaragua's capital market.

2c Presentation of comparative financial indicators.

The figures presented in are based on CLNSA's own documentation and discussions with company officials involved in the decision to undertake the Project, Econergy's own estimates and publicly available information on Nicaraguan debt instruments from 2004 and 2005, and discussions with local financial institutions (Grupo Lafise[7]) conducted in 2005

Capital investment alternatives. The capital investment alternatives reviewed in Section 1a above vary from the BAU case, which would not have delivered any incremental financial return (relative to previous practice) nor any environmental benefit, to those investments that would have delivered limited or no financial returns while enhancing environmental performance and possibly reducing GHG emissions (Option B and Option C), and finally an investment option that would have delivered a possibly attractive financial return and a more limited reduction in emissions (Option D) for a smaller investment and a shorter payback period. For CLNSA, whose hurdle rate for investments is 15%,[8] the investment decision lay between two options delivering similar financial returns: Option D, a relatively small energy efficiency project, which would have been more easy to finance (using the company's own cash and/or a relatively small loan); or the more ambitious biodigester Project that requiring a larger amount of the company's scarce cash (Project case) and a loan of about USD 4 million. Indeed, the details of the Project as implemented – while ambitious – are still far less ambitious than an earlier concept for the project. The reduction in size reflects the constraints that scarce cash and limited external financing impose on any project that represents a departure from a company's traditional operating practices (see discussion on barriers, below).

Investment climate in Nicaragua. It is important to note that Nicaragua is one of the poorest countries in Latin America, a fact that, together with the legacy of political instability (including country's socialist revolution in the late 1970s), contributes to a comparatively difficult environment for local companies to secure financing through conventional means. According to

[7] http://www.grupolafise.com/

[8] See independent analysis of CLNSA's weighted average cost of capital (WACC), included as Annex 6.

information on the Bolsa de Valores de Nicaragua (Nicaraguan Stock Exchange, BVN),[9] 99% of the debt by volume traded in September, 2004, were public-sector instruments. Maturities were short, with less than 10% of the volume invested offering maturities of over one year. Further, a large part of government debt is in the form of government-to-government transactions and there is very little foreign direct investment, contributing to large swings in volume transacted, increasing the difficulty in obtaining transparent, market-derived interest rates with which to make comparisons with project-based financial returns. For the dollar-denominated Certificados Negociables de Inversión (CENIs), two issues in late 2003 and early 2004 (with maturities of up to one year) have delivered returns of about 6% to 8%. Interviews with officials of a Nicaraguan financial institution in mid-2005 confirmed the marked preference of local banks to invest in government paper as opposed to lending to companies, with the exception of transactions that support a relatively short loan tenor (about one year).

Table 2: Financial indicators for project analysis

Case	Description	Required Investment	Operating Costs (Annual)	ROI (10 years)
Project*	Anaerobic digester (without CER sales)	$7.63 million	($1.82 million)**	22%**
Option A*	Business as usual	$0	--	0%
Option B#	Spray irrigation	$972,000	$8,000	Negative
Option C#	Aerobic biological treatment	$3.3 million	$1.27 million	Negative
Option D+	Energy efficiency measures	$850-$975,000	($238,000)	20%-24%
Benchmark investor return in Nicaragua				8%
CLNSA hurdle rate				15%##

Sources: *CLNSA financial model (See Annex 5). #Pollutech report. +Econergy estimate, based on 7% energy savings from a mix of low-cost/no-cost measures and capital investments. **Average figure over ten years. The actual ROI is slightly higher than these figures would suggest due to phasing of project investments over four years. ##Documented in calculation of CLNSA's weighted average cost of capital (WACC), prepared by Ernst & Young (2005), included as Annex 6.

Analysis. While the return on investment for the Project is either similar to or greater than the returns generated by all other credible alternatives, as well as the company's hurdle rate for investments, the Project also involved a substantially higher capital investment than most other probable alternatives (Option B and Option C being considered a relatively unlikely possibilities) as well as a longer time horizon and greater risk than alternative investments. For instance, an investment in energy efficiency measures (Option D) would likely have generated a probably higher return when compared to the Project case, with a smaller overall capital investment. Meanwhile, investment in government paper allows for a return of 8% on a one-year investment, reflecting the short-term time horizon of investors in available Nicaraguan debt. This is presumed to be the least risky investment within the Nicaraguan market context. While the Project case does offer an attractive return on investment, it also requires a longer implementation period, a greater overall investment outlay (with limited or no access to domestic-currency financing), it carries with it significant technology and project risks, and its

[9] See www.bolsanic.com.

implementation involves other management-related barriers. For this reason, the Project case does not necessarily represent the most attractive investment option from the financial standpoint that would automatically be approved for execution.

2d Sensitivity analysis

The sensitivity of the Project's production costs to various possible events is identified in Table 3. The sensitivity analysis is conducted in a largely qualitative manner, since detailed financial models needed to conduct analysis of the impact of several variables on CLNSA in the case of the alternative projects are not available. The matrix of scenarios and options shows that only in the case of a technology failure would the least attractive case, Option C, or the likely second least attractive case, Option B, clearly overtake the Project as the most attractive option with the most favorable return and therefore the corresponding most favorable impact on the financial situation of CLNSA. In the scenarios involving changes in variables exogenous to the Project itself (energy price increase, interest rate increase and sugarcane price increase), the Project case remains the most attractive of the options. The scenario of electricity price or fuel price increases suggests that the impact on CLNSA's overall financial situation would be comparably less in the Project case and Option D than in Option A, Option B or Option C, as in each of these cases there would be no decrease in consumption of grid-supplied electricity and fuel oil. The scenario involving an increase in the interest rate for financing suggests that the net impact on the Project's overall performance would be substantially less than a comparable increase in energy prices, but this impact would not offset the savings generated by the Project, and hence, even with the higher interest rate, the Project case would be more attractive than Option A, Option B and Option C. Finally, an increase in sugarcane prices would tend to depress the overall financial performance of CLNSA across the board, but in the Project case this impact would be mitigated by the savings generated by reducing electricity consumption from the grid and fuel purchases.

Table 3: Sensitivity analysis

Event	*Significance*	*Reference**	*Impact*				
			Project Case	*Option A*	*Option B*	*Option C*	*Option D*
Technology failure	Causes drop in methane and fertilizer output	N/A	Drop in energy output entails increased energy purchases, in addition to financing expenses otherwise covered by cost savings.	No impact.	No impact.	No impact.	No impact.
Electricity price increase / fuel price increase (50%)	Causes increase in operating costs	USD 885,000/annum for 8.3 GWh and USD 2.52 million/annum for 3 million gallons: Total of USD 3.4 million.	Total energy bill is expected to decrease by about 80% (2.81 million). The impact of a 50% price increase would reduce overall savings to 70% of the base case, or USD 2.38 million.	Energy costs will be 150% of reference case, or USD 5.1 million.	Energy consumption will increase slightly relative to the reference case due to added consumption; overall energy cost will increase by more than 50% or more than USD 5.1 million.	Energy consumption will increase slightly relative to the reference case due to added consumption; overall energy cost will increase by more than 50% or more than USD 5.1 million.	Energy savings assumed to be 7%. Energy savings will decrease to 3.5% or USD 0.12 million.
Increase in interest rate (50%)	Causes increase in debt service	No financing associated with the reference case.	Project financed with USD 4.1 million in debt at 8%, resulting in interest payments of USD 0.37 million in Year 1 and decreasing thereafter. A 50% increase in the interest rate would increase interest payments to USD 0.5 in Year 1.	No impact	No financing assumed, since project does not support interest payments.	No financing assumed, since project does not support interest payments.	Assuming that project is financed on similar terms to Project, interest payments would be USD 0.04 million in Year 1. Interest rate increase would result in expense of USD 0.06 million in Year 1.
Increase price of harvested sugarcane	Causes increase in bagasse cost and sugar juice	N/A	Increase in operating costs; erodes overall profitability	Erodes profitability, but without Project to mitigate losses.	Erodes profitability, but without Project to mitigate losses.	Erodes profitability, but without Project to mitigate losses.	Erodes profitability, but without Project to mitigate losses.

* Refers to relevant magnitude of expense in business-as-usual case. Value in project case shown where appropriate under "Impacts."

Step 3. Barrier analysis

3a Identify barriers that would prevent the implementation of type of the proposed project activity:

CLNSA's Project is the first project of this kind implemented, not only in Nicaragua but in all of Central America. Other anaerobic technologies have been utilized unsuccessfully in countries such as Guatemala. These technologies have failed mainly due to the complex qualities of the Central American vinasse. This resulted in technological concerns even when the technology has been proven in other countries, mainly in Asia. Indeed, the CLNSA experience has helped to diminish the concerns over some negative aspects that have hindered the use of this technology in the region such as the corrosive action of gas over boilers and the value for fertilization purposes of the waste water remaining after the biodigestion process.

Ever since CLNSA started operations back in 1890, wastewater has been used directly for the fertilization of the sugar plantations; hence a continuation of this practice would not be impeded in any way. Therefore, CLNSA's decision to proceed with the project entailed substantial perceived risk.

Further, the Project plan entails a comprehensive program to train local employees for operation and maintenance of a technology with which nobody in Nicaragua has previous experience. In addition to the presence of suitable employees, this requires time and additional resources.

However, the most significant barrier is that of the relative scarcity of capital and financing to implement the project. CLNSA is a well-established firm with substantial exports, and hence it enjoys hard currency revenues and therefore would tend to have easier access financing in hard currency than other firms in the country. Even so, it should be noted that CLNSA secured financing for the Project after work actually commenced using the company's own resources. There are several reasons why access to financing proved difficult, even for a company such as CLNSA. Even though the Project's returns are attractive, roughly 40% of the energy savings corresponding to reduced electricity consumption is denominated in local currency, contributing to exposure to exchange-rate risk associated with financing in hard currency. The projected CER revenues from the Project, estimated at the time of Project approval to cover approximately 30% of the interest obligation in Year 1 and increasing each year after that, would compensate for this exposure.

Further, even though the investment yielded new productive capacity, it is not, strictly speaking, within the core business of the distillery and hence at the time the investment decision was taken, it had to compete with other potential investments that would have been. In this sense, the obstacle is one of limited management capacity to contemplate potentially "extraneous" business activities that involve issues and technologies outside of the company's experience to date, and the opportunity cost of allocating substantial resources to a non-core investment. At the same time, however, the Project generates power, which makes it a more attractive addition to the plant's operations from the perspective of overall energy balance and efficiency.

3b Show that the identified barriers would not prevent the implementation of at least one of the alternatives (except the proposed project activity)

The project was the most innovative of the options available to CLNSA not only because of the concept but also because it originated a series of new complex monitoring requirements of variables and parameters, that weren't a common practice before. Option B represented a more standard approach to resolving a liquid waste problem, while Option A represented no change in current practice, as did Option D, for all practical purposes. Accordingly, the challenge to the Project from a management standpoint was greater than would have been encountered in the cases of Option B or Option C. Meanwhile, the energy efficiency measures identified in Option D would have been viewed more likely

as appropriate improvements in "housekeeping" and normal equipment upgrades from a management standpoint than the Project case.

The constraint imposed by limited investment resources would likely have been a consideration for Option B and Option C as well as the Project case. It seems likely, however, that the probability of securing internal approval of the investment required in Option B or Option C would have been lower than in the case of the Project, since the Project does increase productivity and generates economic savings. In contrast, Option D offered an equally attractive investment opportunity with fewer financing and cash requirements, and hence it would have been relatively easy to secure approval for it.

Step 4. Common practice analysis.

4a Analyze other activities similar to the proposed project activity.

As noted elsewhere, projects involving biodigesters in the sugar industry have been reported in Guatemala, with less than satisfactory results. This appears to be because variations in vinasse characteristics pose a challenge to the ability of the technology to deliver consistent results across a range of sugar mills. In consequence one of the most preferred alternatives for the treatment of industrial effluents have been settlement lagoons due in part to the simplicity in the construction and low maintenance and operation costs. For instance sludge removal can be carried out every two to three years.

Despite the potential interest in this type of project given that it involves a new source of renewable energy, biodigestion schemes are often disregarded because of a widespread skepticism of the reliability of the gas produced by them.

A slightly different project has been implemented in Mexico. This project, known as La Costeña, involves biodigestion of organic material at a facility that processes and packages pickles, chile peppers and other condiments made from a variety of vegetables, and combustion of the resulting biogas in small generator sets to produce hot water and electricity. The project has been submitted for registration as a CDM project.[10]

4b Discuss any similar options that are occurring.

There is no other case in Nicaragua of a project of this type.

Step 5. Impact of CDM registration

Without CERs, the Project financial analysis showed a negative NPV until Year 8; with CER sales, the NPV was negative until Year 7. The prospect of CER revenues from the Project did prove helpful in securing a go-ahead decision from the Board, since they diversified the financial returns on investment and provided additional coverage of debt service, which is payable in hard currency. (See Annex 5 for two views of the model showing the impact of the CER sales.)

In the absence of CER sales under the CDM, the project might have taken a different form (perhaps Option D) or might not have been done at all. Of course, Option D would have generated a more limited

[10] See CDM project activity registration and validation report form submitted by DNV, June 2006. Available at cdm.unfccc.int/UserManagement/FileStorage/ZAWTTWZJJ7KDC1MWPC1NBF4ZV0LHBS.

volume of CERs, while alternative wastewater treatment might well have generated methane reductions, but not any energy-use related savings. (The methane-based savings possibly derived from Option B would likely be more valuable than the energy-related savings in Option D.) The Project option, however, provided an opportunity to achieve various objectives for the liquor plants, such as improving the efficiency of operations, reducing waste, reducing fossil fuel consumption and dependence on imported energy, and improving the quality of the organic fertilizer used in the adjoining farms, and at the same time, generating a larger volume of CERs and the corresponding revenues from their sale.

The above assessment shows that the Project does not fall within the baseline scenario and that it would not occur without the assistance of the CDM, or at best it would take a different form that would deliver fewer emissions reductions.

B.6. Emission reductions
B.6.1. Explanation of methodological choices
>>

The chosen methodology has been applied in the context of CLNSA’s project to quantify emissions reductions from three sources:

a. Methane emissions reductions from the industrial wastewater settlement lagoon.
b. Carbon emissions reductions from displacing fossil fuel with biogas used in the steam boilers.
c. Carbon emissions reductions from displacing grid-supplied electricity with on-site-generated electricity using biogas fuel.

Methane emissions from the wastewater settlement lagoon have been calculated for the Base Case and the Project Case. The quantity of these emissions is based on Chemical Oxygen Demand (COD) data that has been measured from the vinasse flowing into the biodigesters after their installation. The former represents the COD that would have been delivered to the lagoon in the absence of the project.

During the project base case and as mentioned before CLNSA’s wasn’t required to analyze the water flowing out of the lagoon because of its use in ferti-irrigation. Therefore the COD from the lagoon’s effluent has been estimated based on the most conservative biodegradation rate (70%) of a typical facultative lagoon.

The steam boiler CO_2 emission reductions are the result of displacement of fossil fuel by biogas in the boilers. The quantity of these emissions is based on actual measured biogas at boilers fuel inlet. In the Base Case, combustion of fossil fuel provides the same amount of energy to the boilers as would be provided by the biogas in the Project Case. Thus, the measured amount of biogas consumed in the Project Case provides the basis for determining the amount of fossil fuel that would have been burned in the absence of the project.

Operating Margin and Build Margin have been used to calculate the emission factor for the electric grid. Then, using both of these derived “margins” to determine the Combined Margin, it was possible to estimate the emission factor of the grid and therefore know “what would happen otherwise”, in terms of GHG emissions associated with electricity consumption.

The monitoring methodology was designed to be applied to projects using AM0013 Version 03. The methodology provides for the monitoring of emission reductions generated from grid-connected biogas-to-electricity projects that also displace fossil fuel with biogas for use in industrial steam boilers. The monitoring methodology is based on the direct measurement of electricity generated by the project and direct measurement of the amount of biogas generated by the digesters. The methodology also presents a means to estimate methane emissions from the wastewater storage lagoon. This calculation is based on

direct measurement of Chemical Oxygen Demand (COD) flowing into the digesters and direct measurement of COD flowing out of the digesters. Raw source data serving as the basis of these calculations are presented in Microsoft Excel workbook files provided electronically to the project Validator, TUV.

In the context of the proposed monitoring methodology applied to the project, Option 1: Monitoring of the emission in the project scenario and the baseline scenario was selected.

The methodology used to calculate emissions associated with wastewater treatment reflects the methodology presented in the AM0013 Version 03 (May 2006). These emissions can be calculated according to the formulae described below.

Baseline emissions

Baseline emissions are the CH_4 emissions from open lagoon wastewater treatment system, the CO_2 emissions associated with grid electricity that is displaced by the project's onsite electricity generation, and the CO_2 emissions associated with fossil fuel that is displaced by the project's use of biogas in the industrial process heating equipment.

(i) Lagoon baseline emissions

The baseline emissions from the lagoon are estimated based on the chemical oxygen demand (COD) of the effluent that would enter the lagoon in the absence of the project activity, the maximum methane producing capacity (B_o) and a methane conversion factor (MCF) that expresses what proportion of the effluent would be anaerobically digested in the open lagoon. These CH4 emissions from wastewater are calculated according to the IPCC Guidelines specified in AM0013 Version 03 (May 2006).

Note: The calculation method and inputs used in the PDD for baseline and project emissions from methane generation in the lagoon system are based on the total amount of wastewater produced by the distillery. However, the calculation method of AM0013, Version 3 is based on the wastewater input to the digester or directed to land application.

Given the fact that AM0013 uses exactly the same formula for lagoon baseline and project emissions, AM0013 assumes that any wastewater stream bypassing the digester and flowing directly to the lagoon system would lead to the same amount of baseline and project emissions, cancelling each other in the emission reduction calculations. The calculation approach has been developed due to the planned laminar irrigation process during the wet season, which would eliminate project emissions from the lagoon system because the lagoon would be completely avoided in the wet season. However, as explained above, there is not enough monitoring data to verify the impact of laminar irrigation in reducing project emissions. Therefore, it is conservatively assumed that the wastewater is always directed to the anaerobic lagoon, leading to higher project emissions. (Also refer to project emissions explanation of choices).

Given the simplification in the calculation approach described above, baseline and project emissions in the first monitoring periods shall be based only on the wastewater volume entering the digester, which is in line with AM0013 Version 3 and leads to a reduction in the emission reduction calculations as compared to ex-ante assumptions in the PDD.

Equation 1

$$CH_{4\,lagoon baseline} = COD_{available,m} \times B_O \times MCF_{baseline}$$

Where:

$CH_{4\ lagoon\ baseline}$ = CH_4 from wastewater lagoon; (kg/month)

$COD_{available,m}$	=	The monthly Chemical Oxygen Demand available for conversion which is equal to the monthly COD entering the digester plus COD carried on from the previous month. (see below)
$COD_{baseline, m}$	=	Monthly Chemical Oxygen Demand of effluent entering Lagoons or directed to land application (see below)
B_o	=	Maximum methane producing capacity; (0.21 kg CH_4/kg COD)
$MCF_{basleine}$	=	Monthly methane conversion factor; (see below)

Table 4 shows a one-year history of monthly COD resulting from the flow of vinasse. $COD_{basleine,m}$ is calculated as the product of COD concentration (mg COD/l) in the wastewater input to the digester and flow rate (m^3/hr). The lagoon is only in operation 350 days out of the 365 days in a year (96%) and therefore this ratio is used to adjust the total effluent treated by the lagoon in the baseline.

Table 4: $COD_{baseline}$ Summary

Month	Wastewater sent to Lagoon – monthly average (m^3/hr)	Wastewater sent to Lagoon (m^3/month)	Concentration - monthly average (mg/l)	Ratio use of lagoon	$COD_{baseline}$[1] (kg COD/month)
Jun-03	57	41,040	99,878	350 / 365	3,930,538
Jul-03	51	36,660	100,610	350 / 365	3,654,733
Aug-03	52	37,740	107,453	350 / 365	4,018,235
Sep-03	52	37,640	115,086	350 / 365	4,292,301
Oct-03	43	30,649	102,432	350 / 365	3,110,788
Nov-03	52	37,103	100,785	350 / 365	3,705,265
Dec-03	54	38,845	108,746	350 / 365	4,185,720
Jan-04	59	42,518	117,475	350 / 365	4,949,189
Feb-04	69	49,489	116,448	350 / 365	5,710,240
Mar-04	65	46,494	103,031	350 / 365	4,746,530
Apr-04	73	52,772	105,995	350 / 365	5,542,441
May-04	80	57,435	103,726	350 / 365	5,903,093
Average	**59**	**42,365**	**106,805**		**4,479,089**

Note 1 – $COD_{baseline}$ is adjusted for 350 days per year of lagoon use.

There was effluent from the lagoon prior to the implementation of this project that was used (as described before) in the Ferti-irrigation process. Therefore $COD_{basleine}$ values were adjusted by multiplying $COD_{basleine}$ by the factor AD shown in

Equation 2.

The COD that left the lagoon with the effluent was not systematically measured in the baseline scenario as explained earlier due to the fact that it was not required by law because the lagoon's effluent wasn't discharged to any water body (i.e. lake, sea or river) but rather used for land applications, additionally is not a common practice and neither required be the industrial process.

This AD factor (equivalent to the project lagoon efficiency for organic mater removal) can be supported with data available from the baseline lagoon effluent analysis (Annex 5) carried out in February 2002, as part of an Environmental Impact Assessment carried out in the facility. The water analysis shows a measured $COD_{a,out}$ value of 14,210 mg/l.

The $COD_{a,in}$ was not available for this same period, so an average value of 106,805 mg/l adopted for the base line ex post calculations was adopted with available data for one year. Using equation 2 with the referred values we could obtain an AD value of: 0,86 or 86% of DQO reduction. This value is consistent with theoretical calculations made for the treatment of the effluent with the base line lagoon (facultative aerobic-anaerobic stabilization pond) and time of residence of 58 days and also as referred in relevant literature consulted (Table 10-20 in Annex 6); AD between 80 to 95%.

Nevertheless a conservative factor was adopted by the fact to have a single value (Annex 5) available of the effluent, for the AD term. AD has been conservatively assumed to be 0,7 (or 70% of $COD_{basleine}$) as the more appropriate for further calculations.

Equation 2

$$AD = 1 - \left(\frac{COD_{a,out}}{COD_{a,in}} \right)$$

Where:

$COD_{a,out}$	=	COD that leaves the lagoon with the effluent
$COD_{a,\ in}$	=	COD that enters the lagoon

The amount of organic matter available for conversion to methane $COD_{available,m}$ is assumed to be equal to the amount of organic matter produced during the month, $COD_{baseline,m,}$ plus the organic matter that may remain in the system from previous months. The amount of organic matter consumed during the month is equal to the amount available for conversion $COD_{available,m}$ multiplied by $MCF_{monthly}$ (see below for $MCF_{monthly}$ calculations). Carried on calculations are conservatively limited to one year. In practice the residence time for the CLNSA lagoon is upwards of three years as the sludge pit is cleaned only every few years.

Table 5: COD Available Summary

Month	$COD_{baseline}$ (kg COD/month)	AD (%)	MCF	$COD_{available}$ (kg COD/month)
Jun-03	3,930,538	70%	0.336	2,751,377
Jul-03	3,654,733	70%	0.363	4,384,140
Aug-03	4,018,235	70%	0.397	5,606,625
Sep-03	4,292,301	70%	0.428	6,384,033
Oct-03	3,110,788	70%	0.412	5,831,947
Nov-03	3,705,265	70%	0.378	6,022,207
Dec-03	4,185,720	70%	0.372	6,676,461
Jan-04	4,949,189	70%	0.382	7,655,403
Feb-04	5,710,240	70%	0.353	8,727,008
Mar-04	4,746,530	70%	0.349	8,967,033
Apr-04	5,542,441	70%	0.340	9,714,968
May-04	5,903,093	70%	0.331	10,548,704
Average	**4,479,089**		**0.370**	**6,939,159**

The default IPCC value for B_o, the maximum amount of CH_4 that can be produced from a given quantity of wastewater, is 0.25 kg CH_4/kg COD. Taking into account the uncertainty of this estimate, AM0013 Version 03 (May 2006) recommends that project participants should use a maximum value of 0.21 kg CH_4/kg COD as a conservative assumption for B_o.

$MCF_{baseline,m}$ is estimated as the product of the fraction of anaerobic degradation due to depth (f_d) and the fraction of anaerobic degradation due to temperature (f_t). This relationship is represented by

Equation 3.

Equation 3

$$MCF_{baseline} = f_d \times f_{t,monthly} \times 0.89$$

Where:

f_d	=	the fraction of anaerobic degradation due to depth of the the sludge pit. Table 1 of AM0013 Version 03 shows that the fraction of degradation under anaerobic conditions due to a depth of 1.5 meters is 50%.
$f_{t,monthly}$	=	the fraction of anaerobic degradation due to temperature (see below for calculation).
0.89	=	the uncertainty conservativeness factor (for uncertainty range of 30% to 50%) to account for the fact that the equation used to estimate $F_{t,monthly}$ assumes full anerobic degradation at 30 °C.

$f_{t,monthly}$ is calculated as follows:

Equation 4

$$f_{t,monthly} = \exp\left[\frac{E \times (T_2 - T_1)}{R \times T_1 \times T_2}\right]$$

Where:

E	=	The Activation energy constant (15,175 cal/mol)
T_2	=	Ambient temperature (Kelvin) for the climate.
T_1	=	303.16 (273.16° + 30°)
R	=	Ideal gas constant (1.987 cal/ K mol).

The factor ($f_{t,monthly}$) represents the proportion of organic matter that are biologically available for conversion to methane based upon the temperature of the system. The assumed temperature is equal to ambient temperature. Monthly values for $f_{t,monthly}$ were calculated by using monthly average temperatures for the area and plugging them into van't Hoff – Arrhenius '$f_{t,monthly}$" factor provided above. Table 6 shows the results for the $f_{t,monthly}$ calculation.

Table 6: Fraction of Anaerobic Degradation Due to Temperature Summary

Month	T_2 (K)	f_t
Jan	299.8	0.756
Feb	300.7	0.815
Mar	301.8	0.893
Apr	302.7	0.961
May	302.2	0.926
Jun	301.2	0.849
Jul	301.0	0.837
Aug	301.3	0.859
Sep	300.4	0.794
Oct	300.3	0.785
Nov	299.9	0.763
Dec	299.6	0.744

$MCF_{baseline,m}$ is next calculated by plugging in the previously established variables into Equation 3.

Table 7 shows the monthly results for the $MCF_{baseline,m}$ calculation.

Table 7: Monthly Methane Conversion Factor Summary

Month	$MCF_{baseline}$
Jan	0.336
Feb	0.363
Mar	0.397
Apr	0.428

May	0.412
Jun	0.378
Jul	0.372
Aug	0.382
Sep	0.353
Oct	0.349
Nov	0.340
Dec	0.331

$CH_{4lagoon\ baseline}$ emissions are next calculated by plugging in the previously established variables into

Equation 1. Table 8 shows the monthly results for the lagoon baseline emissions. The total baseline CH_4 emissions are translated into metric tons CO_2 equivalent emissions by multiplying by its global warming potential (GWP) of 21.

Table 8: Lagoon Baseline Monthly Summary

Month	$COD_{available}$ (kg COD/month)	B_O (%)	MCF	$CH_{4\ lagoon\ baseline}$ (kg CH4)	$CO_{2\ lagoon\ baseline}$ (tCO_2)
Jun-03	2,751,377	0.21	0.336	194,366	4,082
Jul-03	4,384,140	0.21	0.363	333,959	7,013
Aug-03	5,606,625	0.21	0.397	467,712	9,822
Sep-03	6,384,033	0.21	0.428	573,224	12,038
Oct-03	5,831,947	0.21	0.412	504,719	10,599
Nov-03	6,022,207	0.21	0.378	477,908	10,036
Dec-03	6,676,461	0.21	0.372	521,953	10,961
Jan-04	7,655,403	0.21	0.382	614,368	12,902
Feb-04	8,727,008	0.21	0.353	647,335	13,5943
Mar-04	8,967,033	0.21	0.349	657,672	13,811
Apr-04	9,714,968	0.21	0.340	692,670	14,546
May-04	10,548,704	0.21	0.331	733,184	15,397
Total	**83,269,905**			**6,419,070**	**134,800**

Table 9 summarizes the equations and data presented above. Note that since the Project Activity started in June 2003, the values presented for Years 2003 and 2013 are half-year totals such that a full 10-year Crediting Period is provided.

Table 9: Lagoon Baseline Annual Summary

Year	$CO_{2\ lagoon\ baseline}$ (tCO_2)
2003	64,551
2004	134,800
2005	134,800
2006	134,800
2007	134,800
2008	134,800

2009	134,800
2010	134,800
2011	134,800
2012	134,800
2013	70,250
Total	**1,348,005**

$CO2e_{lagoon\_base}$ = 1,348,005 tCO2 over ten years.

(ii) Electricity baseline emissions

AM0013 Version 03 notes that project proponents can estimate electricity and heat component if the captured methane is used for generation of electricity and/or heat. For the CLNSA baseline, all electricity consumed by the distillery plant is provided by grid-supplied electricity. For 2003 through 2007, the project activity will not generate electricity and therefore it will continue that all electricity consumed by the distillery plant will be provided by grid-supplied electricity. Beginning in 2008 the project activity will include on-site cogeneration of steam and electricity using biogas fuel and therefore will produce additional GHG emissions attributable to the baseline.

Beginning in 2008, the electricity generated on-site via the combustion of biogas will displace some of the grid-supplied electricity consumed in the baseline. The quantity of baseline grid-supplied electricity displaced equals the total on-site generation of the project activity[11].

The cogeneration system will be operated so as to just meet the thermal loads of the distillery and to make as much electricity as possible in the process. This will result in electricity generation that will satisfy most of the distillery's electricity needs. The available biogas will fuel a new high-pressure steam boiler that will supply steam to a back-pressure turbine. The high-pressure steam will drive the back-pressure turbine which will in turn drive an electric generator to make electricity. The thermal energy at the turbine outlet will then be used to satisfy the distillery's thermal loads.

The baseline electricity and thermal energy consumption that would take place in the absence of the project activity are estimated using

Equation 5.

Equation 5

$$BE_{elec/heat} = EG_{y} \times CEF_{Bl,elec,y} + EG_{d,y} \times CEG_{grid} + HG_{Bl,y} \times CEF_{bl,therm,y}$$

Where,

EG_y	=	the amount of electricity in the year y that would be consumed at the project site in the absence of the project activity (MWh).
$CEF_{Bl,elec,y}$	=	the CO_2 emission factor for electricity consumed at the project site in the absence of the project activity

[11] Note that the project activity subtracts out the amount of electricity consumed by the cooling system pumps and fans associated with the turbo-generator, and less the electricity consumed by the biodigester auxiliary equipment. Together, the turbo-generator auxiliaries and the biodigester auxiliaries comprise the project parasitics.

		(tCO_2/MWh)
$EG_{d,y}$	=	the amount of electricity generated utilizing the biogas collected during project activity and exported to the grid during the year y (MWh)
CEF_{grid}	=	the CO_2 emission factor for the grid where electricity is exported (tCO_2/MWh)
$HG_{BL,y}$	=	the quantity of thermal energy that would be consumed in year y at the project site in the absence of the project activity (MJ) using fossil fuel.
$CEF_{Bl,therm,y}$	=	the CO2 emissions intensity for thermal energy generation (tCO2 e/MJ)

EG_y

Prior to 2008, **EG_y** is equal to zero. Starting in 2008, EG_y is equal to the project activity electric generation since the electricity that is consumed in the baseline situation is the same as the net generation of the project activity. This holds true because the electric generation will be consumed entirely on-site and will only displace grid imported electricity.

Equation 6

$$EG_y = \left[\frac{VB \times CECF}{CF_1} \right]$$

Where,

VB	=	The volume of biogas recovered from the biodigester process and used in the cogeneration unit; (Nm^3)
CECF	=	Cogeneration electric conversion factor; (0.676 kWh $/Nm^3$ biogas)
CF_1	=	Conversion factor; 1000 kWh / MWh

Note that the volume of biogas has been monitored during the project activity. Therefore, the measured data is used to establish the annual volume of biogas recovered from the biodigester. Table 10 lists the monthly measured data used to establish the annual recovered volume of biogas listed in Table 11. Note that June and July 2003 were estimated using the average of the months of data available for 2003 and starting in July 2006, the monthly biogas was estimated using the respective months previous years of recorded data.

Table 10: Volume of Biogas Monthly Summary

	2003	**2004**	**2005**	**2006**
Jan	n/a	676,860	965,344	794,737
Feb	n/a	614,939	833,051	732,834
Mar	n/a	684,293	1,039,091	673,452
Apr	n/a	782,317	1,074,247	941,688
May	n/a	926,370	1,159,992	716,933
Jun	*543,858*	815,957	832,318	955,261
Jul	*543,858*	877,955	667,458	772,707
Aug	432,017	167,682	720,880	440,193
Sep	639,124	723,382	796,938	719,815
Oct	352,274	997,839	487,509	612,541
Nov	490,517	877,851	895,996	754,788
Dec	805,359	1,013,804	852,174	890,446
Total	**3,807,007**	**9,159,249**	**10,324,998**	**9,005,394**

Table 11: EG_y Annual Summary

Year	**VB_{cogen} (Nm^3)**	**EG_y (MWh)**
2003	3,807,007	n/a
2004	9,159,249	n/a
2005	10,324,998	n/a
2006	9,005,394	n/a
2007	9,263,717	n/a
2008	9,263,717	6,262
2009	9,263,717	6,262
2010	9,263,717	6,262
2011	9,263,717	6,262
2012	9,263,717	6,262
2013	9,263,717	2,609

$EG_{d,y}$ represents the amount of electricity generated utilizing the biogas collected during project activity and exported to the grid during a given year. Since CLNSA will consume all biogas generated electricity onsite, $EG_{d,y}$ is zero for all years of the project.

$HG_{BL,y}$ is equal to the project activity heat generation since the thermal heat that would be consumed in the baseline situation is the same as the generation of the project activity. The project activity will displace the heat generation supplied by the baseline steam boilers. The baseline boilers burn Bunker C fuel oil to generate steam and therefore Bunker C fuel oil is the basis for which the baseline emissions are established.

The quantity of thermal energy that would be consumed in year y at the project site in the absence of the project depends upon the phase of the project activity. From December 2003 through December 2007, the biogas will be used to directly replace Bunker C fuel in the steam boilers. Equation 7 is used to establish $HG_{BL,y}$ for December 2003 through December 2007.

Equation 7

$$HG_{BL,y} = VB \times FOE \times HV$$

Where

$HG_{BL,y}$	=	The quantity of thermal energy that would be consumed in year y at the project site in the absence of the project activity (MJ)
VB	=	Volume of biogas recovered from the digester process and used to replace ; (Nm^3)
FOE	=	Bunker C fuel oil equivalent of biogas; (0.145 gal/ Nm^3)
HV	=	Heating value of Bunker C fuel oil; (152.9 MJ/gal)

Table 12 lists the summary for HB_{BL} on a monthly basis through 2007. Note that VB is based on measured data.

Table 12: HG_{BL} Monthly Summary

Month	VB	$HG_{bl,y}$
Jun-03	*0*	*n/a*
Jul-03	*0*	*n/a*
Aug-03	432,017	9,578,033
Sep-03	639,124	14,169,699
Oct-03	352,274	7,810,091
Nov-03	490,517	10,875,007
Dec-03	805,359	17,855,212
Jan-04	676,860	15,006,325
Feb-04	614,939	13,633,505
Mar-04	684,293	15,171,118
Apr-04	782,317	17,344,359
May-04	926,370	20,538,086
Jun-04	815,957	18,090,175
Jul-04	877,955	19,464,701
Aug-04	167,682	3,717,594
Sep-04	723,382	16,037,741
Oct-04	997,839	22,122,590
Nov-04	877,851	19,462,396
Dec-04	1,013,804	22,476,542
Jan-05	965,344	21,402,159
Feb-05	833,051	18,469,157
Mar-05	1,039,091	23,037,167
Apr-05	1,074,247	23,816,593
May-05	1,159,992	25,717,603
Jun-05	832,318	18,452,906
Jul-05	667,458	14,797,878
Aug-05	720,880	15,982,270
Sep-05	796,938	17,668,514
Oct-05	487,509	10,808,318
Nov-05	895,996	19,864,679
Dec-05	852,174	18,893,124
Jan-06	794,737	17,619,717

Feb-06	732,834	16,247,296
Mar-06	673,452	14,930,768
Apr-06	941,688	20,877,694
May-06	716,933	15,894,763
Jun-06	955,261	21,178,614
Jul-06	*772,707*	*17,131,289*
Aug-06	*440,193*	*9,759,299*
Sep-06	*719,815*	*15,958,651*
Oct-06	*612,541*	*13,580,333*
Nov-06	*754,788*	*16,734,027*
Dec-06	*890,446*	*19,741,626*
Jan-07	*812,314*	*18,009,400*
Feb-07	*726,941*	*16,116,653*
Mar-07	*798,945*	*17,713,018*
Apr-07	*932,751*	*20,679,549*
May-07	*934,432*	*20,716,817*
Jun-07	*867,845*	*19,240,565*
Jul-07	*772,707*	*17,131,289*
Aug-07	*440,193*	*9,759,299*
Sep-07	*719,815*	*15,958,651*
Oct-07	*612,541*	*13,580,333*
Nov-07	*754,788*	*16,734,027*
Dec-07	*890,446*	*19,741,626*

In 2008, the cogeneration unit comes on line and will generate both electricity and steam. Equation 8 is used to establish $HG_{BL,y}$ for 2008 and beyond.

Equation 8

$$HG_{BL,y} = \frac{EG_y \times TER}{\eta_{baselineboiler}} \times CF_2$$

Where

TER	=	The thermal to electric ratio of the cogeneration system; (4.3)
$\eta_{baselineboiler}$	=	Efficiency of the baseline boiler; (80%)
CF_2	=	Conversion factor; 3600 MJ/MWh

Thus,

$$HG_{BL,y} = \frac{6,262 \times 4.3}{0.80} \times 3600 = 121,171,696 \text{ MJ}$$

Table 13 shows the annual summary for HG_{BL}.

Table 13: HG_{BL} Annual Summary

Year	**HG_{BL} (MJ)**
2003	60,288,041
2004	203,065,130
2005	228,910,368

2006	199,654,077
2007	199,654,077
2008	121,171,696
2009	121,171,696
2010	121,171,696
2011	121,171,696
2012	121,171,696
2013	50,488,207

$CEF_{Bl,elec,y}$ is the CO_2 emission factor for electricity consumed at the project site in the absence of the project activity. AM0013 Version 03 specifies that in cases where electricity would in the absence of the project activity be purchased from the grid, the emission factor $CEF_{Bl,elec,y}$ be calculated according to methodology ACM0002 ("Consolidated baseline methodology for grid-connected electricity generation from renewable sources").

Grid-supplied electricity has a carbon intensity (CI) determined by the Combined Margin (CM) methodology described below. On-site generated electricity has a carbon intensity of zero for this project, since the on-site generated electricity is fueled by carbon-neutral biogas.

The carbon intensity (CI) of the grid is represented by the Combined Margin (CM) emission factor, which is the average of the Operating Margin (OM) and the Build Margin (BM), as shown in the following equations:

Equation 9

$$CM_{1stcreditingperiod} = \frac{OM_{year1} + BM_{historical\_(or\_year1-7)}}{2} = \frac{tCO_{2e}}{MWh}$$

The first step is then to calculate the OM_{year1} according to the proposed procedure of the baseline methodology. Since low-cost must-run resources comprise less than 50% of total electricity generation on the Nicaraguan grid, Option B (Simple OM) is allowed for determining the CM. Under Option B, the OM represents the weighted average of all resources *except* low-cost/must-run facilities. The OM can be calculated using Equation 10

Equation 10

$$OM_{year\ i} = Sum(E_i) / Sum(EG_i)\ (tCO_2e/MWh)$$

Where,

E_i = Total tonnes of CO_2-equivalent (tCO_2e) emission per year of plant "i" including all plants <u>except</u> low-cost/must-run facilities;

EG_i = Total annual energy generated (MWh) by plant "i" – including all plants <u>except</u> low-cost/must-run facilities.

E_i is calculated as follows:

Equation 11

$$E_i = FC_i \times CV_i \times EF_i \times Ox$$

Where,

FC_i = Annual fossil fuel consumption (liters, t or m³) of thermal plant "i";

CV_i = Calorific value (TJ/L, TJ/t or TJ/m³) of fuel used in plant "i";

EF_i = Fossil fuel emission factor (tCO_2e/TJ);

Ox = Fraction of carbon oxidized

Operating Margin

To calculate the OM emission factor, data on currently operating thermal generation units were gathered and emissions were calculated for 2002, 2003, and 2004. The arithmetic average of these annual OM factors was then determined and used as the OM factor for the project analysis. All raw source data used in OM and BM calculations have been provided electronically to the project Validator. The results of the OM/BM analysis are presented below.

Table 14: Data used to calculate the OM emission factor (source INE)

Grid Emissions & Emission Factor for 2002

OPERATING MARGIN CALCULATION

Power Plant	Generation (GWh/yr)	Diesel 10^3gal/yr	Fuel oil 10^3gal/yr
. Nicaragua (GEOSA)	613.94	-	46,280.85
. Managua (GECSA)	205.38	-	15,979.15
. Censa - Amfels	196.34	-	12,058.15
. Empresa Energética de Corinto	511.89	-	29,219.09
. Tipitapa Power Company	406.00	-	24,394.97
. Chinandega (GEOSA)	0.29	33.37	-
. Las Brisas (GECSA)	12.54	938.97	-
Total	**1,946**	**972**	**127,932**

Fuel type	Fuel consumption	Units	Heat content (GJ/unit)	Fuel CO_2 Emis. Factor (tCO_2/GJ)	Fuel CO_2 Emis. Factor (tCO_2/unit)	CO_2 Emissions (tCO_2/yr)
Diesel	972,332	gallons	0.136	0.0741	0.0101	9,809
Fuel oil	127,932,214	gallons	0.147	0.0774	0.0114	1,460,482
Total						**1,470,291**
					GWh/yr	1,946
					OM Emission factor (tCO2/GWh)	**755**

Grid Emissions & Emission Factor for 2003

OPERATING MARGIN CALCULATION

Power Plant	Generation (GWh/yr)	Diesel 10^3gal/yr	Fuel oil 10^3gal/yr
. Nicaragua (GEOSA)	525.86		39,498.28
. Managua (GECSA)	200.62		15,747.86
. Censa - Amfels	297.76		18,148.19
. Empresa Energética de Corinto	533.55	316.93	30,281.49
. Tipitapa Power Company	411.48		24,672.47
. Nic.Sugar Estate Ltd. (NSEL)			
. Chinandega (GEOSA)	0.73	97.69	
. Las Brisas (GECSA)	20.92	1,662.80	
Total	**1,991**	**2,077**	**128,348**

Fuel type	Fuel consumption	Units	Heat content (GJ/unit)	Fuel CO_2 Emis. Factor (tCO_2/GJ)	Fuel CO_2 Emis. Factor (tCO_2/unit)	CO_2 Emissions (tCO_2/yr)
Diesel	2,077,425	gallons	0.136	0.0741	0.0101	20,958
Fuel oil	128,348,292	gallons	0.147	0.0774	0.0114	1,465,232
Total						**1,486,190**
					GWh/yr	1,991
					OM Emission factor (tCO2/GWh)	**746**

Grid Emissions & Emission Factor for 2004

OPERATING MARGIN CALCULATION

Power Plant	Generation (GWh/yr)	Diesel 10^3gal/yr	Fuel oil 10^3gal/yr
. Nicaragua (GEOSA)	542.99		40,256.17
. Managua (GECSA)	235.14		18,482.38
. Censa - Amfels	327.66		19,795.32
. Empresa Energética de Corinto	526.85	93.98	29,849.61
. Tipitapa Power Company	412.40		24,640.70
. Generadora San Rafael, S.A. (Gesarsa)	5.60	92.38	440.47
. Chinandega (GEOSA)	0.71	97.08	
. Las Brisas (GECSA)	26.83	2,078.56	
Total	**2,078**	**2,362**	**133,465**

Fuel type	Fuel consumption	Units	Heat content (GJ/unit)	Fuel CO_2 Emis. Factor (tCO_2/GJ)	Fuel CO_2 Emis. Factor (tCO_2/unit)	CO_2 Emissions (tCO_2/yr)
Diesel	2,362,002	gallons	0.136	0.0741	0.0101	23,829
Fuel oil	133,464,662	gallons	0.147	0.0774	0.0114	1,523,640
Total						**1,547,470**
					GWh/yr	2,078
					OM Emission factor (tCO2/GWh)	**745**

OM can be now calculated using the equation above and the following values for the variables are attributed:

E_i =1.470.291 tCO_2e in 2002 + 1,486,190 tCO_2e in 2003 + 1,547470 $mtCO_2e$ in 2004;
EG_i = 1.946.000 MWh in 2002 + 1,991,000 MWh in 2003 + 2,078,000 MWh in 2004;

Thus,

OM = 4,503,951 tCO_2e / 6,015,000 MWh

OM = 0.749 tCO_2e/MWh

Build Margin

In order to calculate the emission factor for the Build Margin, the same procedure is used as for calculating the emission factor for the Operating Margin. However, since the Build Margin should represent the most probable scenario of power plant additions in the future, the calculation considers the most recent 20% of plants built, or the most recent five plants, whichever is greater. In Nicaragua, the most recent five plants built is the greater number, as these represent 42% of the installed capacity and 62% of the 2001 annual generation. The average emission factor from these five plants was calculated. The power plants considered are presented in the table below.

Following the procedures provided in the methodology, $BM_{year1-7}$, can be directly obtained.

Table 15: Five most recent power plants data, used to calculate BM emission factor.

Grid Emissions & Emission Factor for 2002
BUILD MARGIN CALCULATION

Power Plant	Generation (GWh/yr)	Diesel 10^3gal/yr	Fuel oil 10^3gal/yr	Start of Operation (year)
. Censa - Amfels	196.34	-	12,058.15	1997
. Empresa Energética de Corinto	511.89	-	29,219.09	1999
. Tipitapa Power Company	406.00	-	24,394.97	1999
. Nic.Sugar Estates Ltd. (ISA)	83.34	-	72.71	1998
. Las Brisas (GECSA)	12.54	938.97	-	1992
Total	**1,210**	**939**	**65,745**	

Fuel type	Fuel consumption	Units	Heat content (GJ/unit)	Fuel CO_2 Emis. Factor (tCO_2/GJ)	Fuel CO_2 Emis. Factor (tCO_2/unit)	CO_2 Emissions (tCO_2/yr)
Diesel	938,967	gallons	0.136	0.0741	0.0101	9,473
Fuel oil	65,744,928	gallons	0.147	0.0774	0.0114	750,548
Total						**760,021**
					GWh/yr	1,210
					BM Emission factor (tCO2/GWh)	**628**

Grid Emissions & Emission Factor for 2003
BUILD MARGIN CALCULATION

Power Plant	Generation (GWh/yr)	Diesel 10^3gal/yr	Fuel oil 10^3gal/yr	Start of Operation (year)
. Censa - Amfels	297.76	0.00	18,148.19	1997
. Empresa Energética de Corinto	533.55	316.93	30,281.49	1999
. Tipitapa Power Company	411.48	0.00	24,672.47	1999
. Generadora San Rafael, S.A. (Gesarsa)	0.00	0.00	0.00	2004
. Las Brisas (GECSA)	20.92	1,662.80	-	1992
Total	**1,264**	**1,980**	**73,102**	

Fuel type	Fuel consumption	Units	Heat content (GJ/unit)	Fuel CO_2 Emis. Factor (tCO_2/GJ)	Fuel CO_2 Emis. Factor (tCO_2/unit)	CO_2 Emissions (tCO_2/yr)
Diesel	1,979,732	gallons	0.136	0.0741	0.0101	19,973
Fuel oil	73,102,155	gallons	0.147	0.0774	0.0114	834,538
Total						**854,511**
					GWh/yr	1,264
					BM Emission factor (tCO2/GWh)	**676**

Grid Emissions & Emission Factor for 2004
BUILD MARGIN CALCULATION

Power Plant	Generation (GWh/yr)	Diesel 10^3gal/yr	Fuel oil 10^3gal/yr	Start of Operation (year)
. Censa - Amfels	327.66	0.00	19,795.32	1997
. Empresa Energética de Corinto	526.85	93.98	29,849.61	1999
. Tipitapa Power Company	412.40	0.00	24,640.70	1999
. Generadora San Rafael, S.A. (Gesarsa)	5.60	92.38	440.47	2004
. Las Brisas (GECSA)	26.83	2,078.56	-	1992
Total	**1,299**	**2,265**	**74,726**	

Fuel type	Fuel consumption	Units	Heat content (GJ/unit)	Fuel CO_2 Emis. Factor (tCO_2/GJ)	Fuel CO_2 Emis. Factor (tCO_2/unit)	CO_2 Emissions (tCO_2/yr)
Diesel	2,264,919	gallons	0.136	0.0741	0.0101	22,850
Fuel oil	74,726,106	gallons	0.147	0.0774	0.0114	853,078
Total						**875,927**
					GWh/yr	1,299
					BM Emission factor (tCO2/GWh)	**674**

Thus, <u>BM emission factor is</u>

BM = 2,490,459 mtCO2e / 3,773,000 MWh
= 0.660 tCO_2/MWh

Combined Margin

Having already obtained both OM and BM values for the emission factor, it is now easy to calculate the CM, or Combined Margin, emission factor.

CM = 0.5*OM + 0.5*BM
CM = 0.5*0.749 + 0.5*0.660

CM = $CEF_{Bl,elec,y}$ = 0.705 tCO_2/MWh

$CEF_{Bl,therm,y}$ is the CO_2 emissions intensity for thermal energy generation. Thermal energy generation in the project activity displaces Bunker C fuel oil in the baseline. Therefore, $CEF_{Bl,therm,y}$ is equal to 0.00007652 tCO_2/MJ

Equation 5 Summary

Table 16 summarizes the electricity and thermal baseline emissions quantified by plugging in the variables established above into
Equation 5. Note that since the Project Activity started in June 2003, the values presented for Years 2003 and 2013 are half-year totals such that a full 10-year Crediting Period is provided.

Table 16: Electricity Baseline Emissions Summary

Year	EG_y (MWh)	$HG_{BL,y}$ (MJ)	$BE_{elec/heat}$ (tCO_2)
2003	0	60,288,041	4,613
2004	0	203,065,130	15,539
2005	0	228,910,368	17,516
2006	0	199,654,077	15,278
2007	0	199,654,077	15,278
2008	6,262	121,171,696	13,687
2009	6,262	121,171,696	13,687
2010	6,262	121,171,696	13,687
2011	6,262	121,171,696	13,687
2012	6,262	121,171,696	13,687
2013	2,609	50,488,207	5,703
Total	33,920	1,547,918,377	142,360

$BE_{elec/heat}$ = 142,360 tCO2 over ten years

Total GHG Emissions Attributable to the Baseline

Total Baseline emissions are the sum of each of the emissions components previously established.

Equation 12 provides the equation used to sum the Baseline emissions

Equation 12

$$BE = CO2e_{lagoonbase} + BE_{elec/heat}$$

Note that since the Project Activity started in June 2003, the values presented for Years 2003 and 2013 are half-year totals such that a full 10-year Crediting Period is provided. Therefore, the CLNSA Baseline emissions are:

Table 17: Baseline Annual Summary

Year	$CO_{2\ lagoon\ baseline}$ (tCO_2)	$BE_{elec/heat}$ (tCO_2)	BE (tCO_2)
2003	64,551	4,613	69,164
2004	134,800	15,539	150,339
2005	134,800	17,516	152,317
2006	134,800	15,278	150,078
2007	134,800	15,278	150,078
2008	134,800	13,687	148,487
2009	134,800	13,687	148,487
2010	134,800	13,687	148,487
2011	134,800	13,687	148,487
2012	134,800	13,687	148,487
2013	70,250	5,703	75,953
Total	**1,348,005**	**142,360**	**1,490,365**

BE = 1,490,365 tCO2 over 10 years

<u>Project emissions</u>

The physical delineation of the project is defined as the plant site. Project emissions mainly consist of methane emissions from the lagoons, physical leakage from the digester system, stack emissions from flaring and energy generating equipment, emissions related with the consumption of electricity in the digester auxiliary equipment, emissions from land application of sludge, and emissions from wastewater removed in the dewatering process.

(i) Methane emissions from lagoons

Note: The calculation method and inputs used in the PDD for baseline and project emissions from methane generation in the lagoon system are based on the total amount of wastewater produced by the distillery. However, the calculation method of AM0013, Version 3 is based on the wastewater input to the digester or directed to land application.

Given the fact that AM0013 uses exactly the same formula for lagoon baseline and project emissions, AM0013 assumes that any wastewater stream bypassing the digester and flowing directly to the lagoon system would lead to the same amount of baseline and project emissions, cancelling each other in the emission reduction calculations. The calculation approach has been developed due to the planned laminar irrigation process during the wet season, which would eliminate project emissions from the lagoon

system because the lagoon would be completely avoided in the wet season. However, as explained above, there is not enough monitoring data to verify the impact of laminar irrigation in reducing project emissions. Therefore, it is conservatively assumed that the wastewater is always directed to the anaerobic lagoon, leading to higher project emissions.

Given the simplification in the calculation approach described above, baseline and project emissions in the first monitoring periods shall be based only on the wastewater volume entering the digester, which is in line with AM0013 Version 3 and leads to a reduction in the emission reduction calculations as compared to ex-ante assumptions in the PDD.

Although a majority of the COD is treated and reduced by anaerobic digestion, a portion (approximately 30%) of the vinasse is still treated directly by the lagoons.

Additionally, while a significant majority of the COD load from the 70% of vinase treated by the digester will have been reduced by anaerobic digestion, there is still COD leaving the digester and sent to the lagoon.

AM0013 Version 03 states that due to the uncertainty regarding the exact extent of aerobic/anaerobic digestion after project implementation, the calculation of CH_4 emissions is conservatively carried out in the same way as for the baseline, using the same values for Bo and the methane conversion factor (MCF). Equation 13 is used to estimate these emissions.

It is instructive to note that laminar irrigation process begins in May-2005. Recall that during the wet season, laminar irrigation uses the COD previously sent to the settlement lagoon to fertilize and therefore the lagoon does not produce CH_4 emissions during the wet season while using laminar irrigation. The wet season for Nicaragua is conservatively taken as May through December.

Equation 13

$$CH_{4\,lagoon\ project} = \left(COD_{dig\ out}\right) \times (B_O) \times (MCF_{baseline})$$

Where,

$COD_{dig\ out}$	=	The COD of effluent leaving the digester and entering the lagoon, (kg COD/yr)
B_o	=	Maximum methane producing capacity (0.21 kg CH_4/kg COD)
$MCF_{basleine}$	=	Monthly methane conversion factor

$CH_{4lagoon\ project}$ emissions are next calculated by plugging in the previously established variables into Equation 13. Table 18 shows the monthly results for the lagoon project emissions. The total project CH_4 emissions are translated into metric tons CO_2 equivalent emissions by multiplying by its global warming potential (GWP) of 21.

Table 18: Lagoon Project Summary

Month	$COD_{dig\ out}$ (kg COD/month)	MCF	$CH_{4\ lagoon\ project}$ (kg CH4)	$CO_{2\ lagoon\ project}$ (tCO_2)
Jun-03	1,149,120	0.336	81,177	1,705
Jul-03	1,187,424	0.363	90,451	1,899
Aug-03	1,187,424	0.397	99,057	2,080
Sep-03	1,149,120	0.428	103,180	2,167

Oct-03	1,187,424	0.412	102,764	2,158
Nov-03	1,149,120	0.378	91,191	1,915
Dec-03	1,187,424	0.372	92,831	1,949
Jan-04	1,187,424	0.382	95,294	2,001
Feb-04	1,072,512	0.353	79,555	1,671
Mar-04	1,187,424	0.349	87,090	1,829
Apr-04	1,149,120	0.340	81,931	1,721
May-04	1,187,424	0.331	82,531	1,733
Jun-04	1,149,120	0.336	81,177	1,705
Jul-04	1,187,424	0.363	90,451	1,899
Aug-04	1,187,424	0.397	99,057	2,080
Sep-04	1,149,120	0.428	103,180	2,167
Oct-04	1,187,424	0.412	102,764	2,158
Nov-04	1,149,120	0.378	91,191	1,915
Dec-04	1,187,424	0.372	92,831	1,949
Jan-05	1,187,424	0.382	95,294	2,001
Feb-05	1,072,512	0.353	79,555	1,671
Mar-05	1,187,424	0.349	87,090	1,829
Apr-05	1,149,120	0.340	81,931	1,721
May-05	*1,187,424*	*0.331*	82,531	*1,733*
Jun-05	*1,149,120*	*0.336*	81,177	*1,705*
Jul-05	*1,187,424*	*0.363*	90,451	*1,899*
Aug-05	*1,187,424*	*0.397*	99,057	*2,080*
Sep-05	*1,149,120*	*0.428*	103,180	*2,167*
Oct-05	*1,187,424*	*0.412*	102,764	*2,158*
Nov-05	*1,149,120*	*0.378*	91,191	*1,915*
Dec-05	*1,187,424*	*0.372*	92,831	*1,949*

The following table summarizes the equations and data presented above. Note that since the Project Activity started in June 2003, the values presented for Years 2003 and 2013 are half-year totals such that a full 10-year Crediting Period is provided. Years 2006 through 2013 are established using 2005 as a typical year under laminar irrigation.

Table 19: $CO_{2\ lagoong\ project}$ Summary

Year	**$CO_{2\ lagoon\ project}$ (tCO_2)**
2003	13,874
2004	22,828
2005	22,828
2006	22,828
2007	22,828
2008	22,828
2009	22,828
2010	22,828
2011	22,828
2012	22,828
2013	22,828

Total	**242,155**

$CO2e_{lagoon\_project}$ = 242,155 tCO_2 over ten years.

(ii) Physical leakage from biodigesters

The emissions directly associated with the digesters involve the physical leakage from the digester system. IPCC guidelines specify physical leakage from anaerobic digesters ranging from 5 - 15% of total biogas production. Physical leakage has been measured to be less than 5% for the biodiegester. A 5% physical leakage factor is conservatively used in this analysis. Equation 14 is used to calculate the biodigester leakage.

Equation 14

$$BDL = VB \times MF \times VM \times LF_{digester} \times GWP_{CH4}$$

Where

BDL	=	Physical leakage from the biodigesters, (tCO_2)
$COD_{available,y}$	=	Annual organic waste treated by digester; (see Table 5)
$BF_{digester}$	=	COD-to-biogas conversion factor; (0.364 Nm^3 biogas/kg COD)
MF	=	Methane (CH_4) fraction of biogas; (55%)
VM	=	Volume-to-mass conversion factor; (0.0007176 tCH_4/ Nm^3 CH_4)
$LF_{digester}$	=	Percentage of biogas leaking from digester; (5%)
GWP_{CH4}	=	Global warming potential of CH_4; (21)

The following table summarizes the equations and data presented above. Note that since the Project Activity started in June 2003, the values presented for Years 2003 and 2013 are half-year totals such that a full 10-year Crediting Period is provided.

Table 20: BDL Annual Summary

Year	**VB_{cogen} (Nm^3)**	**BDL (tCO_2)**
2003	3,807,007	1,578
2004	9,159,249	3,796
2005	10,324,998	4,279
2006	9,005,394	3,732
2007	9,263,466	3,839
2008	9,263,466	3,839
2009	9,263,466	3,839
2010	9,263,466	3,839
2011	9,263,466	3,839
2012	9,263,466	3,839
2013	9,263,466	1,600
Total	**97,140,911**	**38,017**

BDL = 38,017 tCO_2 over ten years.

(iii) Stack emissions from the flare or energy generation

Methane may be released as a result of incomplete combustion when the recovered biogas is used for electricity and/or heat production. Since the efficiency for the flares are not available, a conservative destruction efficiency factor is used.

The basis for this emissions estimate is the amount of biogas collected in the outlet of the Biodigester.

Equation 15 shows the complete equation used to calculate the stack emissions from energy generation. Recall that biogas was not used in the project activity until December 2003.

Equation 15

$$SEEG = VB \times MF \times VM \times \left(1\text{-}LF_{digester}\right) \times GWP_{CH4} \times \left(1 - DEF_{boiler}\right)$$

Where,

SEEG	=	Stack emissions from energy generation; (tCO_2)
DEF_{boiler}	=	Destruction efficiency factor; (95% for boiler No. 2 and No. 3 and 80% for boiler No. 1[12])

Note: at the time of the monitoring, it will be calculated the stack emissions for the biogas volume going to the boilers No. 2 and No. 3 with 95% of destruction efficiency factor and with 80% of destruction efficiency factor when the biogas goes to the boiler No. 1.

Note: As indicated in "Tool to determine project emissions from flaring gases containing methane", Project Emissions from flaring residual gases are calculated based on both flare combustion efficiency and flow of residual gases. The flare efficiency is calculated as a comparison between the methane content in the exhaust gas (stack gas) of the flare and the methane content of the residual gas entering the flare. In the case of an open flare, stack gases (which include remaining methane) are mixed with external air, making unreliable the measure of efficiency. The same rationale applies to the measure of the flow in the flare stack, as the exhaust flow is constantly mixed with external air, making unreliable the measure of the flow rate.

When a determined biogas volume is sent to the flare instead of being sent to the boilers, the calculation of the stack emissions from the flare will be performed as follows:

Equation 15 (a)

$$SE_{flare} = MF \times VB_{flare} \times \left(1 - DEF_{flare}\right) \times VM_{flare} \times GWP_{CH4}$$

Where,

SE_flare	=	Stack emissions from the flare; (tCO_2)
DEF_{flare}	=	Destruction efficiency factor; (50%)

Note: AM0013 Version 03 indicates that 99% can be used for enclosed flares and 50% can be used for open flares as destruction efficiency factor.

[12] Files: Manufacturer specification boiler 2 and 3 (95%) and Manufacturer specification boiler 1 (80%).

The following table summarizes the equations and data presented above. Note that since the Project Activity started in June 2003, the values presented for Years 2003 and 2013 are half-year totals such that a full 10-year Crediting Period is provided.

Table 21: SEEG Annual Summary

Year	VB_{cogen} (Nm^3)	SEEG (tCO_2)
2003	805,359	317
2004	9,159,249	3,606
2005	10,324,998	4,065
2006	9,005,394	3,545
2007	9,263,466	3,647
2008	9,263,466	3,647
2009	9,263,466	3,647
2010	9,263,466	3,647
2011	9,263,466	3,647
2012	9,263,466	3,647
2013	9,263,466	1,520
Total	**94,139,263**	**34,935**

SEEG = 34,935 tCO_2 over ten years

(iv) Emissions from heat use and electricity use due to the project activity

There are emissions associated with the electricity consumed by digester auxiliary equipment prior to the installation of on-site generating equipment in 2008. Starting in 2008, the electricity consumed by the digester auxiliary equipment and then condenser fans and pumps used to generate electricity on-site will consume electricity.

Therefore, the electric consumed by the project activity is the sum of the digester auxiliary equipment as well as the condenser fans and pumps used to generate electricity on-site. Together, the digester auxiliaries and condenser electricity consumption are referred here as parasitic loads and are estimated to be 1,176 and 443 MWh per year, respectively.

The project activity does not include the addition of any thermal energy use and therefore there are no emissions estimated for heat use in this section.

Equation 16

$$PE_{elec/heat} = EL_{p,y} \times CEF_d$$

Where,

$PE_{elec/heat}$	=	The project activity emissions from heat and electricity use due to the project activity; (tCO_2)
$EL_{p,y}$	=	The amount of electricity in the year y that is consumed at the project site for the project activity; (MWh)
CEF_d	=	The CO_2 emissions factors for the electricity consumed at the project site during the project activity. This value is equal to the $CEF_{Bl,elec,y}$ variable established above.

Table 22: $PE_{elec/heat}$ Annual Summary

Year	$EL_{p,y}$ (MWh)	$PE_{elec/heat}$ (tCO_2)
2003	563	397
2004	1176	829
2005	1176	829
2006	1176	829
2007	1176	829
2008	1,619	1,141
2009	1,619	1,141
2010	1,619	1,141
2011	1,619	1,141
2012	1,619	1,141
2013	844	595
Total	**14,206**	**10,015**

$$PE_{elec\,/\,heat} = 10{,}015\ tCO_2 \text{ over ten years}$$

(v) Emissions from land application of sludge

No sludge is present in the project activity as the sludge from the digester is re-injected back into the digester.

(vi) Emissions from wastewater removed in the dewatering process

The project activity does not include the removal of wastewater from the dewatering process and therefore no emissions are estimated for this section.

Total GHG Emissions Attributable to the Project

Total project emissions attributable to project activities are the sum of each of the emissions components established above.

Equation 17

$$PE = CO2e_{lagoon\text{-}project} + BDL + SEEG + PE_{elec\,/\,heat}$$

Therefore, for the CLNSA project,

Table 23: Project Annual Summary

Year	CO_2 lagoon project (tCO_2)	BDL (tCO_2)	SEEG (tCO_2)	PEelec/heat (tCO_2)	PE (tCO_2)
2003	13,874	1,578	317	397	16,165
2004	22,828	3,796	3,606	829	31,059

2005	22,828	4,279	4,065	829	32,001
2006	22,828	3,732	3,545	829	30,935
2007	22,828	3,839	3,647	829	31,143
2008	22,828	3,839	3,647	1,141	31,455
2009	22,828	3,839	3,647	1,141	31,455
2010	22,828	3,839	3,647	1,141	31,455
2011	22,828	3,839	3,647	1,141	31,455
2012	22,828	3,839	3,647	1,141	31,455
2013	22,828	1,600	1,520	595	26,542
Total	**242,155**	**38,017**	**34,935**	**10,015**	**325,122**

Total PE = 325,122 tCO_2 over ten years

Leakage

No leakage is associated with the project activity.

A summary of the changes made to the emission reductions spreadsheet vs. the registered PDD is presented as follows:

1. A cover page was added.
2. Sheet ”MCF”: no changes were made.
3. Sheet ”Ft”: the names of the months and the titles in column A were translated to English.
4. Sheet ”Monthly Summary”: the name of spreadsheet was translated to English, as were the titles in rows 2 and 3, and the texts in cells b17 and c18.
5. Sheet ”Monthly Detail”: the name of spreadsheet was translated to English, as were the few texts that were in Spanish in the spreadsheet.
6. Sheet ”COD”: the average on cell b15 was corrected (does not affect results), and the names of the months were translated.
7. Sheet ”COD Avail”: the names of the months were translated into English.
8. Sheet “Base Lagoon”: the names of the months were translated into English.
9. Sheet “biogas”: most of the texts and names of months were translated into English.
10. Sheet “BE Elec”: the names of the months were translated into English.
11. Sheet “Baseline”: no changes were made.
12. Sheet “Project Lagoon”: The portion of the formula “COD Lagoon” was removed (to remove the portion of untreated vinasse). Column “COD enter lagoon” was removed, and columns “CH4 lagoon project” and “CO2 lagoon project” were corrected to remove the portion of untreated vinasse. The formula on cell D45 was dragged into cells D46-D53 to account for the fact that the amount of vinasse directed to the land application was not measured. Titles and other texts were translated into English.
13. Sheet “BDL”: no changes were made.
14. Sheet “SEEG”: no changes were made.
15. Sheet “PE elec”: no changes were made.

Parameter	Proposed Change	Comments About Excel Spreadsheet
M5: Lagoon depth	To use a conservative value of "1m < d < 5 m", with 50% anaerobic conditions, which represents the most conservative scenario in terms of project emissions.	No change was necessary, since at the time of the preparation of the PDD a 2.1 m lagoon depth was assumed, which corresponds to 50% anaerobic conditions, as the proposed approach.
M12: Biogas flow entering flare	To calculate the amount of biogas entering the flare on a mass balance basis by comparing the biogas volume leaving the biogas reactor (measured by a flow meter) and the biogas volume entering the heat generation system (measured by another flow meter).	No change was necessary, since no change is expected between the measurement of a single flow meter and the mass balance analysis.
M1/M6: Wastewater flow into the digester	The calculation method and inputs used in the PDD for baseline and project emissions from methane generation in the lagoon system are based on the total amount of wastewater produced by the distillery. However, the calculation method of AM0013, Version 3 is based on the wastewater input to the digester or directed to land application. Given the fact that AM0013 uses exactly the same formula for lagoon baseline and project emissions, AM0013 assumes that any wastewater stream bypassing the digester and flowing directly to the lagoon system would lead to the same amount of baseline and project emissions, cancelling each other in the emission reduction calculations. The calculation approach in the PDD has been developed due to the planned laminar irrigation process during the wet season, which would eliminate project emissions from the lagoon system because the lagoon would be completely avoided in the wet season. However, there is not enough monitoring data to verify the impact of laminar irrigation in reducing project emissions, so it is conservatively assumed that the wastewater is always directed to the anaerobic lagoon, leading to higher project emissions.	1. The portion of the formula “COD Lagoon” was removed (to remove the portion of untreated vinasse). Column “COD enter lagoon” was removed, and columns “CH4 lagoon project” and “CO2 lagoon project” were corrected remove the portion of untreated vinasse. 2. On spreadsheet “Project Lagoon” the formula from cell D45 was copied to cells D46-D53. Originally the values of COD in these cells were zero because the vinasse would be directed to land application. Since it was not directed to land application, COD is not zero.

B.6.2. Data and parameters fixed ex ante

Data / Parameter	**B_O**
Unit	kg CH_4/kg COD
Description	Maximum methane producing capacity
Source of data	AM0013 version 03 (p.7)
Value(s) applied	0.21
Choice of data or Measurement methods and procedures	Refer to methodology AM0013 version 03 (p.7)
Purpose of data	Baseline emissions calculations
Additional comment	-

Data / Parameter	**f_d**
Unit	%
Description	Fraction of anaerobic degradation due to depth
Source of data	AM0013 version 03 (p. 7)
Value(s) applied	50 %
Choice of data or Measurement methods and procedures	Refer to methodology AM0013 version 03 (p.7)
Purpose of data	Baseline emissions calculations
Additional comment	Table 1 of AM0013 Version 03 states that the fraction of degradation under anaerobic conditions for an average depth of 1.5 meters is 50%.

Data / Parameter	**Uncertainty conservativeness factor**
Unit	-
Description	Uncertainty conservativeness factor
Source of data	AM0013 version 03 (p. 7)
Value(s) applied	0.89
Choice of data or Measurement methods and procedures	Refer to methodology AM0013 version 03 (p.7)
Purpose of data	Baseline emissions calculations
Additional comment	The uncertainty conservativeness factor (for an uncertainty range of 30% to 50%) is used to account for the fact that the equation used to estimate Ft,monthly assumes full anaerobic degradation at 30 °C.

Data / Parameter	**E**
Unit	Cal / mol
Description	Activation energy constant
Source of data	AM0013 version 03 (p. 7)
Value(s) applied	15,175
Choice of data or Measurement methods and procedures	Refer to methodology AM0013 version 03 (p.7)
Purpose of data	Baseline emissions calculations
Additional comment	-

Data / Parameter	**T1**
Unit	ºK
Description	Temperature at which full anaerobic degradation occurs
Source of data	AM0013 version 03 (p. 7)
Value(s) applied	303.16
Choice of data or Measurement methods and procedures	Refer to methodology AM0013 version 03 (p.7)
Purpose of data	Baseline emissions calculations
Additional comment	-

Data / Parameter	**R**
Unit	Cal / K mol
Description	Ideal gas constant
Source of data	AM0013 version 03 (p. 8)
Value(s) applied	1.987
Choice of data or Measurement methods and procedures	Refer to methodology AM0013 version 03 (p.8)
Purpose of data	Baseline emissions calculations
Additional comment	-

Data / Parameter	**GWP_{CH4}**
Unit	-
Description	Global warming potential of CH_4
Source of data	AM0013 version 03 (p. 8)
Value(s) applied	21
Choice of data or Measurement methods and procedures	Refer to methodology AM0013 version 03 (p.8)
Purpose of data	Baseline / Project emissions calculations
Additional comment	-

Data / Parameter	**EG**
Unit	MWh
Description	The amount of electricity that would be consumed at the project site in the absence of the project activity.
Source of data	PDD (p. 48)
Value(s) applied	0 (prior to 2012)
Choice of data or Measurement methods and procedures	Refer to registered PDD P. 48
Purpose of data	Baseline emissions calculations
Additional comment	-

Data / Parameter	CEC_F
Unit	kWh/Nm^3 biogas
Description	Cogeneration electric conversion factor
Source of data	PDD (p. 48)
Value(s) applied	0.676
Choice of data or Measurement methods and procedures	Refer to registered PDD P. 48
Purpose of data	Baseline emissions calculations
Additional comment	-

Data / Parameter	FOE
Unit	gal / Nm3
Description	Bunker C fuel oil equivalent of biogas
Source of data	PDD (p. 50)
Value(s) applied	0.145
Choice of data or Measurement methods and procedures	Refer to registered PDD P. 50
Purpose of data	Baseline emissions calculations
Additional comment	-

Data / Parameter	HV
Unit	MJ/gal
Description	Heating value of bunker C fuel oil
Source of data	PDD (p. 50)
Value(s) applied	152.9
Choice of data or Measurement methods and procedures	Refer to registered PDD P. 50
Purpose of data	Baseline emissions calculations
Additional comment	-

Data / Parameter	**TER**
Unit	-
Description	Thermal to electric ratio of the cogeneration system
Source of data	PDD (p. 51)
Value(s) applied	4.3
Choice of data or Measurement methods and procedures	Refer to registered PDD P. 51
Purpose of data	Baseline emissions calculations
Additional comment	-

Data / Parameter	$\eta_{baselineboiler}$
Unit	%
Description	Efficiency of the baseline boiler
Source of data	PDD (p. 51)
Value(s) applied	80%
Choice of data or Measurement methods and procedures	Refer to registered PDD P. 51
Purpose of data	Baseline emissions calculations
Additional comment	-

Data / Parameter	$BF_{digester}$
Unit	Nm^3 biogas/kg COD
Description	COD to biogas conversion factor
Source of data	PDD (p. 60)
Value(s) applied	0.364
Choice of data or Measurement methods and procedures	Refer to registered PDD P. 60
Purpose of data	Project emissions calculations
Additional comment	-

Data / Parameter	**MF**
Unit	%
Description	Methane fraction of biogas
Source of data	PDD (p. 60)
Value(s) applied	55%
Choice of data or Measurement methods and procedures	Refer to registered PDD P. 60
Purpose of data	Project emissions calculations
Additional comment	-

Data / Parameter	**VM**
Unit	tCH_4 / Nm^3 CH_4
Description	Volume to mass conversion factor
Source of data	PDD (p. 60)
Value(s) applied	0.0007176
Choice of data or Measurement methods and procedures	Refer to registered PDD P. 60
Purpose of data	Project emissions calculations
Additional comment	-

Data / Parameter	**$LF_{digester}$**
Unit	%
Description	Percentage of biogas leaking from digester
Source of data	PDD (p. 60)
Value(s) applied	5%
Choice of data or Measurement methods and procedures	Refer to registered PDD P. 60
Purpose of data	Project emissions calculations
Additional comment	-

Data / Parameter	**DEF_{boiler}**
Unit	%
Description	Destruction efficiency factor for low pressure boiler
Source of data	Manufacturer specification
Value(s) applied	95%
Choice of data or Measurement methods and procedures	N.A.
Purpose of data	Project emissions calculations
Additional comment	95% has been applied in the ex-ante calculation as it is expected to send the biogas at outlet of the biodigester to the newest boilers (boiler 2 and boiler 3); however during the monitoring for those cases the biogas is sent to the boiler 1, it will be consider for that volume of biogas 80%. As per the manufacturer specification, for boiler 2 and boiler 3, the efficiency is 95%. As per the manufacturer specification, for boiler 1, the efficiency is 80%.

Data / Parameter	**DEF_{flare}**
Unit	%
Description	Destruction efficiency factor for open flare
Source of data	AM0013 version 3 (p.10)
Value(s) applied	50%
Choice of data or Measurement methods and procedures	Refer to methodology AM0013 version 03 (p.10)
Purpose of data	Project emissions calculations
Additional comment	As proposed in page 10 of AM0013 Version 3 and in the description of project emissions calculation formulas under Section E.2 of the PDD (p. 61), a conservative destruction factor of 50% should be used for open flares in cases where the efficiency of the flare cannot be measured.

Data / Parameter	**$CEF_{Bl,elec,y}$**
Unit	tCO_2/MWh
Description	CO_2 emission factor for electricity consumed at the project site in the absence of the project activity
Source of data	AM0013 Version 03 (p. 9) and ACM0002 Version 6
Value(s) applied	0.705
Choice of data or Measurement methods and procedures	Refer to methodology AM0013 version 03 (p.9) and ACM0002 Version 6
Purpose of data	Baseline emission calculations
Additional comment	**-**

Data / Parameter	**$CEF_{Bl,therm}$**
Unit	tCO_2 / MJ
Description	CO_2 emissions intensity for thermal energy generation
Source of data	AM0013 version 3 (p.9)
Value(s) applied	0.00007652
Choice of data or Measurement methods and procedures	Refer to methodology AM0013 version 03 (p.9)
Purpose of data	Baseline emission calculations
Additional comment	-

B.6.3. Ex ante calculation of emission reductions

>>

The following tables shows the application of the formulas, procedures and methodological choices described in section B.6.1:

Baseline emissions

Equation[13]	**Description**
Lagoon Baseline Emissions	
$CH_{4lagoonbaseline} = COD_{available,m} \times B_O \times MCF_{baseline}$ **Sample calculation December 2003:**	$CH_{4\ lagoon\ baseline}$ = CH_4 emissions from wastewater lagoon that would have occurred in the absence of the project (kg/month)

[13] For complete calculations please refer to CER Calculation Spreadsheet

Equation[13]	Description
$CH_{4lagoon\ baseline}$ = 6,676,461 x 0.21 x 0.372 $CH_{4lagoon\ baseline}$ = 521,953 kg	$COD_{available,m}$ = The monthly Chemical Oxygen Demand available for conversion which is equal to the monthly COD entering the digester plus COD carried on from the previous month B_o = Maximum methane producing capacity (0.21 kg CH_4/kg COD) $MCF_{baseline}$ = Monthly methane conversion factor
$COD_{available,\ m} = COD_{baseline,\ m} \times AD + (1-MCF_{baseline,\ m-1}) \times COD_{available,\ m-1}$ **Sample calculation December 2003:** $COD_{available,m}$ = 4,185,720 x 70% + (1-0.378) x 6,022,207 $COD_{available,m}$ = 6,676,461 kg	$COD_{baseline,m}$ = Monthly Chemical Oxygen Demand of effluent entering Lagoons or directed to land application AD = Factor by which the COD is adjusted to account for the effluent present in the lagoon prior to the implementation of the project $MCF_{baseline,\ m-1}$ = The monthly methane conversion factor from the previous month $COD_{available,m}$ = The monthly Chemical Oxygen Demand available for conversion from the previous month
$AD = 1 - \left(\frac{COD_{a,out}}{COD_{a,in}}\right)$ **Sample calculation used for entire period:** (Default value, conservative value as explained in section B.6.1)**:** AD = 70%	$COD_{a,out}$ = COD that leaves the lagoon with the effluent $COD_{a,\ in}$ = COD that enters the lagoon
$MCF_{baseline} = f_d \times f_{t,monthly} \times 0.89$ **Sample calculation December 2003:** $MCF_{baseline}$ = 0.50 x 0.744 x 0.89 $MCF_{baseline}$ = 0.331	F_d = the fraction of anaerobic degradation due to depth of the sludge pit. Table 1 of AM0013 Version 03 shows the fraction of degradation under anaerobic conditions for different depths. $f_{t,monthly}$ = the fraction of anaerobic degradation due to temperature 0.89 = the uncertainty conservativeness factor (for uncertainty range of 30% to 50%) to account for the fact that the equation used to estimate $F_{t,monthly}$ assumes full anaerobic degradation at 30 °C.
$f_{t,monthly} = \exp\left[\frac{E \times (T_2 - T_1)}{R \times T_1 \times T_2}\right]$ **Sample calculation December 2003:** $f_{t,monthly}$ = exp [15,175 x (299.6 – 303.16) ÷ (1.987 x 303.16 x 299.6)] $f_{t,monthly}$ = 0.744	E = The Activation energy constant (15,175 cal/mol) T_2 = Ambient temperature (Kelvin) for the climate. T_1 = 303.16 (273.16° + 30°) R = Ideal gas constant (1.987 cal/ K mol).
$CO_{2e\ lagoon\ base} = CH_{4\ lagoon\ baseline} \times GWP_{CH4} / 1000$ **Sample calculation December 2003:** $CO_{2e\ lagoon\ base}$ = 521,953 x 21 / 1000	$CO_2e_{\ lagoon\ base}$ = The baseline metric tons of CO_2 equivalent emissions from lagoon that would take place in the absence of the project activity (tCO_{2eq}) GWP_{CH4} = Global warming potential of CH_4 (21)

Equation[13]	Description
$CO_{2e\ lagoon\ base}$ = 10,961.01	
Electricity Baseline Emissions	
$BE_{elec/heat} = EG_y \times CEF_{Bl,elec,y} + EG_{d,y} \times CEG_{grid} + HG_{Bl,y} \times CEF_{bl,therm,y}$ **Sample calculation December 2003:** $BE_{elec/heat}$ = 0 x 0 + 0 x 0 + 17,855,212 x 0.00007652 $BE_{elec/heat}$ = 1,366	$BE_{elec/heat}$ = The baseline electricity and thermal energy consumption that would take place in the absence of the project activity (tCO_{2eq}) EG_y = the amount of electricity in the year y that would be consumed at the project site in the absence of the project activity (MWh). $CEF_{Bl,elec,y}$ = the CO_2 emission factor for electricity consumed at the project site in the absence of the project activity (tCO_2/MWh) $EG_{d,y}$ = the amount of electricity generated utilizing the biogas collected during project activity and exported to the grid during the year y (MWh) CEF_{grid} = the CO_2 emission factor for the grid where electricity is exported (tCO_2/MWh) $HG_{BL,y}$= the quantity of thermal energy that would be consumed in year y at the project site in the absence of the project activity using fossil fuel (MJ). $CEF_{Bl,therm,y}$ = the CO_2 emissions intensity for thermal energy generation (tCO_2 e/MJ)
EG_y **Sample calculation: N/A** (There was no electricity generation during the reporting period)	Prior to 2008, EG_y is equal to zero. Starting in 2008, EG_y is equal to the project activity electric generation since the electricity that is consumed in the baseline situation is the same as the net generation of the project activity. This holds true because the electric generation will be consumed entirely on-site and will only displace grid-imported electricity.
$EG_y = \left[\frac{VB \times CECF}{CF_1}\right]$ **Sample calculation: N/A (**No cogeneration unit has been installed during the reporting period)	VB = The volume of biogas recovered from the biodigester process and used in the cogeneration unit; (Nm^3) CECF = Cogeneration electric conversion factor; (0.676 kWh /Nm^3 biogas) CF1 = Conversion factor; 1000 kWh / MWh
$HG_{BL,y} = VB \times FOE \times HV$ **Sample calculation December 2003:** HG_{BL} = 805,359 x 0.145 x 152.9 HG_{BL} = 17,855,212	$HG_{BL,y}$ = The quantity of thermal energy that would be consumed in year y at the project site in the absence of the project activity (MJ) VB = Volume of biogas recovered from the digester process and used to replace ; (Nm^3) FOE = Bunker C fuel oil equivalent of biogas; (0.145 gal/ Nm^3) HV = Heating value of Bunker C fuel oil; (152.9 MJ/gal)
$HG_{BL,y} = \frac{EG_y \times TER}{\eta_{baselineboiler}} \times CF_2$	TER = The thermal to electric ratio of the cogeneration system; $\eta_{baselineboiler}$ = Efficiency of the baseline boiler;

Equation[13]	**Description**
Sample calculation: N/A (No cogeneration unit has been installed during the reporting period)	(80%) CF_2 = Conversion factor; 3600 MJ/MWh
$CM_{1stcreditingperiod} = \frac{OM_{year1} + BM_{historical\_(or\_year1-7)}}{2} = \frac{tCO_{2e}}{MWh}$ **Sample calculation:** $CM_{1stcreditingperiod}$ = 0.749 / 2 + 0.660 / 2 $CM_{1stcreditingperiod}$ = 0.705	$CM_{1stcreditingperiod}$ = Combined Margin emission factor, which represents the carbon intensity (CI) of the grid and is the average of the Operating Margin (OM) and the Build Margin (BM). Since low-cost must-run resources comprise less than 50% of total electricity generation on the Nicaraguan grid, Option B (Simple OM) is allowed for determining the CM. Under Option B, the OM represents the weighted average of all resources except low-cost/must-run facilities.
OMyear i = Sum (E_i) / Sum (EG_i) (tCO_2e/MWh) **Sample calculation:** Ei =1,470,291 + 1,486,190 + 1,547470 EGi = 1,946,000 + 1,991,000 + 2,078,000 Thus, OM = 4,503,951 / 6,015,000 OM = 0.749	OMyear i = Operating Margin for year i, which needs to be calculated according to the proposed procedure of the baseline methodology E_i = Total tonnes of CO_2-equivalent emission per year of plant "i" including all plants except low-cost/must-run facilities (tCO_2e) EG_i = Total annual energy generated (MWh) by plant "i" – including all plants except low-cost/must-run facilities.
$E_i = FC_i \times CV_i \times EF_i \times Ox$ **Sample calculation:** Refer to registered PDD.	FC_i =Annual fossil fuel consumption of thermal plant "i" (liters, t or m^3); CV_i = Calorific value of fuel used in plant "i" (TJ/L, TJ/t or TJ/m^3) EF_i = Fossil fuel emission factor (tCO_2e/TJ); Ox = Fraction of carbon oxidized
OM can be now calculated using the equation above and the following values for the variables are attributed: E_i =1.470.291 tCO_2e in 2002 + 1,486,190 tCO_2e in 2003 + 1,547470 $mtCO_2e$ in 2004; EG_i = 1.946.000 MWh in 2002 + 1,991,000 MWh in 2003 + 2,078,000 MWh in 2004; Thus, OM = 4,503,951 tCO_2e / 6,015,000 MWh OM = 0.749 tCO2e/MWh BM emission factor is BM = 2,490,459 $mtCO_2e$ / 3,773,000 MWh = 0.660 tCO_2/MWh Combined Margin CM = 0.5*OM + 0.5*BM CM = 0.5*0.749 + 0.5*0.660 CM = $CEF_{Bl,elec,y}$ = 0.705 tCO_2/MWh	
$CEF_{Bl,therm,y}$ is the CO_2 emissions intensity for thermal energy generation. Thermal energy generation in the project activity displaces Bunker C fuel oil in the baseline. Therefore, $CEF_{Bl,therm,}$y is equal to 0.00007652 tCO_2/MJ.[14]	
Total GHG Emissions Attributable to the Baseline	

[14] Refer to page 56 of the registered PDD.

Equation[13]	Description
$BE = CO2e_{lagoonbase} + BE_{elec/heat}$ **Sample calculation year 2003:** BE= 64,555 + 4,613 BE = 69,164	BE = Total baseline emissions (tCO_{2eq})

Project emissions

Equation[15]	Description
Methane Emissions From Lagoon	
$CH_{4\,lagoonproject} = COD_{digout} \times B_0 \times MCF_{baseline}$ **Sample calculation December 2003:** $CH_{4lagoon\ project}$ = 1,187,424 x 0.21 x 0.372 $CH_{4lagoon\ project}$ = 92,831	$CH_{4\ lagoon\ project}$ = CH_4 emissions from wastewater lagoon (kg/month) $COD_{dig\ out}$ = The COD of effluent leaving the digester and entering the lagoon, (kg COD/yr) B_o = Maximum methane producing capacity (0.21 kg CH_4/kg COD) $MCF_{baseline}$ = Monthly methane conversion factor
$CO_2e_{\ lagoon\ project}$ = $CH_{4\ lagoon\ project}$ x GWP_{CH4} / 1000 **Sample calculation December 2003:** $CO_{2\ lagoon\ project}$ = 92,831 x 21 / 1000 $CO_{2\ lagoon\ project}$ = 1,949	$CO_{2e\ lagoon\ project}$ = The metric tons of CO_2 equivalent emissions from lagoon (tCO_2eq) GWP_{CH4} = Global warming potential of CH_4 (21)
Physical Leakage from Biodigesters	
$BDL = VB \times MF \times VM \times LF_{digester} \times GWP_{CH4}$ **Sample calculation year 2003:** BDL = 3,807,007 x 55% x 0.0007176 x 5% x 21 BDL = 1,578	BDL = Physical leakage from the biodigesters, (tCO_2) VB = Volume of biogas recovered from the digester process (Nm^3) $COD_{available,y}$ = Annual organic waste treated by digester (kg); $BF_{digester}$ = COD-to-biogas conversion factor; (0.364 Nm^3 biogas/kg COD) MF = Methane (CH_4) fraction of biogas; (55%) VM = Volume-to-mass conversion factor; (0.0007176 tCH_4/ Nm^3 CH_4) $LF_{digester}$ = Percentage of biogas leaking from digester; (5%) GWP_{CH4} = Global warming potential of CH_4; (21)
Stack Emissions From Energy Generation	
$SEEG = VB \times MF \times VM \times (1\text{-}LF_{digester}) \times GWP_{CH4} \times (1\text{-}\ DEF_{boiler})$ Sample calculation year 2003: **SEEG =** 805,359 x 0.55 x 0.0007176 x (1 – 0.05%) x 21 x (1 – 0.95) SEEG = 317	SEEG = Stack emissions from energy generation; (tCO_2) DEF_{boiler} = Destruction efficiency factor; (95%) Note: it has been applied a destruction efficiency factor of 95% corresponding to the boilers 2 and 3, due it is expected to send the biogas to these

[15] For complete calculations please refer to CER Calculation Spreadsheet

Equation[15]	Description
	boilers (the newest equipment); however if the biogas is sent to the boiler 1, it will be considered a destruction efficiency factor of 80%. In accordance with the manufacturer specification for boilers 2 and 3, the destruction efficiency factor is 95%. In accordance with the manufacturer specification for boiler 1, the destruction efficiency factor is 80%.
Stack Emissions From the Flare	
$SE_{flare} = MF \times VB_{flare} \times \left(1 - DEF_{flare}\right) \times VM_{flare} \times GWP_{CH4}$	SE_{FLARE} = Stack emissions from the flare; (tCO_2) DEF_{flare} = Destruction efficiency factor; (50%) Note: It has been considered for the exante calculation that all the biogas at te outlet of the biodigester goes to the boilers and not to the flare; however during the monitoring the above formula will be applied for the biogas volume that is sent to the flare to the determine the stack emissions from the flare. At the time of the PDD registration it is not possible to determine in advance the volume that will be sent to the boilers and the biogas volume that will be sent to the flare
Emissions From Heat Use and Electricity Use due to the Project Activity	
$PE_{elec/heat} = EL_{p,y} \times CEF_d$ [16] **Sample calculation year 2003:** $PE_{elec/heat}$ = 563 x 0.705 $PE_{elec/heat}$ = 397	$PE_{elec/heat}$ = The project activity emissions from heat and electricity use due to the project activity; (tCO_2) $EL_{p,y}$ = The amount of electricity in the year y that is consumed at the project site for the project activity; (MWh). It is worth noting that prior to the installation of the meters project electricity consumption for the effluent treatment plant and the boiler was calculated by multiplying the rated capacity of the equipment and assuming 24 hour operation during the monitoring period, as indicated by the Executive Board in the approval for the Request for Deviation. CEF_d = The CO_2 emissions factors for the electricity consumed at the project site during the project activity. This value is equal to the $CEF_{Bl,elec,y}$ variable established above.
Emissions from land application of sludge	
No sludge is present in the project activity as the sludge from the digester is re-injected back into the digester.	
Emissions from wastewater removed in the dewatering process	
The project activity does not include the removal of wastewater from the dewatering process and therefore no emissions are estimated for this section.	

[16] Refer to page 62 of the registered PDD, to the paragraph titled "(iv) Emissions from heat use and electricity use due to the project activity".

Equation[15]	Description
Total GHG Emissions Attributable to the Project are the Sum of Each of the Emissions Components Established Above.	
$PE = CO_2e_{lagoon-project} + BDL + SEEG + SE_{flare} + PE_{elec/heat}$ **Sample calculation year 2003:** PE = 13,874 + 1,578 + 317 + 0 + 397 PE = 16,165	PE = Total project emissions (tCO_2e)

Leakage

There is no leakage is associated with the project activity.

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

Year	Baseline emissions ($t\ CO_2e$)	Project emissions ($t\ CO_2e$)	Leakage ($t\ CO_2e$)	Emission reductions ($t\ CO_2e$)
2003	69,164	16,165	0	52,998
2004	150,339	31,059	0	119,280
2005	152,317	32,001	0	120,316
2006	150,078	30,935	0	119,143
2007	150,078	31,143	0	118,935
2008	148,487	31,455	0	117,032
2009	148,487	31,455	0	117,032
2010	148,487	31,455	0	117,032
2011	148,487	31,455	0	117,032
2012	148,487	31,455	0	117,032
2013	75,953	26,542	0	49,411
Total	1,490,365	325,122	0	1,165,243
Total number of crediting years	10			
Annual average over the crediting period	149,036	35,512	0	116,524

B.7. Monitoring plan

B.7.1. Data and parameters to be monitored

Data / Parameter	**M1 (F_{dig})**
Unit	m^3 / yr
Description	Flow rate of organic wastewater into the digester
Source of data	Measurements
Value(s) applied	Refer to file: ER Calculation x PDD UNFCCC Ref. No. 0675.xls
Measurement methods and procedures	Flow meter (Biodigester A hourly inlet flow rate * hours of operation) + (Biodigester B hourly inlet flow rate * hours of operation)
Monitoring frequency	Measuring: Continuous Reading: Continuous Recording: 3 times per day This parameter will be aggregated monthly for calculations
QA/QC procedures	Flow meters will be subject to regular maintenance and testing regime to ensure accuracy. Calibration frequency: as per manufacturer recommendation or at least once per year Accuracy: at least 1%
Purpose of data	Baseline emissions calculations
Additional comment	It will be added the flow of each biodigester flow meter to calculate the total amount of wastewater flowing into the digesters. M1 and B2 should not be necessarily the same. B2 is the vinasse generated by the distillation process. M1 is the vinasse that goes into the Biodigestor. It is possible that: a) B2 could be higher than M1 if a portion of the vinasse from CLNSA´s Alcohol Production Process was sent directly to the lagoon; this effluent would be accounted for in parameter B2 and not in parameter M1 (Flow rate of organic wastewater into the digester); and b) M1 could be higher B2 when the vinasse that entered into the biodigesters was diluted. M1 measures the diluted vinasse effluent. **B**aseline and project emissions shall be based only on the wastewater volume entering the digester, which is in line with AM0013 Version 3 and leads to a reduction in the emission reduction calculations as compared to ex-ante assumptions in the PDD.

Data / Parameter	**M2 ($COD_{c,BI)}$**
Unit	KgCOD / m^3
Description	COD concentration of organic wastewater into the digester or directed to land application
Source of data	Measurements
Value(s) applied	Refer to file: ER Calculation x PDD UNFCCC Ref. No. 0675.xls
Measurement methods and procedures	The monitoring equipment will consist of: - Spectrophotometer - Thermo reactor Average daily COD concentration of effluent entering the digester in m gCOD/Liter / 1000
Monitoring frequency	Measuring: 3 times per day Reading: 3 times per day Recording: 3 times per day
QA/QC procedures	The spectrophotometer will be subject to regular maintenance and testing regime to ensure accuracy. Calibration frequency: as per the manufacturer recommendation or in lower time intervals Accuracy: at least ± 1,5 nm, 5 mAbs at 0.0–0.5 Abs, 1% at 0.50–2.0 Abs The thermo reactor will be subject to regular maintenance and testing regime to ensure accuracy. Calibration frequency: not applicable to this type of equipment Accuracy: ± 2 °C
Purpose of data	Baseline emissions calculations
Additional comment	**---**

Data / Parameter	**M3 ($COD_{a,in}$)**
Unit	KgCOD/yr
Description	COD enters the lagoon
Source of data	Measurements
Value(s) applied	Refer to file: ER Calculation x PDD UNFCCC Ref. No. 0675.xls
Measurement methods and procedures	Parameter M3 can be considered an indirect measurement, it is a result of the following two direct measurements: a) Flow rate of organic wastewater into the digester ***(M1, measured)***; which is multiplied by b) COD concentration in discharged effluent from digester ***(M7, measured)***, as follows: Flow rate of organic wastewater into the digester (M1) * COD concentration in discharged effluent from digester (M7) Measurements with the spectrophotometer will use: closed reflux, colorimetric method.
Monitoring frequency	Measuring: Daily Reading: Daily Recording: Historical 1 year data
QA/QC procedures	The spectrophotometer will be subject to regular maintenance and testing regime to ensure accuracy. Calibration frequency: as per the manufacturer recommendation or in lower time intervals Accuracy: at least ± 1,5 nm, 5 mAbs at 0.0–0.5 Abs, 1% at 0.50–2.0 Abs The thermo reactor will be subject to regular maintenance and testing regime to ensure accuracy. Calibration frequency: not applicable to this type of equipment Accuracy: ± 2 °C
Purpose of data	Baseline emissions calculations
Additional comment	At the distillery, the total effluent is divided; part is directed to the biodigester and another part is directed to the lagoon. This parameter was not measured as indicated above, as the project only considers the effluents that enter the biodigester. At the distillery, the total effluents are divided to the biodigester (70%) and the lagoon (30%). The effluents that go directly to the lagoon are not affected by the project activity. In other words, these effluents are the same with or without project. Therefore, emissions related to this parameter are not considered.

Data / Parameter	**M4 (T_{lag})**
Unit	°K
Description	Ambient Temperature
Source of data	Measurements
Value(s) applied	Refer to file: ER Calculation x PDD UNFCCC Ref. No. 0675.xls
Measurement methods and procedures	A thermometer will be used to perform these measurements. Temperature °C + 273.15 = °K Calibration frequency: not applicable if the equipment has a lifelong guarantee on accuracy according to equipment manual Accuracy: ± 3 °C
Monitoring frequency	Measuring: Daily Reading: Daily Recording: Daily
QA/QC procedures	N/A
Purpose of data	Baseline emissions calculations
Additional comment	---

Data / Parameter	**M5 (D_{lag})**
Unit	m
Description	Depth of wastewater in the lagoon
Source of data	Measured
Value(s) applied	2.1
Measurement methods and procedures	An annual physical verification of the maximum lagoon depth will be performed to confirm that the value used is appropriate and conservative in terms of project emissions (i.e. tape measure or other method available)
Monitoring frequency	Annual verification
QA/QC procedures	N/A
Purpose of data	Project emissions calculations
Additional comment	According to methodology AM0013 Version 3 there are only three lagoon depth ranges that can influence the outcome of project emissions (d < 1m, 1m < d < 5m, d > 5m). The depth range >5 m can be excluded due to dimensional constraints of the lagoon, which reaches a maximum depth of 2.1 m at its deepest point. Thus, for project emission calculations there are only two possible ranges: "d < 1m" with fully aerobic conditions and "1m < d <5 m" with 50% anaerobic conditions, which represents the most conservative scenario in terms of project emissions. An annual physical verification of the maximum lagoon depth will be performed to confirm that the value used is appropriate and conservative in terms of project emissions (i.e. tape measure or other method available), evidence of this verification task will be presented to the verification DOE.

Data / Parameter	M6 (F_{dig_out})
Unit	m^3 / yr
Description	Flow rate of wastewater into digester
Source of data	Measurements
Value(s) applied	Refer to file: ER Calculation x PDD UNFCCC Ref. No. 0675.xls
Measurement methods and procedures	Flow meter measurments, (Biodigester A hourly inlet flow rate * hours of operation) + (Biodigester B hourly inlet flow rate * hours of operation)
Monitoring frequency	Measuring: Continuous Reading: Continuous Recording: 3 times per day
QA/QC procedures	Flow meters were subject to regular maintenance and testing regime to ensure accuracy. Calibration frequency: At least once per year Accuracy: At least 1%
Purpose of data	Project emissions calculations
Additional comment	It will be added the flow of each biodigester flow meter to calculate the total amount of wastewater flowing into the digesters. Baseline and project emissions in the monitoring reports shall be based only on the wastewater volume entering the digester, which is in line with AM0013 Version 3 and leads to a reduction in the emission reduction calculations as compared to ex-ante assumptions in the PDD.

Data / Parameter	M7 (COD_{c,dig_out})
Unit	kg COD / m^3
Description	COD concentration in discharged effluent from digester
Source of data	Measurements
Value(s) applied	Refer to file: ER Calculation x PDD UNFCCC Ref. No. 0675.xls
Measurement methods and procedures	Measurement with the spectrophotometer COD concentration of effluent entering the digester in mgCOD/Liter / 1000
Monitoring frequency	Measuring: 3 times per week Reading: 3 times per week Recording: 3 times per week
QA/QC procedures	The spectrophotometer was subject to regular maintenance and testing regime to ensure accuracy Calibration frequency: as per the manufacturer recommendation or in lower time intervals Accuracy: ± 2 °C
Purpose of data	Project emissions calculations
Additional comment	**---**

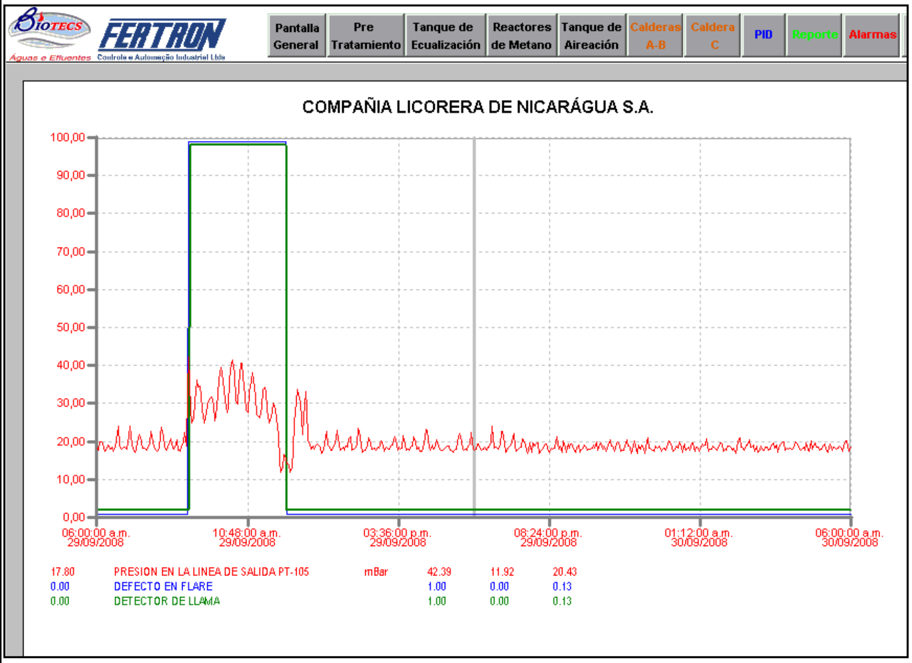
Data / Parameter	**M8 ($EL_{p,y}$)**
Unit	MWh
Description	Amount of electricity consumed by the project activity during the monitoring period
Source of data	Measurements
Value(s) applied	Refer to file: ER Calculation x PDD UNFCCC Ref. No. 0675.xls
Measurement methods and procedures	Measurement with an energy meter (Energy consumption from meter at Biodigester Plant in kWh + Energy consumption from meter at boilers in kWh) / 1000
Monitoring frequency	Measuring: Continuous Reading: Continuous Recording: Daily
QA/QC procedures	Electricity meters were subject to a regular maintenance and testing regime to ensure accuracy Calibration frequency: 0.2% Accuracy: 0.2% class
Purpose of data	Project emissions calculations
Additional comment	--

Data / Parameter	**M9**
Unit	Kg
Description	Mass of fossil fuel used onsite during the monitoring period
Source of data	Measurements
Value(s) applied	Refer to file: ER Calculation x PDD UNFCCC Ref. No. 0675.xls
Measurement methods and procedures	Flow meter measurements (Boiler A flow in liters + Boiler B flow in liters + Boiler C flow in liters) * Density of fuel oil / 1000
Monitoring frequency	Measuring: Continuous Reading: Continuous Recording: Daily
QA/QC procedures	Flow meters were subject to regular maintenance and testing regime to ensure accuracy. Calibration frequency: At least once per year Accuracy: +/-0.1%
Purpose of data	Although the mass of fossil fuel used onsite is not a parameter that is used in the emission reduction calculations in accordance to Methodology AM0013 version 3, the mass of fossil fuel used onsite is measured as part of the operating parameters monitored by the company.
Additional comment	This variable is measured because, for the company´s internal processes, it is necessary to measure the amount of fossil fuel used onsite. However, this value is not used in the calculation of the emission reductions in accordance with the Methodology AM0013 version 3 formulae. Table “Variable Equivalence Table” on this Monitoring Report shows that variable M9 has no corresponding variable according to the methodology.

Data / Parameter	**M10 (FR_{bio})**
Unit	Nm^3 / yr
Description	Biogas flow rate at digester outlet
Source of data	Measurements
Value(s) applied	Refer to file: ER Calculation x PDD UNFCCC Ref. No. 0675.xls
Measurement methods and procedures	Flow meter measurements
Monitoring frequency	Measuring: Continuous Reading: Continuous Recording: Daily
QA/QC procedures	Flow meters were subject to regular maintenance and testing regime to ensure accuracy Calibration frequency: as per the manufacturer recommendation or in lower time interval Accuracy: 0.15%
Purpose of data	Project emissions calculations
Additional comment	---

Data / Parameter	**M11 ($P_{CH4,bio}$)**
Unit	%
Description	Percentage of methane in the biogas at biodigester outlet
Source of data	Measurements
Value(s) applied	Refer to file: ER Calculation x PDD UNFCCC Ref. No. 0675.xls
Measurement methods and procedures	Chromatograph measurements (Measurement during shift 1 + Measurement during shift 2 + Measurement during shift 3) / 3
Monitoring frequency	Measuring: 3 times per day Reading: 3 times per day Recording: 3 times per day
QA/QC procedures	Chromatograph was subject to regular maintenance and calibration Calibration frequency: once per year Accuracy: Injector: ± 0.1 psi, 5% full scale flow. Detector: ± 7% set point flow
Purpose of data	Project emissions calculations
Additional comment	--

Data / Parameter	M12 ($FR_{f,inlet}$)
Unit	Nm^3 / yr
Description	Biogas flow rate at flare inlet
Source of data	Calculated
Value(s) applied	Refer to file: ER Calculation x PDD UNFCCC Ref. No. 0675.xls
Measurement methods and procedures	Biogas at digester outlet (M10) – biogas at boilers inlet (M16) = biogas at flare inlet (M12)
Monitoring frequency	Refer to M10 and M16
QA/QC procedures	Refer to M10 and M16
Purpose of data	Project emissions calculations
Additional comment	The amount of biogas entering the flare can be calculated on a mass balance basis by comparing the biogas volume leaving the biogas reactor (measured by a flow meter) and the biogas volume entering the heat generation system (measured by another flow meter). The difference between both values shall be the volume of biogas that entered the flare system. This assumption will be cross-checked by flame detection readings from the flare system indicating that the flare was operational whenever there was a difference between the digester’s outflow and the boiler’s inflow. In case there are no flame detection readings to confirm the mass balance analysis, it shall be assumed that the biogas has been released to the atmosphere un-burnt. A potential overestimation of emission reductions related to uncertainties of the mass balance analysis due to pipeline and/or equipment biogas leakage is addressed by regular monitoring procedures and conservative assumptions in the calculation of project emissions. Therefore, the mass balance approach as described above is deemed to be conservative.

<table>
<tr><td>Data / Parameter</td><td>M15 ($T_{comb,f}$)</td></tr>
<tr><td>Unit</td><td>Hours</td></tr>
<tr><td>Description</td><td>Fraction of time gas is combusted in the flare</td></tr>
<tr><td>Source of data</td><td>Calculated</td></tr>
<tr><td>Value(s) applied</td><td>Refer to file: ER Calculation x PDD UNFCCC Ref. No. 0675.xls</td></tr>
<tr><td>Measurement methods and procedures</td><td>Thermocouple
In order to determine the amount of time that the flare has been in operation, the control computer and the SCADA program installed on it are used.
The following graph is displayed upon entering the window that displays the history of the operation of the flare:


This graph indicates the moment (time expressed as: dd/mm/yyyy hh:mm:ss) when the "default" value of the flare is detected, i.e., when an electric current is activated; the graph also show when the flame is detected, that is, when the temperature reaches 310 °C (for viewing purposes, the y axis displays up to 100ºC). Thus, the graph shows a vertical line at the times that the flare is turned on and off. When the cursor is positioned on this line, the program indicates the exact time of operation of the flare.

The difference in time between these two points (the time when the flare began operating and the time when the flare finished operating), is the time the flare was in operation, in minutes. This number is then divided by 60 to obtain the time of flare operation in hours, and therefore we know during how long the biogas was burned in the flare.

The temperature is measured with a thermocouple described in the above row of this parameter table.</td></tr>
<tr><td>Monitoring frequency</td><td>Measuring: Continuous
Reading: Continuous
Recording: Daily</td></tr>
</table>

QA/QC procedures	Thermocouple was subject to regular maintenance and calibration. Calibration frequency: at least once per year Accuracy: 0.2 ºC
Purpose of data	Project emissions calculations
Additional comment	---

Data / Parameter	**M16 ($FR_{e,inlet}$)**
Unit	Nm^3 / yr
Description	Biogas flow rate at low pressure boiler inlet
Source of data	Measurements
Value(s) applied	Refer to file: ER Calculation x PDD UNFCCC Ref. No. 0675.xls
Measurement methods and procedures	Gas flow meter measurements Gas inlet Boiler A + gas inlet boiler B + gas inlet boiler C
Monitoring frequency	Measuring: Continuous Reading: Continuous Recording: Daily
QA/QC procedures	Flow meters were subject to regular maintenance and testing regime to ensure accuracy Calibration frequency: at least once per year Accuracy: 0.1%
Purpose of data	Project emissions calculations
Additional comment	Since there are three boilers, and each has its own flow meter to measure the flow rate of biogas into it, this variable is measured by three flow meters, whose results are added to calculate the total amount of wastewater flowing into the digesters.

Data / Parameter	**M19 ($T_{comb,e}$)**
Unit	Hours
Description	Fraction of time gas is combusted in low pressure boiler equipment
Source of data	Calculated
Value(s) applied	Refer to file: ER Calculation x PDD UNFCCC Ref. No. 0675.xls
Measurement methods and procedures	System Control and Data Acquisition (SCADA): Intellution iFix Workspace version 3
Monitoring frequency	Measuring: Continuous Reading: Continuous Recording: Daily
QA/QC procedures	Equipment was subject to regular maintenance
Purpose of data	Project emissions calculations
Additional comment	---

Data / Parameter	M20
Unit	m^3 / yr
Description	Biogas flow rate at high pressure boiler inlet
Source of data	N/A **--** This variable was not monitored because the co-generation phase was not yet implemented during the current monitoring period.
Value(s) applied	Refer to file: ER Calculation x PDD UNFCCC Ref. No. 0675.xls
Measurement methods and procedures	N/A
Monitoring frequency	N/A
QA/QC procedures	N/A
Purpose of data	Project emissions calculations
Additional comment	---

Data / Parameter	M21
Unit	m^3/yr
Description	Flow rate of high pressure boiler equipment stack gases
Source of data	N/A **--** This variable was not monitored because the co-generation phase was not yet implemented during the current monitoring period.
Value(s) applied	Refer to file: ER Calculation x PDD UNFCCC Ref. No. 0675.xls
Measurement methods and procedures	N/A
Monitoring frequency	N/A
QA/QC procedures	N/A
Purpose of data	Project emissions calculations
Additional comment	---

Data / Parameter	M22
Unit	%
Description	Percentage of methane content in stack gases of boiler equipment (co-generation)
Source of data	N/A **--** This variable was not monitored because the co-generation phase was not yet implemented during the current monitoring period.
Value(s) applied	Refer to file: ER Calculation x PDD UNFCCC Ref. No. 0675.xls
Measurement methods and procedures	N/A
Monitoring frequency	N/A
QA/QC procedures	N/A
Purpose of data	Project emissions calculations
Additional comment	---

Data / Parameter	**M23**
Unit	Hours
Description	Fraction of time gas is combusted in high pressure boiler equipment
Source of data	N/A **--** This variable was not monitored because the co-generation phase was not yet implemented during the current monitoring period.
Value(s) applied	Refer to file: ER Calculation x PDD UNFCCC Ref. No. 0675.xls
Measurement methods and procedures	N/A
Monitoring frequency	N/A
QA/QC procedures	N/A
Purpose of data	Project emissions calculations
Additional comment	**---**

Data / Parameter	**M24**
Unit	MWh
Description	Electricity consumed by digester parasitic
Source of data	N/A **--** This variable was not monitored because the co-generation phase was not yet implemented during the current monitoring period.
Value(s) applied	Refer to file: ER Calculation x PDD UNFCCC Ref. No. 0675.xls
Measurement methods and procedures	N/A
Monitoring frequency	N/A
QA/QC procedures	N/A
Purpose of data	Project emissions calculations
Additional comment	**---**

Data / Parameter	**M25**
Unit	MWh
Description	Electricity consumed by condenser pumps and fans associated with electricity generation
Source of data	N/A **--** This variable was not monitored because the co-generation phase was not yet implemented during the current monitoring period.
Value(s) applied	Refer to file: ER Calculation x PDD UNFCCC Ref. No. 0675.xls
Measurement methods and procedures	N/A
Monitoring frequency	N/A
QA/QC procedures	N/A
Purpose of data	Project emissions calculations
Additional comment	**---**

Data / Parameter	B1
Unit	kg COD / m^3
Description	COD concentration of raw effluent (at digester inlet)
Source of data	Measurements
Value(s) applied	Refer to file: ER Calculation x PDD UNFCCC Ref. No. 0675.xls
Measurement methods and procedures	Spectrophotometers measurements Average daily COD concentration of raw effluent in mgCOD/Liter / 1000
Monitoring frequency	Measuring: Twice per Month Reading: Twice per Month Recording: Twice per Month
QA/QC procedures	The Spectrophotometer was subject to regular maintenance and testing regime to ensure accuracy Calibration frequency: as per the manufacturer recommendation or in lower time intervals Accuracy: ± 2 °C
Purpose of data	Baseline emissions calculations
Additional comment	---

Data / Parameter	B2
Unit	m^3 / hr
Description	Flow rate of raw effluent at digester inlet
Source of data	Measurements
Value(s) applied	Refer to file: ER Calculation x PDD UNFCCC Ref. No. 0675.xls
Measurement methods and procedures	Flow meter measurements
Monitoring frequency	Measuring: Continuous Reading: Continuous Recording: Daily
QA/QC procedures	Flow meters were subject to regular maintenance and testing regime to ensure accuracy Calibration frequency: at least once per year Accuracy: 1%
Purpose of data	Baseline emissions calculations
Additional comment	M1 and B2 should not be necessarily the same. B2 is the vinasse generated by the distillation process. M1 is the vinasse that goes into the Biodigestor. It is possible that: a) B2 could be higher than M1 if a portion of the vinasse from CLNSA´s Alcohol Production Process was sent directly to the lagoon; this effluent would be accounted for in parameter B2 and not in parameter M1 (Flow rate of organic wastewater into the digester); and b) M1 could be higher B2 when the vinasse that entered into the biodigesters was diluted. M1 measures the diluted vinasse effluent.

Data / Parameter	B3
Unit	MWh
Description	Electricity generated by project
Source of data	N/A **--** This variable was not monitored because the co-generation phase was not yet implemented during the current monitoring period.
Value(s) applied	Refer to file: ER Calculation x PDD UNFCCC Ref. No. 0675.xls
Measurement methods and procedures	N/A
Monitoring frequency	N/A
QA/QC procedures	N/A
Purpose of data	Baseline emissions calculations
Additional comment	--

Data / Parameter	B4
Unit	Klbs
Description	Low pressure steam at back pressure turbine exit
Source of data	N/A **--** This variable was not monitored because the co-generation phase was not yet implemented during the current monitoring period.
Value(s) applied	Refer to file: ER Calculation x PDD UNFCCC Ref. No. 0675.xls
Measurement methods and procedures	N/A
Monitoring frequency	N/A
QA/QC procedures	N/A
Purpose of data	Baseline emissions calculations
Additional comment	--

B.7.2. Sampling plan

>>

The monitored data portion has been established as per the monitoring methodology AM0013 version 03.

B.7.3. Other elements of monitoring plan

>>

The plant has a system in place to ensure an effective monitoring of the project activity. The following procedures apply to the project activity monitoring:

- PSI-153.0.1: Biogas Generation (including Operation Integrity & QA/QC (this procedure contains 15 specific work instructions)

Formats used to monitor operations are:

- PSI-153.1.4.1 Biodigestor Operational Performance Control Report and Biodigestor Daily Operating Report.

Monitoring procedures are within the scope of ISO 9001 certification.

Monitoring Plan is thoroughly included in Annex IV.

All of the required monitoring points for Stages 1, 2 and 3 are already operational in the project operator's SCADA system. The additional monitoring points required for monitoring Stage 4 on-site electricity generation will be added when the electricity generation phase of the project is constructed.

Measurement instrumentation associated with the biodigesters is state-of-the-art. A CLNSA monitoring and reporting system has been developed and implemented to meet ISO 9001 certification requirements. The Biodigester facility has also received ISO 14001 certification (see below). As a result, processes and procedures have been established to assure maximum operational integrity. Measurement instrumentation is, and will continue to be, regularly calibrated to maintain ISO certifications. CLNSA has instituted specific guidelines for measuring, monitoring, and reporting operational conditions. For these reasons, it is expected that the monitoring points listed above are characterized as having LOW uncertainty levels for those parameters that are measured directly. For the few parameters that are measured indirectly, uncertainty levels have here been characterized as MEDIUM to be conservative.

The only project parameter that is certainly characterized as having certain uncertainty is the volume of methane produced by the lagoon at the baseline scenario. The AM0013 version 03 monitoring methodology does not require direct or indirect measurements relating to lagoon methane production. Rather, this parameter is dealt with in AM0013 version 03 by specifying values for B_0 and MCF that are to be used in calculating lagoon methane production. Moreover, estimations of emissions without the project activity were possible by using available data from the monitoring of biodigesters parameters such as flow rates and COD.

SECTION C. Duration and crediting period
C.1. Duration of project activity
C.1.1. Start date of project activity
>>
December, 2002

C.1.2. Expected operational lifetime of project activity
>>
21Y – 0 M.

C.2. Crediting period of project activity
C.2.1. Type of crediting period
>>
Fixed

C.2.2. Start date of crediting period
>>
03/06/2003

C.2.3. Length of crediting period
10y – 0 m

SECTION D. Environmental impacts
D.1. Analysis of environmental impacts
>>
The possible environmental impacts of CLNSA project activity are to be reviewed by the Ministry of the Environment and Natural Resources (MARENA) of Nicaragua through an Environmental Impact

Assessment (EIA)[17]prepared by an independent party and sent to MARENA. After analyzing the EIA, MARENA authorized the state environmental agency (Dirección General de Calidad Ambiental) to issue CLNSA a build and operate environmental license (based on Law 217, May 1996 and its corresponding norms, Decree 9-96 July 1996[18]), which was the license 007-2001, dated April 10, 2002. At this point, since the project will be built in phases, the EIA focuses on phase 1 only. Separate EIA´s will be performed for each of the following phases that require it.

Following is a summary of the EIA´s main points:

1) The populated area closest to the project site is located to the East, separated from it by the riverbed La Carbonera; however, these homes are far apart from each other (the area is not densely populated). The North side of the project is not populated; these lands were recently purchased by the Company to keep the area free from homes. Presently, these lands are unused. To the West, the project boundary is the road that leads to the León-Chinandega Highway, and to the South, there is the Company´s manufacturing plant.

2) **Socioeconomic Issues:** these issues are highly important in the evaluation of the environmental impacts due to the fact that the installation of a wastewater treatment plant will allow the Company to be part of the group of "Clean Producing Industries", and therefore its products will be more widely accepted both nationally and internationally. This should lead to an increase in revenue, which in turn should lead to grater investment, more jobs, and more taxes coming into Chichigalpa. This is valued as a positive impact for the town.

3) The following points summarize the project's main direct environmental impacts:

   a) The treatment of the vinasse has a positive and direct effect due to two reasons:
      i) The methane generated will substitute the use of fuel oil (much more contaminant)
      ii) The final effluent used for irrigation will have a less negative effect on the environment due to the reduction in its organic load.

   b) Gas and particulate emissions of lesser impact to the environment as a result of the use of 46% less fuel oil. Emissions of Carbon Monoxide (CO), Sulfur Dioxide (SO_2) and particulate matter will be reduced, with the result of a decrease in atmosphere pollution. Although better than in the baseline, these emissions are considered a negative effect, and of relatively little importance because they will affect the population only when the wind direction changes occasionally.

   c) The reduction of the organic load from COD contained in the vinasse that irrigates the cane fields is considered a positive effect due to the fact that it reduces the impact the effluent may have on any body of water it reaches (surface or underground).

   d) The contribution that the effluent will have on the fertilization of the sugarcane fields is considered a positive effect.

   e) The health risk posed to the lab workers that handle Sodium Hydroxide and Phosphoric Acid may become a negative impact if the adequate measures are not taken.

   f) The installation of a wastewater treatment system such as the Biodigester will allow CLNSA to become part of the group of Clean Production Industries, therefore its products will be widely

[17] The EIA is available in Spanish up on request.
[18] National Assembly's website (2004): www.asamblea.gob.ni

accepted both nationally and internationally. This is considered a positive effect because it may translate into more revenue for the Company.

g) Temperature outside the plant will not be affected because of the distance that exists between the population and the plant, and also because the winds predominantly blow in the direction of the unpopulated areas. Inside the plant, due to the weather characteristics of Chichigalpa, temperature may pose a health hazard for the workers; heat stress may be likely, but heat stroke is unlikely. Some measures may be considered to improve the work environment.

h) Noise is considered a negative effect because of the health effects it may have. The equipment used during landscaping will produce noise and particulate matter that will affect the workers involved directly in that activity. However, this is not a permanent activity and the noise levels generated will not call for mitigation measures.

The indirect impacts, in order of importance, are: Sanitary Quality of the Environment, Health of the Population, Health of the Workers, Health Services, Culture and Recreation, Flora, Fauna, Urban Design, and Land Use.

D.2. Environmental impact assessment

>>

The impacts from CLNSA project activity are not considered significant. The state environmental agency (Dirección General de Calidad Ambiental) already analyzed the most relevant impact from the project activity through the EIA, and issued the build and operational license to the compliance with the technical demands for the installation of the project. Figures, 1, 2, 3 and 4 show the licenses and the respect compliance.

MINISTERIO DEL AMBIENTE Y RECURSOS NATURALES
MARENA

DIRECCIÓN GENERAL DE CALIDAD AMBIENTAL
DGCA

MARENA

RESÕLUCION ADMINISTRATIVA No. 007-2001

Vista para resolver la documentación del expediente No. 09-2002 de la solicitud de Permiso Ambiental para la ejecución de la Primera Etapa del proyecto **"SISTEMA DE TRATAMIENTO ANAEROBIO DE VINAZA, COMPAÑIA LICORERA DE NICARAGUA, S. A."**, en el cual se tratará un flujo de vinaza de 266 galones/minuto, a desarrollarse en el costado norte de las edificaciones actuales de la Compañía Licorera de Nicaragua, S. A., en el municipio de Chichigalpa, departamento de Chinandega, la cual fue presentada al Ministerio del Ambiente y Recursos Naturales (MARENA) por el Dr. Simón Pedro Pereira, representante legal del proyecto. En base a los criterios y recomendaciones del grupo técnico y en aplicación a las leyes y reglamentos sobre medio ambiente y recursos naturales vigentes, la Dirección General de Calidad Ambiental del MARENA resuelve **otorgar el presente Permiso Ambiental** al referido proyecto, con la condicionante de cumplir obligatoriamente con las siguientes disposiciones:

1. La Compañía Licorera de Nicaragua, de aquí en adelante denominada la Compañía, debe cumplir con todas las medidas, acciones y obras para prevenir y reducir los impactos ambientales que generará el proyecto, presentadas en el informe final del Estudio de Impacto Ambiental y que se detallan a continuación:
- Para evitar afectación a la calidad del aire y a la salud de los trabajadores, por emisiones gaseosas y de material particulado, y por el incremento de la temperatura generada en la combustión del metano respectivamente, se utilizará material refractario en la tubería de conducción del calor y las calderas. Se implementará una adecuada ventilación de la planta y no se permitirá que la exposición de los trabajadores al calor sea por períodos de más de 8 horas diarias, teniendo interrupciones de al menos 15 minutos por la mañana y 15 minutos por la tarde, y al menos media hora para el almuerzo. Asimismo, la planta cuenta con una chimenea de aproximadamente 20 m de altura, diseñada para contribuir a la dilución o dispersión de las emisiones.
- Para mitigar la afectación por ruido, a los trabajadores que trabajarán en la instalación de los digestores, durante la etapa de movimiento de tierra, se les brindará protectores auditivos.
- Para evitar afectación a la salud y seguridad de los trabajadores por fuga de gas metano, la conducción de este gas se hará por medio de tuberías aéreas.
- Para evitar afectación al personal que opere la planta de tratamiento por causa del manejo de sustancias corrosivas como el hidróxido de sodio y el ácido fosfórico, utilizados para el control del pH de los digestores y suplir de nutrientes a las bacterias, se les proporcionará equipo de protección personal (lentes, bata, mascarilla y guantes), el cual deberá ser de uso obligatorio y no se permitirá que los trabajadores coman, beban o fumen durante el trabajo.
- En caso de verse disminuida la vida útil de los materiales de construcción de las viviendas ubicadas en el área de influencia del proyecto, por las emisiones de la Compañía, se compensará a la población basados en políticas de indemnización.

2. Durante la etapa de movimiento de tierra, la Compañía debe realizar control del polvo mediante el rociado del área del proyecto con agua, por lo menos dos veces al día.

Km. 12½ Carretera Norte - Apartado N° 1631 - 5123 - Managua, Nicaragua, C. A.
Teléfonos: 263 2353 - 263 2095. Fax: 263 2620 - 263 2354 -
E-mail dgamarena@tmx.com.ni

Figure 1. **Build and operate Environmental License (page 1 of 4)**

MINISTERIO DEL AMBIENTE Y RECURSOS NATURALES
MARENA
DIRECCIÓN GENERAL DE CALIDAD AMBIENTAL
DGCA

3. Para evitar afectación por ruido a la población, la Compañía debe realizar las actividades de construcción en las horas del día y exigir al constructor la utilización de maquinaria en buen estado.

4. La Compañía debe remitir al MARENA, a más tardar 30 días después de emitido el presente permiso, el plan de manejo de los lodos, producidos en el sistema de tratamiento que no serán recirculados. El MARENA no acepta la propuesta de que los lodos sean incorporados al efluente tratado.

5. La conducción de las aguas tratadas hasta el sitio de ferti-riego debe realizarse por tuberías cerradas para impedir la formación de criaderos de vectores.

6. La Compañía debe cumplir con el plan de gestión ambiental presentado en el Estudio de Impacto Ambiental, con las debidas ampliaciones por parte del grupo técnico, que comprende lo siguiente:

a) Monitoreo de las emisiones gaseosas y material particulado, y monitoreo del efluente de la planta de tratamiento.

Monitoreo propuesto en EIA	Monitoreo propuesto por el Grupo Técnico
- Monitoreo de las emisiones gaseosas y material particulado: Se analizará concentración de gases (CO y NO_2) y material particulado (PM_{10} y PTS), los cuales serán medidos en la salida de la chimenea, en distintos sitios del área de influencia y dentro de la planta.	La Compañía debe presentar al MARENA, los resultados de estos monitoreos semestralmente. Asimismo, debe remitir al MARENA a más tardar 30 días después de emitido el presente permiso, la ubicación de los sitios a evaluar dentro del área de influencia.
- Monitoreo de la calidad del efluente del sistema de tratamiento.	Compañía Licorera debe realizar muestreos trimestrales del efluente del sistema de tratamiento, según lo establecido en el Decreto 33-95, analizando los parámetros: DBO_5, DQO, pH, sólidos suspendidos totales, sólidos sedimentables, grasas y aceite, nitrógeno amoniacal y fósforo total.
Análisis físico-químicos en pozos que se encuentren cercanos al área de riego del efluente y en los cuerpos de aguas superficiales receptores: ríos, esteros y manglares, para detectar contaminación de las aguas subterráneas y superficiales por las filtraciones y descargas del efluente de la planta de tratamiento.	Compañía Licorera debe remitir al MARENA, a más tardar 30 días después de emitido el presente permiso, la ubicación exacta de los pozos y los cuerpos de agua a monitorear.

Figure 2. Build and operate Environmental License (page 2 of 4)

MINISTERIO DEL AMBIENTE Y RECURSOS NATURALES
MARENA
DIRECCIÓN GENERAL DE CALIDAD AMBIENTAL
DGCA

MARENA

b) Análisis médicos para evaluar la salud de los trabajadores que manipulan compuestos químicos peligrosos.

Los trabajadores que manipularán los reactivos que se utilizarán para controlar el pH y los niveles de nutrientes en los biodigestores, serán sometidos a chequeos médicos trismestrales, de manera que se implemente una vigilancia sistemática que permita prevenir enfermedades que puedan aparecer a largo plazo, así como aplicar medidas curativas.

c) Plan de contingencia.

La generación, conducción, almacenamiento y combustión del gas metano implican riesgos específicos y la consecuente adopción de medidas de protección y prevención. La Compañía implementará las medidas, presentadas en el Estudio de Impacto Ambiental, para el control de los siguientes riesgos:
- Liberación y fuga de gas metano.
- Seguridad contra incendios.
- Ocurrencia de movimientos sísmicos.

7. La Compañía debe remitir al MARENA el manual de operación y mantenimiento del sistema de tratamiento, elaborado por el fabricante de la planta.

8. La Compañía debe considerar como una actividad permanente, la capacitación y entrenamiento del personal involucrado en el proyecto.

MARENA podrá presentarse al sitio del proyecto con o sin previo aviso, con la finalidad de verificar el cumplimiento de las cláusulas de este permiso y las medidas ambientales contempladas en el Estudio de Impacto Ambiental.

La Compañía , se compromete a cumplir con las condiciones a las cuales se somete esta autorización, entre ellas realizar medidas de prevención, mitigación o compensación de los impactos ambientales generados por el proyecto, indicados en el **Estudio de Impacto Ambiental Sistema de Tratamiento Anaerobio de Vinaza,** así mismo, notificará a la DGCA-MARENA sobre cualquier modificación al proyecto para su debida revisión y aprobación.

El incumplimiento o violación de alguna de las cláusulas anteriores por parte de la Compañía, será objeto de amonestaciones, multa, suspensión temporal o cancelación del Permiso Ambiental, según sea la gravedad de la falta.

El presente Permiso Ambiental determina que la ejecución del proyecto es factible ambientalmente, bajo el cumplimiento de las condiciones establecidas en el mismo, pero no exime a la Compañía, de la obligatoriedad y responsabilidades que la ley determine en relación a permisos de otra índole, ni del cumplimiento de leyes de otra materia que estén en vigencia.

Km. 12½ Carretera Norte - Apartado N° 1631 - 5123 - Managua, Nicaragua, C. A.
Teléfonos: 263 2353 - 263 2095. Fax: 263 2620 - 263 2354 -
E-mail dgamarena@tmx.com.ni

Figure 3. Build and operate Environmental License (page 3 of 4)

MINISTERIO DEL AMBIENTE Y RECURSOS NATURALES
MARENA
DIRECCIÓN GENERAL DE CALIDAD AMBIENTAL
DGCA

El presente Permiso Ambiental entra en vigencia a partir de la fecha de su otorgamiento. En caso de no ejecutarse el proyecto en los próximos 18 meses, éste pierde validez.

Dado en la ciudad de Managua a los 10 días del mes de abril del dos mil dos.

Ing. Leonel Wheelock
Director
Dirección General de Calidad Ambiental

Cc: Ing. Jorge Salazar C., Ministro MARENA
Ing. Ezzard Urbina, Director DGCTOC MARENA
Ing. María Gabriela Abarca, Coordinadora Técnica, DGCTOC - MARENA
Ing. Mauricio Ocaña, Delegado MARENA - Chinandega
Dra. María Antonieta Rivas, Asesoría Legal MARENA
Expediente

Km. 12½ Carretera Norte - Apartado N° 1631 - 5123 - Managua, Nicaragua, C. A.
Teléfonos: 263 2353 - 263 2095. Fax: 263 2620 - 263 2354 -
E-mail dgamarena@tmx.com.ni

Figure 4. **Build and operate Environmental license (page 4 of 4)**

CERTIFICATE OF APPROVAL

This is to certify that the Environmental Management System of:

Compañía Licorera de Nicaragua S.A.
Managua, Nicaragua

has been approved by Lloyd's Register Quality Assurance
to the following Environmental Management System Standard:

ISO 14001: 1996

The Environmental Management System is applicable to:

Site Activities including and associated with Design and Production of Rum, Aguardientes, Non Aged and Aged Alcohols and Production of Carbon Dioxide.

Approval
Certificate No: SQA 712003

Original Approval:	*19 April 2002*
Current Certificate:	*1 May 2005*
Certificate Expiry:	*14 May 2006*

Lloyd's Register Quality Assurance

UKAS
ENVIRONMENTAL
MANAGEMENT
001

This document is subject to the provision on the reverse
This approval is carried out in accordance with the LRQA assessment and certification procedures and monitored by LRQA.
The use of the UKAS Accreditation Mark indicates Accreditation in respect of those activities covered by the Accreditation Certificate Number 001
Macro Revision 12

Figure 5. ISO Certification

SECTION E. Local stakeholder consultation

E.1. Solicitation of comments from local stakeholders

>>

In order for the Ministry of the Environment and Natural Resources of Nicaragua to emit the permit to build and operate a project, an Environmental Impact Assessment (EIA) has to be performed by an independent party. For the permit to be emitted, the EIA has to be presented to the local community so that they can get to know the project, ask any questions they may have, and also so that the company can know the population's concerns and address them properly.

The hearing took place on Thursday April 4th, 2002, and several means were used to invite the population to participate in the public hearing: a large temporary sign was posted at the entrance of Chichigalpa (the town where the project is located), a car with speakers was hired to spread the message around Chichigalpa, and an invitation was also publicized in La Prensa (the largest newspaper in Nicaragua). The information given was the date, time and place of the hearing, as well as its objective. Two additional hearings were conducted to disclose specific issues related to the CDM project activity. These hearings were held on: April 16, 2004 (in Managua) and June 16, 2004 (in Chichigalpa). Both consultations were required by the Designated National Authority.

E.2. Summary of comments received

>>

Primary Comments and Concerns:

Concern 1. The vinasse currently flows in open canals close to the population, if now it will carry chemicals, is there any chance of cancer development?

Concern 2. The vinasse releases a certain unpleasant odour. You have mentioned that the lab workers will use protective equipment. Will the population be provided with protective equipment as well?

Concern 3. Will the underground waters be affected by the digging?

Concern 4. Methane is a flammable gas. Is there a chance of explosion?

Concern 5. Jobs will be created; however, there is also mention of the need to wear protective equipment, which implies there are health hazards involved. What guaranties will you provide the workers?

Concern 6. Isn't six months too long to wait? Shouldn't the medical exams be performed more often?

Concern 7. What will happen if the Biodigester doesn't work? Would there be any safety risk? How will the quality of life in Chichigalpa improve with this project? How will the Environment be affected? It is always a concern that when the air is contaminated, diseases can reach the population.

Concern 8. Is there any risk from the exposure to the bad odor?

Concern 9. Will the vinasse pipeline be sufficiently buried and protected?

E.3. Report on consideration of comments received
>>
Company's Response/Account Taken

Concerns	**Company's Response/Account Taken**
Concern 1. *The vinasse currently flows in open canals close to the population, if now it will carry chemicals, is there any chance of cancer development?*	The process is biological, not chemical, and it will not pose any health risks to the population. The effluent will be similar to the one being released now; however, it will be cleaner because its organic load will be lower. The chemical mentioned (phosphoric acid) is a nutrient for the bacteria, and it will be consumed by the bacteria; it won't be released in the effluent.
Concern 2. *The vinasse releases a certain unpleasant odour. You have mentioned that the lab workers will use protective equipment. Will the population be provided with protective equipment as well?*	The protective equipment will be provided for the plant workers only, and the system will not produce bad odors. Also, much of the unpleasant odour coming from the vinasse flow comes from the sewage waters that have been attached to the vinasse pipeline by the population without the company's permission. **Note:** although the vinasse releases an unpleasant smell, that smell is non toxic, and it will be substantially reduced after the treatment. The lab workers will be provided with the necessary protection for the type of work they are doing and the type of chemicals they are handling; however, no protective equipment is required for the smell coming form the vinasse.
Concern 3. *Will the underground waters be affected by the digging?*	Underground waters are 12 to 14 meters deep, and any digging done will only be up to 2 ½ meters deep. Also, as an additional precaution, the soil will be made impermeable.
Concern 4. *Methane is a flammable gas. Is there a chance of e xplosion?*	This type of system has been widely used in Brazil, Europe, South America, North America, etc. The system has a very advanced safety system which detects a flammable atmosphere immediately. Also, the methane will not be under pressure at any time, therefore reducing the risk of explosion. The methane will be transported in a secure pipeline to the boilers, and in case the boiler is not working, the methane will be burned in the flare. At no point is the methane stored.
Concern 5*. Jobs will be created; however, there is also mention of the need to wear protective equipment, which implies there are health hazards involved. What guaranties will you provide the workers?*	For the handling of the chemicals, every worker that needs to come in contact with them will be provided with the adequate protective gear and proper training. Additionally, the company performs medical checkups every six months to every worker, so in case there is any health problem, it can be detected in a timely manner. The company has always been responsible with its workers, and proof of this is that CLNSA has earned the recognition from the Ministry of Labour as a Leader in Safety and Health for the fourth year in a row.

Concerns	Company's Response/Account Taken
Concern 7. *Isn't six months too long to wait? Shouldn't the medical exams be performed more often?*	All safety measures are being taken, and most importantly, the chemicals won't be handled directly in great quantities. The operator will manage all the chemicals from the control room. The lab operators are the only ones that will handle chemicals, and it will be in small amounts and with all their protective equipment.
Concern 8. *What will happen if the Biodigester doesn't work? Would there be any safety risk?*	In the worst case, if the Biodigester were not to work properly, the situation would be exactly as the present one. The effluent would remain the same as it is today.
Concern 9. *How will the quality of life in Chichigalpa improve with this project? How will the Environment be affected? It is always a concern that when the air is contaminated, diseases can reach the population.*	First of all, let us emphasize that the purpose of this project is strictly environmental. The benefits for Chichigalpa can be summarized as follows: ▪ The effluent will contain less organic contaminants ▪ The air will be cleaner, since fuel oil will not be burned any more, and it will be substituted by methane, which is cleaner ▪ Jobs will be created

SECTION F. Approval and authorization

>>

Approval and authorization has been provided to the project participants as per the information uploaded at the UNFCCC website:
http://cdm.unfccc.int/Projects/DB/TUEV-SUED1159511157.97/view

- - - - -

Appendix 1: Contact information of project participants

Organization name	Compañia Licorera Nacional de Nicaragua
Street/P.O. Box	Apartado 1494, Managua, Nicaragua
Building	Centro BAC, 8vo piso
City	Managua
State/Region	Managua
Postcode	n/a
Country	Nicaragua
Telephone	(505) 274-4040
Fax	(505) 274-4041
E-mail	epenalba@CLNSA.com.ni
Website	www.flordecana.com
Contact person	
Title	Analista de Negocios
Salutation	Mrs.
Last name	Peñalba
Middle name	Marie
First name	Elianne
Department	Planificación y Proyectos
Mobile	(505) 886-8556
Direct fax	(505) 274-4041
Direct tel.	(505) 274-4589
Personal e-mail	epenalba@CLNSA.com.ni

Project Developer responsible for the CDM project Activity.

Organization name	CORPORACIÓN ANDINA DE FOMENTO
Street/P.O. Box	Carrrera 9 No 76 49 piso 7
Building	
City	Bogota
State/Region	Distrito Capital
Postcode	
Country	Colombia
Telephone	571 313 23 11
Fax	571 313 27 87
E-mail	mtorres@caf.com
Website	www.caf.com
Contact person	
Title	
Salutation	Mrs.
Last name	Gomez
Middle name	
First name	Mary
Department	Dirección de Medio Ambiente
Mobile	
Direct fax	571 313 27 87
Direct tel.	571 313 23 11
Personal e-mail	mtorres@caf.com

Sponsor

Organization name	Ministry of Housing, Spatial Planning and Environment (VROM)
Street/P.O. Box	PO Box 30945
Building	
City	Den Haag
State/Region	
Postcode	2500 GX
Country	The Netherlands
Telephone	+31 70 3394693
Fax	+31 70 3391306
E-mail	
Website	www.minvrom.nl
Contact person	
Title	Head of Clean Development Mechanism Division
Salutation	Mr
Last name	de Jonge
Middle name	
First name	Lex
Department	Directorate General for Environmental Protection
Mobile	
Direct fax	+ 31 70 3391306
Direct tel.	+ 31 70 3394693
Personal e-mail	Lex.dejonge@minvrom.nl

Appendix 2: Affirmation regarding public funding

There is no public funding involved in the CLNSA project. The investment made in the project were financed by "Banco Agrícola Comercial de El Salvador". In spite of that, there is an advanced negotiation with The State of Netherlands acting through the Ministry of Housing, Spatial Planning and the Environment for purchasing the Certified Emission Reductions generated by the CLNSA project.

Appendix 3: Applicability of selected methodology

No further information other than the included in section B.2. is available.

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

BASELINE INFORMATION

Parameters (Project Scenario)		Source	Reference	Justification
$COD_{lagoon\_project}$	Chemical oxygen demand of wastewater entering the lagoon in the project case (kg COD/yr)	Estimated from host facility operator data		Based on actual historic measurements
B_0,	maximum methane producing capacity of wastewater (kg CH_4/kg COD)	Specified by AM0013 VERSION 03		
MCF_{lagoon},	methane conversion factor for lagoon	Specified by AM0013 VERSION 03		
$COD_{digester}$	Chemical oxygen demand of wastewater entering the digester in the project case (kg COD/yr)	Estimated from host facility operator data		Based on actual historic measurements
$BF_{digester}$	COD-to-biogas conversion factor	Calculated from host facility operator data		
MF	Fraction of methane in biogas	Calculated from host facility operator data		
$LF_{digester}$	Percent leakage of biodigester	Specified by AM0013 VERSION 03		
COD_{lagoon_base}	Chemical oxygen demand of wastewater entering the lagoon in the base case (kg COD/yr)	Calculated from host facility operator data		Based on actual measurements
FOE	Bunker C fuel oil equivalent of biogas, (gal/ Nm^3)	IPCC standard value	IPCC Greenhouse Gas Inventory Reference Manual, Volume 3	Country-specific value may not be readily available
$CC_{Bunker\ C}$	Carbon dioxide content of Bunker C fuel oil, ($mtCO_2$/gal)	Calculated using IPCC standard values		This is a credible, readily available source

Parameters (Base Scenario)		Source	Reference	Justification
COD_{lagoon_base}	Chemical oxygen demand of wastewater entering the lagoon in the base case (kg COD/yr)	Calculated from host facility operator data		Based on actual measurements
FOE	Bunker C fuel oil equivalent of biogas, (gal/ Nm^3)	IPCC standard value	IPCC Greenhouse Gas Inventory Reference Manual, Volume 3	Country-specific value may not be readily available
$CC_{Bunker\ C}$	Carbon dioxide content of Bunker C fuel oil, ($mtCO_2$/gal)	Calculated using IPCC standard values		This is a credible, readily available source
OM	Operating Margin grid emissions factor ($mtCO_2$/MWh)	Calculated using fuel consumption and electricity generation data provided by government authorities	AM0013 VERSION 03	
BM	Build Margin grid emissions factor ($mtCO_2$/MWh)	Calculated using fuel consumption and electricity generation data provided by government authorities	AM0013 VERSION 03	

Please refer to part B of this PDD for complementary information.

RESULTS FROM THE BASELINE LAGOON EFFLUENT ANALYSIS

Universidad Nacional de Ingeniería
Facultad de Ingeniería Química
Managua, Nicaragua

Resultados de Análisis

Interesado: *Compañía Licorera de Nicaragua, S.A*
Fecha: *Managua, 18 de Febrero del 2002.*

Resultados de Análisis Físico-Químicos de muestra de efluente de un punto de muestreo.

Parámetros	Valor	Decreto 33-95
Temperatura	30°C	40 °C
pH	7.97	6-9
Sólidos Sedimentables	7.50 ml/l/h	1 ml/l
Sólidos Suspendidos Totales	13931 mg/l	200 mg/l
DBO_5	10800 mg/l	180 mg/
DQO	14210 mg/l	260 mg/l
Aceites y Grasas	11 mg/l	10 mg/l
Nitrógeno total	18.44	n.e
Nitrógeno Orgánico	12.00 mg/l	n.e
Nitrógeno Amoniacal	3.88 mg/l	n.e
Fósforo	38.27 mg/l	n.e

n.e no especificado en normas
Determinaciones realizadas con el Standard Methods for the Examination of Water and Waste Water, 20th edition,1998.

Ing. Indiana García
Responsible del Análisis

cc. Archivo Personal

THEORETICAL CALCULATIONS AND USUAL VALUES FOR SABILIZATION POND USED
(Ref. Metcalf and Eddy. Wastewater Engineering. McGraw-Hill. Third Edition. 1991. p.p 644 – 645)

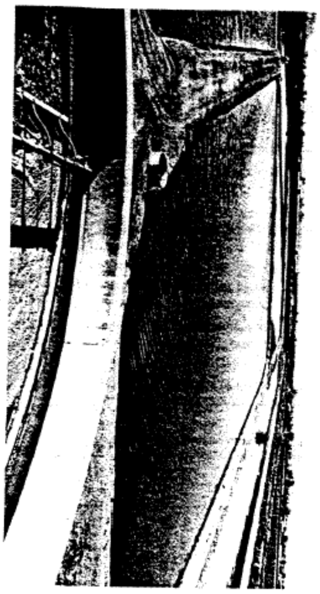


FIGURE 10-43
Typical facultative stabilization ponds.

by Wehner and Wilhelm [65] for a reactor with an arbitrary flow-through pattern (between a complete-mix pattern and a plug-flow pattern), as follows:

$$\frac{S}{S_o} = \frac{4a \exp(1/2d)}{(1+a)^2 \exp(a/2d) - (1-a)^2 \exp(-a/2d)} \quad (10\text{-}30)$$

where S = effluent substrate concentration
S_o = influent substrate concentration
$a = \sqrt{1 + 4ktd}$
d = dispersion factor $= D/uL$
D = axial dispersion coefficient, ft²/h (m²/h)
u = fluid velocity, ft/h (m/h)
L = characteristic length, ft (m)
k = first-order reaction constant, 1/h
t = detention time, h

To facilitate use of Eq. 10-30 for stabilization ponds, Thirumurthi developed the graph in Fig. 10-44, in which the term kt is plotted against S/S_o for dispersion factors varying from zero for an ideal plug-flow reactor to infinity for a complete-mix reactor [45]. For most stabilization ponds, the dispersion factors are within the range of 0.1 to 2.0. Because the contents of aerobic ponds must be mixed to achieve the best performance, it is estimated that a typical value for the pond dispersion factor would be about 1.0. Typical values for the overall first-order BOD_5 removal-rate constant k vary from about 0.05 to 1.0 per day, depending on the operational and hydraulic characteristics of the pond. The use of Fig. 10-44 is illustrated in Example 10-9. The design of an aerobic stabilization pond is illustrated in Example 10-10.

TABLE 10-20
Typical design parameters for stabilization ponds

	Type of pond					
Parameter	**Aerobic low rate**[a]	**Aerobic high rate**	**Aerobic maturation**	**Aerobic-anaerobic facultative**[b]	**Anaerobic pond**	**Aerated lagoon**
Flow regime	Intermittently mixed	Intermittently mixed	Intermittently mixed	Mixed surface layer		Completely mixed
Pond size, acres	<10 multiples	0.5–2	2–10 multiples	2–10 multiples	0.5–2 multiples	2–10 multiples
Operation[c]	Series or parallel	Series	Series or parallel	Series or parallel	Series	Series or parallel
Detention time,[c] d	10–40	4–6	5–20	5–30	20–50	3–10
Depth, ft	3–4	1–1.5	3–5	4–8	8–16	6–20
pH	6.5–10.5	6.5–10.5	6.5–10.5	6.5–8.5	6.5–7.2	6.5–8.0
Temperature range, °C	0–30	5–30	0–30	0–50	6–50	0–30
Optimum temp ature, °C	20	20	20	20	30	20
BOD_5 loading,[d] lb/acre · d	60–120	80–160	≤ 15	50–180	200–500	
BOD_5 conversion, %	80–95	80–95	60–80	80–95	50–85	80–95
Principal conversion	Algae, CO_2, bacterial cell tissue	Algae, CO_2, bacterial cell tissue,	Algae, CO_2, bacterial cell tissue NO_3	Algae, CO_2, CH_4, bacterial cell tissue	CO_2, CH_4, bacterial cell tissue	CO_2, bacterial cell tissue
Algal concentration, mg/L	40–100	100–260	5–10	5–20	0–5	
Effluent suspended solids,[e] mg/L	80–140	150–300	10–30	40–60	80–160	80–250

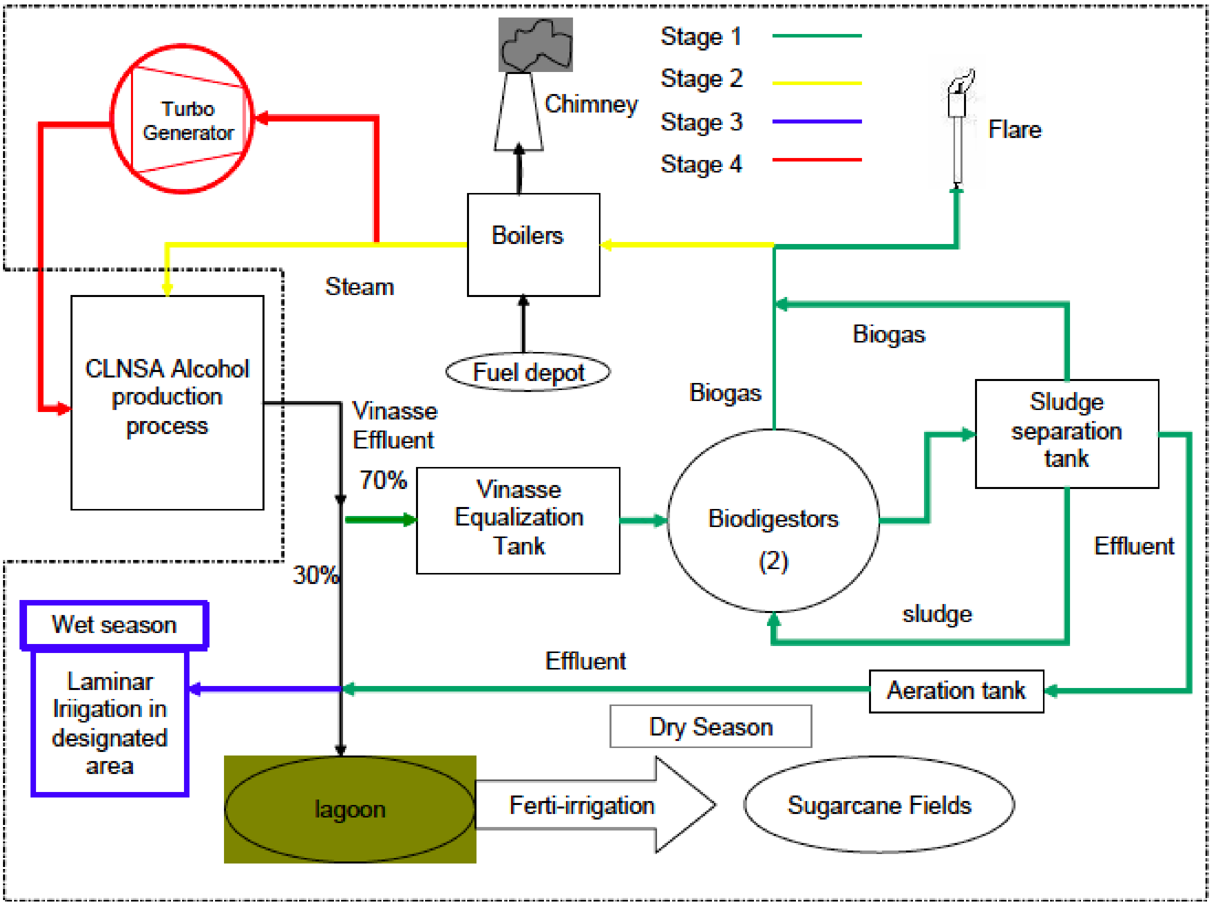
[a] Conventional aerobic ponds designed to maximize the amount of oxygen produced rather than the amount of algae produced.
[b] Pond includes supplemental aeration. For ponds without supplemental aeration, typical BOD_5 loadings are about one-third of those listed.
[c] Depends on climactic conditions.
[d] Typical values. Much higher values have been applied at various locations. Loading values are often specified by state regulatory agencies.
[e] Includes algae, microorganisms, and residual suspended solids. Values are based on an influent soluble BOD_5 of 200 mg/L and, with the exception of the aerobic ponds, an influent suspended solids of 200 mg/L.
Note: acre × 0.4047 = ha
ft × 0.3048 = m

331

Appendix 5: Further background information on monitoring plan

The Monitoring Methodology presented in AM0013 VERSION 03 *"Forced methane extraction for grid-connected electricity supply and/or heat production"* will be implemented for the CLNSA project in the manner described below.

The existing System Control and Data Acquisition (SCADA) system that CLNSA currently uses to monitor and control the biodigester systems will be expanded to include the monitoring points identified in the following schematic diagram.



----- Project boundary

Type of Fossil Fuel	Value for SV_{ff}	Reference
Bunker C oil	945.5 litres/mt of fuel	IPCC
Diesel fuel	1095.4 litres/mt of fuel	IPCC
Natural gas	1394.3 Nm^3/mt of gas	IPCC

This Monitoring plan will set out a number of monitoring tasks in order to ensure that all aspects of projected greenhouse gas (GHG) emission reductions for the CLNSA project are controlled and reported. This requires an on going monitoring of the project to ensure performance according to its design and that claimed Certified Emission Reductions (CERs) are actually achieved.

What is a monitoring plan?

The Compañia Licorera de Nicaragua (CLNSA) Project Monitoring Plan is a guidance document that provides the set of procedures for preparing key project indicators, tracking and monitoring the impacts of the CLNSA project. The Monitoring Plan is being used and it will be used throughout the defined crediting period for the project to determine and provide documentation of GHG emission impacts from the CLNSA Project.

This monitoring plan fulfils the requirement set out by the Kyoto Protocol that emission reductions projects under the Clean Development Mechanism have real, measurable and long-term benefits and that the reductions in emissions are additional to any that would occur in the absence of the certified project activity.

What is required by the monitoring plan?

Managers of the CLNSA Project must maintain credible, transparent, and adequate data estimation, measurement, collection, and tracking systems to maintain the information required for an audit of an emission reduction project. These records and monitoring systems are needed to allow the selected Operational Entity to verify project performance as part of the verification and certification process. This process also reinforces that CO_2 reductions are real and credible to the buyers of the Certified Emissions Reductions (CERs). Emission reductions will be achieved through the capture of uncontrolled methane emissions to the atmosphere from anaerobic decomposition of the vinasse in a settlement lagoon, through the combustion of methane instead of fuel oil in the boilers, and through avoided methane generation trough land field application and electric power displacement.

The monitoring plan provides the requirements and instructions for:

I. Establishing and maintaining the appropriate monitoring systems for the project activity and data used to establish the base line;
II. Quality control of the measurements;
III. Procedures for the periodic calculation of GHG emission reductions;
IV. Assigning monitoring responsibilities to personnel;
V. Data storage and filing system;
VI. Preparing for the requirements of an independent, third party auditor/verifier.

Who uses the monitoring plan?

Compañia Licorera de Nicaragua, who is developing the Vinasse Anaerobic Treatment Project - Compañía Licorera de Nicaragua, S. A. (CLNSA) is using this document as guide in monitoring of the project emission reduction performance and is adhered to the guidelines set out in this monitoring plan.

Key definitions

The monitoring plan will use the following definitions of monitoring and verification.

I. ***Monitoring:*** the systematic surveillance of the CLNSA project's performance by measuring and recording performance-related indicators relevant in the context of GHG emission reductions.
II. ***Verification:*** the periodic ex-post auditing of monitoring results, the assessment of achieved emission reductions and of the project's continued conformance with all relevant project criteria by a selected Operational Entity.

For determining base line emissions

CLNSA has monitored through the use of on site measuring equipment:

A. Flow rate of organic wastewater into the digester
B. Flow rate of organic wastewater out of the digester
C. Flow rate of organic wastewater by-passing the digester and sent directly to the lagoon.
D. Ambient temperature.
E. Flow rate of biogas leaving the digester
F. Flow rate of biogas entering the boilers
G. COD into the digester
H. COD out of the digester
I. COD by-passing the digester and sent directly to the lagoon
J. Heat production to estimate CO_2 emissions from displaced fossil fuel at boilers

The main variable for determining project emissions:

CLNSA monitor the project through the use of on site metering equipment:

A. Flow rate of organic wastewater into the digester.
B. Flow rate of organic wastewater out of the digester.
C. Flow rate of organic wastewater by-passing the digester and sent directly to the lagoon.
D. Flow rate of biogas leaving the digester.
E. Flow rate of biogas entering the boilers.
F. COD into the digester.
G. COD out of the digester.
H. COD by-passing the digester and sent directly to the lagoon (ferti-irrigation) and to the land application (laminar-irrigation system) in order to estimate CH_4 emissions in the project case.

I. Heat production to estimate CO_2 emissions from displaced fossil fuel at boilers, biogas flow rate at digester outlet, percentage of methane in the biogas at biodigester outlet, and mass/volume of fossil fuel used onsite.

J. Depth of wastewater in the lagoon, this variable will ensure when the lagoon is empty after it is no longer part of the wastewater system.

K. Amount of electricity in the year that is consumed by the project activity and consumed by digester parasitic

L. Fraction of time gas is combusted in the flare and in low pressure boiler equipment.

The meter reading records are readily accessible for auditors, calibration tests records are maintained for the auditors.

Calibration of Meters & Metering Dispute Resolution Procedures

ISO Work Instruction 72.1 - Control de Equipos de Inspección, Medición y Análisis (Inspection, Metering and Analysis Equipment Control) defines the metering arrangements and the required quality control procedures to ensure accuracy of the laboratory metering equipment. The laboratory metering equipment is properly calibrated and checked for accuracy; the frequency of calibration depends on the type of equipment.

A monitoring and reporting system has been developed and implemented by CLNSA, and the company (including the Biodigester) are ISO-9001 and ISO-14001 certified. As a result, processes and procedures have been established to assure maximum operational integrity. Laboratory measurement instrumentation is, and will continue to be, regularly calibrated to maintain ISO certifications. CLNSA has instituted specific guidelines for measuring, monitoring, and reporting operational conditions. For these reasons, it is expected that the monitoring procedures listed above were, are and will be characterized properly according the exigencies of any audits or verification procedures.

Management and operational system for emissions reduction monitoring

In order to ensure a successful operation of the project, credibility and verifiability of the CER´s achieved this monitoring plan provides guidelines on record keeping of the data collected. CLNSA has been monitoring the project according to the guidelines from the 3^{rd} June, 2003, date of the beginning of the accreditation period. Record keeping is the most important exercise in relation to the monitoring process. Without accurate and efficient record keeping, project emission reductions cannot be verified. Below follows an outline of how project related records will be managed.

The overall responsibility for monitoring of greenhouse gas emissions reduction will be CLNSA´s. The following section sets out the procedures for tracking information from the primary source to the end-data calculations, mainly in digital format, and others as paper document. CLNSA will provide the CERs and necessary data to allow it to transfer to the Buyer.

Electronic and paper-based documentation

Physical documentation such as paper-based maps, diagrams and environmental assessments, excel files and any digital files related to the project will be stored in a central place, together with this monitoring plan. In order to facilitate auditor´s reference of relevant literature relating to CLNSA project, the project material and monitoring results will be properly archived. All information will be stored at CLNSA´s production facilities in Chichigalpa, Chinandega. The person with overall responsibility for the documentation of the CLNSA project at Chichigalpa is, Fermín Ramírez.

The following is the list of the key documents relevant to monitoring and verification of the emissions reductions from the project.

- PDD, including the electronic spreadsheets and supporting documentation (assumptions, data estimations, measurement methods, etc.)
- CO_2 ER Calculations & Monitoring Plan
- Validation Report
- Dispatch Meter calibration Reports. Digital files.
- Documentation related to assessments and any site visits carried out by Operational Entity for verification of the annual emission reductions
- Monthly Meter reading reports. Digital files.
- Records on CO_2 emission reductions (CERs)
- Records on project management, including data collection and management systems.

VERIFICATION AND MONITORING RESULTS

The verification of the monitoring results of the CLNSA project is a mandatory component, which is required for all CDM projects. The main objective of the verification is to independently verify that the project has achieved the emission reductions as reported and projected in the PDD. It is expected that the verification will be done on annual basis.

The responsibilities for verification of the CLNSA project are as follows:

1. Contract an Operational Entity and agree a time schedule for carrying out verification activities throughout the crediting period in accordance with the Buyer and the CDM Executive Board requirements. Make the arrangements for the verification and prepare for the audit and verification process to the best of its abilities.
2. CLNSA will facilitate the verification through providing the Operational Entity with all the required necessary information, before, during and, in the event of queries, after the verification.
3. CLNSA will fully cooperate with the Operational Entity and instruct its staff and management to be available for interviews and respond honestly to all questions from the Operational Entity.
4. The selected Operational Entity must be an Accredited Entity with a proven track record in environmental auditing and verification, experience with CDM projects and work in developing countries. The Operational Entity should be accredited by the CDM Executive Board.

Appendix 6: Summary of post registration changes

There is any post registration changes in the project activity.

- - - - -

History of the document

Version	Date	Nature of revision
04.1	11 April 2012	Editorial revision to change version 02 line in history box from Annex 06 to Annex 06b.
04.0	EB 66 13 March 2012	Revision required to ensure consistency with the "Guidelines for completing the project design document form for CDM project activities" (EB 66, Annex 8).
03	EB 25, Annex 15 26 July 2006	
02	EB 14, Annex 06b 14 June 2004	
01	EB 05, Paragraph 12 03 August 2002	Initial adoption.
Decision Class: Regulatory **Document Type:** Form **Business Function:** Registration		