CLEAN DEVELOPMENT MECHANISM
PROJECT DESIGN DOCUMENT FORM (CDM-PDD)
Version 02 - in effect as of: 1 July 2004)

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Annexes

SECTION A. General description of project activity

A.1 Title of the project activity:

Vinasse Anaerobic Treatment Project - Compañía Licorera de Nicaragua, S. A. (CLNSA)

A.2. Description of the project activity:

The purpose of the project is to treat the wastewater generated in the production of alcohol 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 wastewater 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 the CLN´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 the capture of methane, which is currently emitted from a settlement pond for five months of the year, and from the displacement of fuel oil and grid-fed electricity by combusting methane to produce energy. In Phase 1, the project will substantially reduce and in Phase 2 and 3 eliminate the wastewater that is sent to the lagoons. These existing lagoons have an average depth of one meter.

Due to the scale of the project it will be completed in stages, as follows (Figure 1):

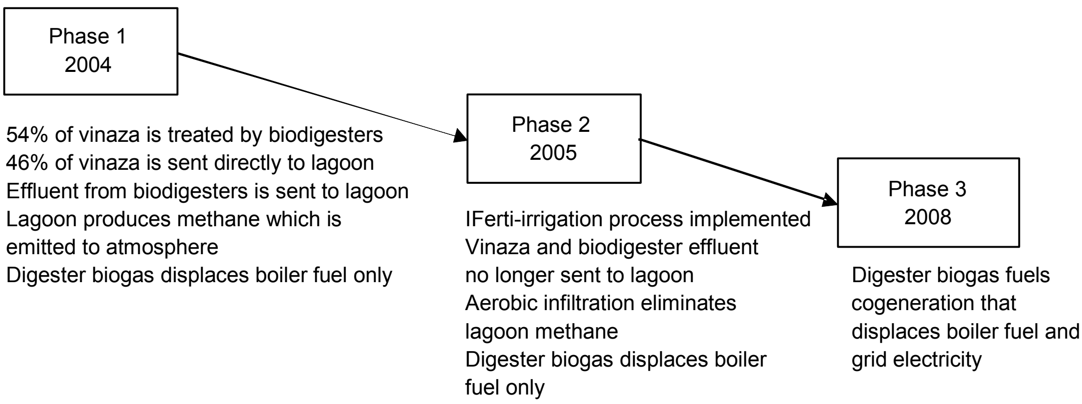


Figure 1. Description of The Project Activity

Stage 1 (July 2003): Anaerobic Treatment System – Initially, the treatment facility will be constituted by an anaerobic process, which will produce biogas from the organic material in the wastewater through anaerobic reactions. Biogas is combustible and in Stage 1 it will be used in the boiler systems to produce steam for the distillery's needs (in later stages the biogas will be used to produce steam for the distillery's needs as well as generate electricity. This will be accomplished by the co-generation system installed at Stage 3).

The components will be 2 heat exchangers, 1 cooling tower, 1 equalization tank, 2 biodigester tanks, 2 degasifying tanks, 2 separator tanks, 1 aeration tank, 1 compressor, and 3 blowers. These components will only treat 54% of the vinaza and the other 46% of the vinaza will be sent directly to the lagoons. The effluent from the biodigesters will also be sent to the lagoons. The Chemical Oxygen Demand (COD) of these vinaza streams are used to estimate the methane emissions. The quantity of these emissions is based on actual measured COD of the industrial process wastewater flowing into the CLNSA digesters and flowing out of the digesters. The COD entering the digester, directly to lagoon, and leaving the digester are 26,146,379, 22,401,800, and 6,413,179 kilograms COD per year, respectively.

Stage 2 (October 2004): Ferti-irrigation (Infiltration System) – The wastewater will be applied constantly and uniformly, in very thin layers over a 25 hectare area, which is itself divided into 6 sub-areas. Each sub area will be irrigated every 3 days. On the first day, the water film will be applied, and on the second day, the soil is revolved, and on the third day another film of water will be applied. After this stage is implemented the anaerobic lagoon storage will not be used and therefore the anaerobic lagoon storage will not be part of the wastewater treatment facility. It is instructive to note that the vinaza streams and COD concentrations are identical in this stage as they were in Stage 1. Thus, this stage will treat 54% of the vinaza in the digesters and send the effluent to the Ferti-irrigation system. The other 46% of the vinaza will be sent directly to the Ferti-irrigation system.

Stage 3 (December 2007): Co-Generation System – After the entire anaerobic treatment system is in place, the biogas will be used to generate energy by a co-generation system This stage requires a design, construction, installation a high-pressure boiler and a turbo generator. The electricity produced will be used to meet the distillery 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 additional biodigester capacity. Therefore, it remains that only 54% of the vinaza is sent to the digester.

The project contributes greatly to sustainable development for several reasons:

- It treats one of the by products from CLN (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 2,500 gallons of fuel oil per day on the first stage.
- By reducing the use of fuel oil and substituting it with methane, CLN is replacing a fossil fuel with a 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 pond where the vinasse is kept in the winter months will not be emitted anymore because it will be released and processed in the biodigesters, reducing the greenhouse emissions.

- 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 Nicaragua.

A.3. Project participants:

Name of Party Involved ((host) indicate a host Party)	Private and/or public entity(ies) project participants (as applicable)	Kindly indicate if the Party involved wishes to be considered as project participant
Government of Nicaragua	Public Entity	No
Corporación Andina de Fomento (CAF)	Public Entity*	Yes
Compañía Licorera de Nicaragua, S. A. (CLN)	Private Entity	Yes

* multilateral financial institution based in Caracas, Venezuela

A.4. Technical description of the project activity:

A.4.1. Location of the project activity:

A.4.1.1. Host Party(ies):

Nicaragua

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

Chinandega

A.4.1.3. City/Town/Community etc:

Chichigalpa

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

Chichigalpa is a small city located in the North-western side of the country, 130 Km away from Managua, Nicaragua's capital. It is part of the department (state) of Chinandega. Its area is 222 Km^2 and its population is 50,000 people.

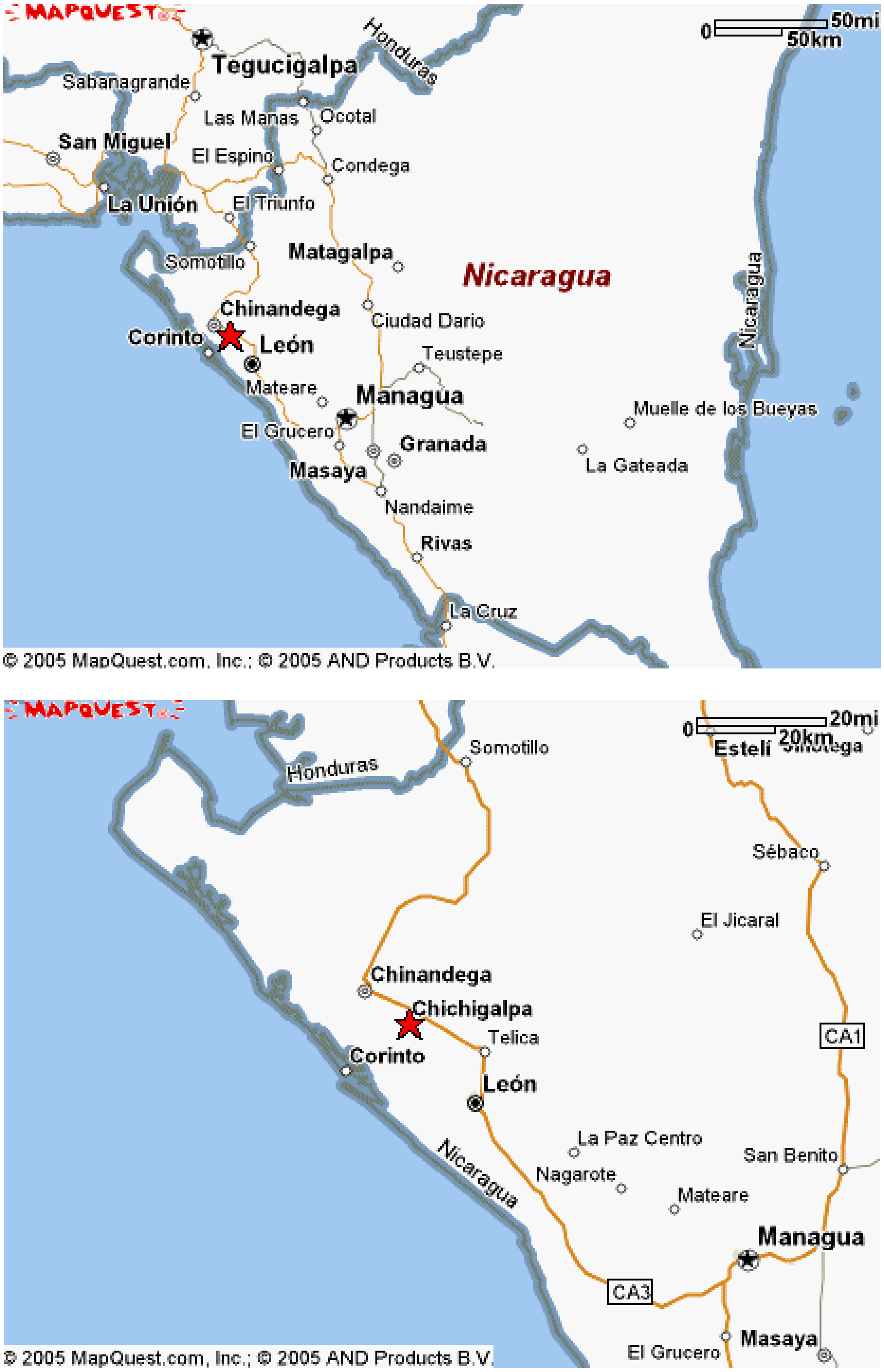


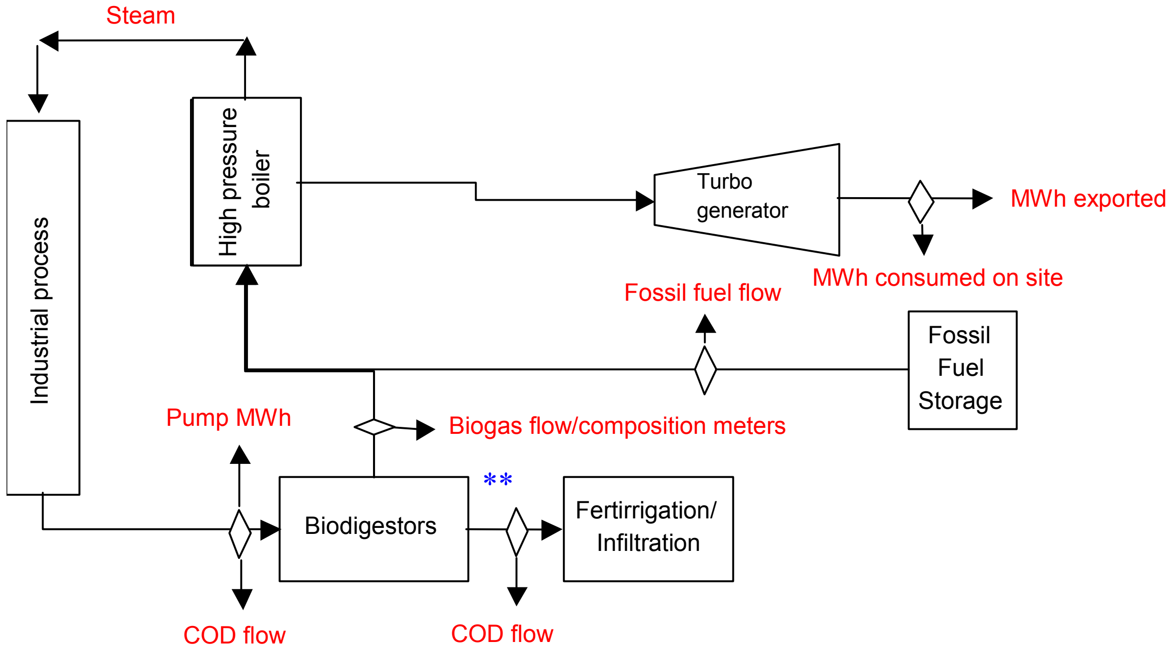
Figure 2. Geographical position of the city of Chichigalpa

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

Forced methane extraction from organic waste-water treatment plants for grid-connected electricity supply and/or heat production. Sectoral scopes 1: Energy industries (renewable - / non-renewable sources) and Sectoral scope 4: Manufacturing industries

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

The CLNSA biogas project involves three sequential phases of implementation (See Figure 1). It consists of a wastewater treatment facility as well as a co-generating facility (Figure 3). Phase 1 consists of two anaerobic digesters that convert the organic material in the vinasse into biogas, which is used as fuel for industrial steam boilers, thus displacing fuel oil. The digesters treat 54% of the total wastewater volume. The remaining 46% of the vinasse continues to be treated in the same fashion as in the Baseline, namely, by storage in a lagoon. Effluent from the digesters is also further processed by lagoon storage. Phase 1 has been implemented and characterizes the project through 2004.



** Before phase 2, 46% of the vinasse continues to be treated in the same fashion as in the Baseline, namely, by storage in an anaerobic lagoon.

Figure 3. Schematic Diagram of the wastewater and co-generation facilities (Project Activity)

In 2005, Phase 2 will be implemented. Phase 2 involves the substitution of an ferti-irrigation/infiltration wastewater treatment system for the lagoon storage system. The infiltration system comprises the spreading of both vinasse that has not been treated by the digesters and effluent from the digesters onto a field, where the wastewater percolates into the ground. This is an aerobic process. After five years of infiltration treatment, the field will have become well-fertilized by the infiltration process and will thus be ready to be replanted with cane. At that time, another field will receive five years of infiltration treatment.

In 2008, Phase 3 will be implemented. Phase 3 comprises a high-pressure boiler that converts biogas into high-pressure steam, and a steam extraction turbogenerator that converts high-pressure steam into electricity. Extracted steam will be used to serve the thermal loads in the industrial process. Thus, Phase 3 will cogenerate thermal energy and electricity, displacing both fuel oil and grid-supplied electricity.

The anaerobic digestion technology for the project is the Upflow Anaerobic Contact (UAC) technology, which is a sludge separator suitable for wastewater with high solids content.

Each biodigester is 12 meters high and 33.6 meters in diameter. The two biodigesters will produce 28,000 m^3 of biogas per day. A heat exchanger is used to reduce the temperature of the wastewater from 90°C to a temperature of 38°C. The water is then cooled for recycling. The wastewater 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 to the degasifier to separate

out the last quantities of gas from the effluent. The effluent from each biodigester flows to a separation tank where the sludge is separated from the effluent. This sludge is reinjected into the biodigester to maintain the required level of anaerobes.

In cases where the boilers go offline, an atmospheric flare burns the methane, so that at no point is methane released to the atmosphere, except for normal system leakage which is typically only about 5% of total biogas production.

Project design, engineering, equipment supply, installation, supervision, start-up supervision, and training for the anaerobic-aerobic treatment system of wastewaters for Compañía Licorera de Nicaragua 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 more than one occasion, remaining in Chichigalpa for periods that ranged from a week to a month, to make sure that CLN is operating the plant properly and that the project manager and other operators are well trained.

A.4.4. Brief explanation of how the anthropogenic emissions of anthropogenic greenhouse gas (GHGs) by sources are to be reduced by the proposed CDM project activity, including why the emission reductions would not occur in the absence of the proposed project activity, taking into account national and/or sectoral policies and circumstances:

The CLNSA Biogas Project will reduce anthropogenic GHG emissions in three ways: 1) By reducing direct methane emissions from wastewater lagoons, 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.

The existence of the CLNSA Biogas Project increases the amount of renewable energy supplied to 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 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 result in first the 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.

[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.

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.

A.4.4.1. Estimated amount of emission reductions over the chosen crediting period:

The estimated amount of emission reductions over the crediting period is 621,973 mtCO2e

Years	Annual estimation of emission reductions in tones of CO_2e
2004	30,662
2005	67,348
2006	67,348
2007	67,348
2008	64,878
2009	64,878
2010	64,878
2011	64,878
2012	64,878
2013	64,878
Total estimated reductions (tonnes of CO_2e)	**621,973**
Total number of crediting years	**10**
Annual average over the crediting period of estimated reductions (tonnes of CO_2e)	**54,469**

A.4.5. Public funding of the 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.

SECTION B. Application of a baseline methodology

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

The methodology applied to the CLN project is AM0013 - Forced methane extraction from organic waste-water treatment plants for grid-connected electricity supply and/or heat production.

B.1.1. Justification of the choice of the methodology and why it is applicable to the project activity:

AM0013 is applicable to this project because it explicitly addresses emission reductions produced by the CLN project. Specifically, emission reductions resulting from grid-connected projects using biogas from anaerobic digester treatment of industrial wastewater to fuel industrial steam boilers and to fuel on-site electricity generation.

B.2. Description of how the methodology is applied in the context of the project activity:

The methodology is applied in the context of a project activity that comprises anaerobic digesters treating wastewater 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.3. Description of how the anthropogenic emissions of GHG by sources are reduced below those that would have occurred in the absence of the registered CDM project activity:

(1) Emission Reduction.

The chosen methodology has been applied in the context of the CLNSA project to quantify emissions reductions from three sources: 1) methane emissions reductions from an industrial wastewater storage lagoon, 2) carbon emissions reductions from displacing fossil fuel with biogas as industrial steam boiler fuel, and 3) carbon emissions reductions from displacing grid-supplied electricity with on-site-generated electricity using biogas fuel.

Methane emissions from the wastewater storage lagoon have been calculated for the Base Case and the Project Case. The quantity of these emissions is based on actual measured Chemical Oxygen Demand (COD) of the industrial process wastewater flowing into the CLNSA digesters and flowing out of the digesters. The former represents the COD that would be delivered to the lagoon in the absence of the project. The measured COD leaving the digesters is substantially reduced from the COD levels entering the digesters, and provides the basis for quantifying the methane emissions from the lagoon in the Project Case.

The steam boiler CO_2 emissions treated by this methodology are not the total emissions produced by these boilers in the Base Case. Rather, they are only the emissions associated with that portion of Base Case boiler fossil fuel that is displaced by the Project Case biogas. The quantity of these emissions is based on actual measured biogas produced by the digesters. In the Base Case, combustion of fossil fuel provides the same amount of energy to the boilers as is provided by the biogas consumed by the boilers in the Project Case. Thus, the measured amount of biogas consumed by the boilers in the Project Case provides the basis for determining the amount of fossil fuel that would be burned by the steam boilers 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.

(2) Additionality analysis.

Additionality was established by using the Tool for the demonstration and assessment of additionality" developed by the Executive Board (Annex 1 of EB16)[i] The detail 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, initiated discussions with Ecosecurities to undertake the development of a comprehensive baseline for the project. The project is not yet registered.

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	
	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.

The alternatives to the project include business-as-usual (which would leave CLNSA in compliance with applicable law, as noted below), or the implementation of a composting project to process the vinasse into a more conventional fertilizer. Another possibility might be a conventional industrial pre-treatment facility, with utilization of the remaining sludge for fertilization purposes. 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 cost. While it is possible that a pre-treatment facility would be more costly than the project, it seems likely that the composting facility would likely be less costly

than the project. For the purposes of this discussion, the business-as-usual case will be labelled Option A, while construction of a conventional treatment facility is Option B, and a composting facility is designated as Option C. Finally, efficiency measures are designated as Option D.

1b Enforcement of applicable laws and regulations.

Executive Decree 33-95[3] 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 sugar plantations and used for fertilization.

CLNSA's biodigester project goes above and beyond existing environment requirements because the prior treatment and disposal method (anaerobic lagoon) fulfils the legal requirements for environmental protection. The environmental standard does not oblige the use of anaerobic digestion technology for treating vinasse.

Both the project itself as well as the alternatives involving pre-treatment of the wastewater using conventional technologies and composting would be in compliance with applicable laws.

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 Table 1 are based on CLNSA's own documentation and discussions with company officials involved in the decision to undertake the Project, as well as publicly available information on Nicaraguan debt instruments.

Capital investment alternatives. The capital investment alternatives reviewed in Section 1a above vary from the BAU case, which would deliver zero financial return and no environmental benefit, to those investments that would deliver limited or no financial returns while enhancing environmental performance and potentially reducing GHG emissions (Option B and Option C), and finally the investment option that would deliver an attractive financial return and some (more limited) reduction in emissions (Option D) for a smaller investment and a shorter payback period. For CLNSA, the investment decision lies between two options that deliver similar financial returns: a relatively small energy

[3] 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

efficiency project, which would be more easily financed (using the company's own cash) - Option D; and the more ambitious biodigester Project that would require a larger amount of the company's scarce cash (project case). 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 information on the Bolsa de Valores de Nicaragua (Nicaraguan Stock Exchange, BVN),[4] 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%.

[4] See www.bolsanic.com.

Table 1: Financial indicators for project analysis

Case	Description	Required Investment	ROI (ten years)
Project	Anaerobic digester (without CER sales)	$7.6 million	20%-23%
Option A	Application as liquid fertilizer (BAU)	$0	0%
Option B	Conventional pre-treatment and sludge application	N/A	negative
Option C	Composting	N/A	negative to 0
Option D	Efficiency measures on boiler	<$1 million	20-25%
Benchmark investor return in Nicaragua, 360-day note			8%
CLNSA hurdle rate			15%

Source: CLNSA, Econergy.

Analysis. While the return on investment for the Project is either equal to or greater than the returns generated by all other credible alternatives, and the company hurdle rate, the Project also involved a substantially higher capital investment than most other probable alternatives (Option B being considered a relatively unlikely possibility) and a longer time horizon than alternative investments. For instance, an investment in energy efficiency measures (Option D) would likely have generated a similar return to the Project case, with a smaller overall capital investment and a shorter payback. 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 payback period, a greater overall investment outlay (with limited or no access to domestic-currency financing), carries with it significant technology and project risks, and it faces other management-related barriers. For this reason, the Project case does necessarily not represent the most favourable investment option from the financial standpoint.

2d Sensitivity analysis

The sensitivity of the Project's production costs to various possible events is identified in Table 2. The sensitivity analysis is conducted in a qualitative manner, since the detailed financial models needed to conduct analysis of the impact of several variables on CLNSA and the alternative projects are not available. What the matrix of scenarios and options shows is that there is no instance where the least attractive scenario, Option C, or the probably second least attractive scenario, Option B, would clearly overtake the Project as the least-expensive option with the corresponding most favourable impact on the financial situation of CLNSA. The case of electricity price or fuel price increases does suggest that the impact would be comparably less in the project case as opposed to Option A or Option B, but this does not necessarily imply that overall the project case would be the least cost scenario, since Option A would not include financing costs or opportunity costs, which the project case, Option B, Option C and Option D clearly would to varying degrees.

Table 2: Sensitivity analysis

Event	*Significance*	*Impact*	*Option*			
		Project Case	***Option A***	***Option B***	***Option C***	***Option D***
Technology failure	Causes drop in methane and fertilizer output	Drop in energy output entails increased energy purchases and costs	No impact	No impact	No impact	No impact
Electricity price increase / fuel price increase	Causes increase in operating costs	Tariff increase will affect overall energy bill in direct proportion to extent of energy purchases – limited impact	Energy purchases are higher than in project case; overall energy bill increases more compared to project case	Energy purchases are higher than in project case; overall energy bill increases more compared to project case	Energy purchases are higher than in project case; overall energy bill increases more compared to project case	Increased efficiency softens impact of price increases on overall operating costs, but would be greater than project case
Increase price of harvested sugarcane	Causes increase in bagasse cost and sugar juice	Increase in operating costs	Increase in operating costs likely more than project case	Increase in operating costs likely more than project case	Increase in operating costs likely more than project case	Increase in operating costs similar to project case

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. 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 availability of capital and financing to implement the project. CLNSA is a well-established firm with substantial exports, and hence access to hard currency and even financing in hard currency. However, even though the Project's returns are attractive, the energy savings are denominated in local currency, and therefore do not cover exchange-rate risk incurred with financing in hard currency. Further, even though the investment would yield new productive capacity, it is not, strictly speaking, within the core business of the distillery and must compete with other potential investments that are. 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 is the most "innovative" of the options available to CLNSA. Option B represents a more standard approach to a liquid waste problem, while Option A represents no change in current practice, as do Option C and Option D, for all practical purposes. Accordingly, the challenge to the project from a management standpoint is greater than would be encountered in the case of Option B. Meanwhile, the energy efficiency measures identified in Option D would be more likely to be viewed as appropriate improvements in "housekeeping" from a management standpoint than the Project case.

The constraint imposed by limited investment resources would likely be a consideration in the instance of Option B as well as the Project case. It seems likely, however, that the probability of securing internal approval of the investment required in Option B would be lower than in the case of the Project, since the project does increase productivity and generates economic savings.

Step 4. Common practice analysis.

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

The only option remotely similar to this project would likely involve industrial pre-treatment of organic wastewater discharges at food-processing facilities in Nicaragua. As noted elsewhere, projects involving biodigesters in the sugar industry have been tried in Guatemala with less than satisfactory results, with variations in vinasse characteristics posing a challenge to the ability of the technology to deliver consistent results across a range of sugar mills.

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 shows a negative NPV until Year 8, but until Year 7 in the event that CERs are sold. Even so, the prospect of CDM credits for the projects did prove helpful in securing a go-ahead decision for this project, since they diversified the financial returns on investment. In the absence of CDM, the project might have taken a different form (perhaps Option D) or might not have been done at all. Of course, this option would have generated a more limited volume of CERs, while alternative wastewater treatment might well have generated methane reductions, but not necessarily 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 improve some non-BAU goals for the liquor plants, such as efficiency of the operations, reduce waste, reduce fossil fuel consumption and dependency, and improve the quality of the organic fertilizer used in the adjoining farms, and at the same time, generate a larger volume of CERs and the corresponding revenues from their sale.

From the above assessment, it is clear 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.4. Description of how the definition of the project boundary related to the baseline methodology selected is applied to the project activity:

The project boundary includes the electric grid and the project site. 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 storage lagoon, and
- methane emissions due to physical leakage from the biodigesters.

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.

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 included within the project boundary produce both direct emissions and indirect emissions. Direct emissions include: 1) methane emissions from the wastewater storage lagoon, 2) methane emissions resulting from physical leakage from the biodigesters, and 3) CO2 emissions from the combustion of fossil fuel by the steam boilers. Indirect emissions comprise CO2 emissions associated

with grid-supplied electricity that is generated from fossil fuel by the electricity generating plants serving the electric grid. These indirect emissions appear on the project's carbon balance sheet as a result of consumption of grid-supplied electricity by equipment at the project site.

B.5. Details of baseline information, including the date of completion of the baseline study and the name of person (s)/entity (ies) determining the baseline:

The baseline study was completed on 17/06/2005. Econergy International Corporation is the project participant responsible for the technical services related to GHG emission reductions. On behalf of CAF, Econergy is the author of this document and the entity that determined the baseline. For follow-on questions please contact Mr. Evan Evans at +1 303 473 9007 or evans@econergy.net.

SECTION C. Duration of the project activity / Crediting period

C.1 Duration of the project activity:

C.1.1. Starting date of the project activity:

June 03, 2003

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

21Y – 0 M.

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

C.2.1. Renewable crediting period

Not applicable

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

Not applicable

C.2.1.2. Length of the first crediting period:

Not applicable

C.2.2. Fixed crediting period:

C.2.2.1. Starting date:

06/03/03

C.2.2.2. Length:

10y – 0m

SECTION D. Application of a monitoring methodology and plan

D.1. Name and reference of approved monitoring methodology applied to the project activity:

The monitoring methodology selected is the methodology outlined in Annex II of AM0013.

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

The monitoring methodology was designed to be applied to projects using AM0013. 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.

D.2. 1. Option 1: Monitoring of the emissions in the project scenario and the baseline scenario

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.

D.2.1.1. Data to be collected in order to monitor emissions from the project activity, and how this data will be archived:

ID number *(Please use numbers to ease cross-referencing to D.3)*	Data Type	Data variable	Data unit	Measured (m), calculated (c) or estimated (e)	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic/ paper)	For how long is archived data kept?	Comment
M1	Activity level (open lagoon)	COD concentration of effluent (at digester outlet)	$KgCOD/m^3$ raw effluent	m	At least monthly	100%	Electronic	Minimum of two years after last issuance of CERs	
M2	Activity level (open lagoon)	Flow rate of effluent at digester outlet	m^3 raw effluent per hour	m	Continuous	100%	Electronic	Minimum of two years after last issuance of CERs	
M3	Activity level (open lagoon)	COD concentration of effluent (sent directly to lagoon)	$KgCOD/m^3$ raw effluent	m	At least monthly	100%	Electronic	Minimum of two years after last issuance of CERs	
M4	Activity level (open lagoon)	Flow rate of effluent sent directly to lagoon	m^3 raw effluent per hour	m	Continuous	100%	Electronic	Minimum of two years after last issuance of CERs	

M5	Activity level (fossil fuel use)	Mass of fossil fuel used onsite	Kg fuel	m	Continuously (aggregate)	100%	Electronic	Minimum of two years after last issuance of CERs	
M6	Activity level (fugitive CH_4)	Biogas flow rate at digester outlet	m^3/hr	m	Continuous	100%	Electronic	Minimum of two years after last issuance of CERs	
M7	Activity level (fugitive CH_4)	Biogas flow rate at boiler inlet	m^3/hr	m	Continuous	100%	Electronic	Minimum of two years after last issuance of CERs	
M8	Activity level (fugitive CH_4)	Biogas flow rate at flare inlet	m^3/hr	m	Continuous	100%	Electronic	Minimum of two years after last issuance of CERs	
M9	Emission rate (fugitive CH_4)	Biogas CH_4 content at digester outlet or boiler outlet	%	m	Interval to satisfy statistical 95% confidence level. At least quarterly	--	Electronic	Minimum of two years after last issuance of CERs	
M10	Activity level (stack gas CH_4 low pressure boiler)	Low pressure boiler stack gas flow rate	m^3/hr	m	Continuously	100%	Electronic	Minimum of two years after last issuance of CERs	
M11	Emission rate (stack	Low pressure boiler stack gas	%	m	Interval to satisfy	--	Electronic	Minimum of two years	

	gas CH_4 low pressure boiler)	CH_4 content			statistical 95% confidence level. At least quarterly			after last issuance of CERs	
M12	Activity level (fugitive CH_4)	Biogas flow rate at low pressure boiler inlet	m^3/hr	m	Continuous	100%	Electronic		
M13	Activity level (stack gas CH_4 high pressure boiler)	High pressure boiler stack gas flow rate	m^3/hr	m	Continuously	100%	Electronic	Minimum of two years after last issuance of CERs	
M14	Emission rate (stack gas CH_4 high pressure boiler)	High pressure boiler stack gas CH_4 content	%	m	Interval to satisfy statistical 95% confidence level. At least quarterly	--	Electronic	Minimum of two years after last issuance of CERs	
M15	Activity level (fugitive CH_4)	Biogas flow rate at low pressure boiler inlet	m^3/hr	m	Continuous	100%	Electronic	Activity level (fugitive CH_4)	
M15	Activity level (parasitics)	Electricity consumed by digester parasitics	MWh	m	Monthly	100%	Electronic	Minimum of two years after last issuance of CERs	
M16	Activity level	Electricity consumed by	MWh	m	Monthly	100%	Electronic	Minimum of two years	

	(parasitics)	condenser pumps and fans associated with electricity generation						after last issuance of CERs	

D.2.1.2. Description of formulae used to estimate project emissions (for each gas, source, formulae/algorithm, emissions units of CO_2 equ.)

Please see Section E for a detailed description of formulae.

D.2.1.3. Relevant data necessary for determining the baseline of anthropogenic emissions by sources of GHGs within the project boundary and how such data will be collected and archived :

ID number *(Please use numbers to ease cross-referencing to D.3)*	Data Type	Data variable	Data unit	Measured (m), calculated (c) or estimated (e)	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic/ paper)	For how long is archived data kept?	Comment
B1	Activity level (open lagoon)	COD concentration of effluent (at digester inlet)	$KgCOD/m^3$ raw effluent	m	At least monthly	100%	Electronic	Minimum of two years after last issuance of CERs	
B2	Activity level (open lagoon)	Flow rate of effluent at digester inlet	m^3 raw effluent per hour	m	Continuous	100%	Electronic	Minimum of two years after last issuance of CERs	
B3	Activity level	Electricity generated by project	MWh	m	Continuous	100%	Electronic	Minimum of two years after last	

	(electric generation)							issuance of CERs	
B4	Activity level (steam production)	Low pressure steam at back pressure turbine exit	klbs	m	Monthly	100%	Electronic	Minimum of two years after last issuance of CERs	

D.2.1.4. Description of formulae used to estimate baseline emissions (for each gas, source, formulae/algorithm, emissions units of CO_2 equ.)

Please see Section E for a detailed description of formulae.

D. 2.2. Option 2: Direct monitoring of emission reductions from the project activity (values should be consistent with those in section E).

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. Therefore option 2 was not developed.

D.2.2.1. Data to be collected in order to monitor emissions from the project activity, and how this data will be archived:								
ID number *(Please use numbers to ease cross-referencing to table D.3)*	Data variable	Source of data	Data unit	Measured (m), calculated (c), estimated (e),	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic/ paper)	Comment

D.2.2.2. Description of formulae used to calculate project emissions (for each gas, source, formulae/algorithm, emissions units of CO_2 equ.):

>>

D.2.3. Treatment of leakage in the monitoring plan

D.2.3.1. If applicable, please describe the data and information that will be collected in order to monitor leakage effects of the project activity

ID number *(Please use numbers to ease cross-referencing to table D.3)*	Data variable	Source of data	Data unit	Measured (m), calculated (c) or estimated (e)	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic/ paper)	Comment

D.2.3.2. Description of formulae used to estimate leakage (for each gas, source, formulae/algorithm, emissions units of CO_2 equ.)

>>

D.2.4. Description of formulae used to estimate emission reductions for the project activity (for each gas, source, formulae/algorithm, emissions units of CO_2 equ.)

>>

D.3. Quality control (QC) and quality assurance (QA) procedures are being undertaken for data monitored		
Data	Uncertainty level of data (High/Medium/Low)	Explain QA/QC procedures planned for these data, or why such procedures are not necessary.
M1	*Low*	*The gas analyzer will be subjected to regular maintenance and testing regime to ensure accuracy*
M2	*Low*	*Flow meters will be subjected to regular maintenance and testing regime to ensure accuracy.*
M3	*Low*	*The gas analyzer will be subjected to regular maintenance and testing regime to ensure accuracy*
M4	*Low*	*Flow meters will be subjected to regular maintenance and testing regime to ensure accuracy.*
M5	*Low*	*Flow meters will be subjected to regular maintenance and testing regime to ensure accuracy.*
M6	*Low*	*Flow meters will be subjected to regular maintenance and testing regime to ensure accuracy.*
M7	*Low*	*Flow meters will be subjected to regular maintenance and testing regime to ensure accuracy..*
M8	*Low*	*Flow meters will be subjected to regular maintenance and testing regime to ensure accuracy.*
M9	*Low*	*Flow meters will be subjected to regular maintenance and testing regime to ensure accuracy.*
M10	*Low*	*The gas analyzer will be subjected to regular maintenance and testing regime to ensure accuracy*
M11	*Low*	*The gas analyzer will be subjected to regular maintenance and testing regime to ensure accuracy*
M12	*Low*	*Flow meters will be subjected to regular maintenance and testing regime to ensure accuracy.*
M13	*Low*	*Flow meters will be subjected to regular maintenance and testing regime to ensure accuracy.*
M14	*Low*	*The gas analyzer will be subjected to regular maintenance and testing regime to ensure accuracy*
M15	*Low*	*Electricity meters will be subjected to a regular maintenance and testing regime to ensure accuracy*
M16	*Low*	*Electricity meters will be subjected to a regular maintenance and testing regime to ensure accuracy*
B1	*Low*	*The gas analyzer will be subjected to regular maintenance and testing regime to ensure accuracy*
B2	*Low*	*Flow meters will be subjected to regular maintenance and testing regime to ensure accuracy.*
B3	*Low*	*Electricity meters will be subjected to a regular maintenance and testing regime to ensure accuracy*
B4	*Low*	*Steam meters will be subjected to a regular maintenance and testing regime to ensure accuracy*

D.4 Please describe the operational and management structure that the project operator will implement in order to monitor emission reductions and any leakage effects, generated by the project activity

Most of the required monitoring points are already operational in the project operator's SCADA system. The additional monitoring points required for monitoring on-site electricity generation will be added when the electricity generation phase of the project is constructed.

D.5 Name of person/entity determining the monitoring methodology:

Econergy International Corporation is the project participant responsible for the technical services related to GHG emission reductions. On behalf of CAF, Econergy is the author of this document and the entity that determined the baseline.

SECTION E. Estimation of GHG emissions by sources

E.1. Estimate of GHG emissions by sources:

GHG Emissions related to wastewater lagoon

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

GHG Emissions related to wastewater lagoon

The Project Case emissions from the wastewater lagoon are estimated based on the chemical oxygen demand (COD) of the effluent that directly enters the lagoon and the effluent entering the lagoon from the digesters, the maximum methane producing capacity (Bo) and a methane conversion factor (MCF). These CH_4 emissions from wastewater are calculated according to the IPCC Guidelines specified in AM0013. COD entering the lagoon was estimated based on actual data provided by CLN for previous years.

Note that 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 recommends that project participants should use a maximum value of 0.21 kg CH_4/kg COD as a conservative assumption for B_o.

Also note that the IPCC guidelines do not provide a single default factor for MCF, but provide a value of 0.9 for MCF in Africa, Asia and Latin America & Caribbean. In order to reflect the uncertainty of this key parameter and for the purpose of providing conservative estimates of emission reductions, a conservativeness factor must be applied to the default value, assuming an uncertainty range of 50-100%. The MCF default value to be adopted for projects in these area will be then 0.738. Quantification of emissions from the wastewater lagoon is accomplished with the following formulae.

$$WLE_{project} = COD_{lagoon\_project} \times B_O \times MCF$$ **[Equation 1]**

Where

$WLE_{project}$	= CH_4 from wastewater lagoon; (kg/yr)
$COD_{lagoon\_project}$	= Chemical Oxygen Demand of effluent entering lagoons (kg COD/yr)
B_o	= Maximum methane producing capacity; (0.21 kg CH_4/kg COD)
MCF	= Methane conversion factor; (0.738)

$$CO2e_{lagoon\_project} = \frac{WLE_{project}}{1{,}000} \times 21$$ **[Equation 2]**

Where $CO2e_{lagoon\_project}$ = quantity of CO_2-equivalent emitted from lagoon (mtCO2e/yr)

The following table summarizes the equations and data presented above.

Emissions from Lagoon, Project Case

	COD direct to lagoon (kg COD/yr)	COD leaving digester sent to lagoon (kg COD/yr)	COD total to lagoon (kg COD/yr)	B0 (kg CH4/kg COD)	MCF	CO2e lagoon (mtCO2e/yr)
Project Case in 2004	9,390,344	1,881,785	11,272,128	0.210	0.738	36,686
Project Case in 2005-2007	0	0	0	0.210	0.738	0
Project Case after 2007	0	0	0	0.210	0.738	0

$CO2e_{lagoon\_project}$ = 36,686 mtCO2e/yr in 2004;
$CO2e_{lagoon\_project}$ = 0 mtCO2e/yr in 2005 - 2007;
$CO2e_{lagoon\_project}$ = 0 mtCO2e/yr after 2007

GHG Emissions related to anaerobic digesters

The emissions directly associated with the digesters involve only physical leakage from the system. IPCC guidelines specify physical leakage from anaerobic digesters as being 15% of total biogas production. Quantification of digester leakage is accomplished with the following formulae.

$$B_{digester} = COD_{digester} \times BF_{digester}$$ **[Equation 3]**

Where $B_{digester}$ = volume of biogas produced by digester (Nm^3/yr)
$COD_{digester}$ = total organic waste treated by digester (kg COD/yr)
$BF_{digester}$ = COD-to-biogas conversion factor (Nm^3 biogas/kg COD)

$$L_{digester} = B_{digester} \times MF \times 0.7176 \times LF_{digester}$$ **[Equation 4]**

Where $L_{digester}$ = physical leakage from digester (kg CH_4/yr)
$B_{digester}$ = volume of biogas produced by digester (Nm^3/yr)
MF = fraction of biogas that comprises methane
0.7176 = volume-to-mass conversion factor (kg CH_4/ Nm^3 CH_4)
$LF_{digester}$ = percentage of biogas leaking from digester (15%)

$$CO2e_{digester} = \frac{L_{digester}}{1,000} \times 21$$ **[Equation 5]**

Where $CO2e_{digester}$ = quantity of CO_2-equivalent physically leaked by digester (mtCO2e/yr)
$L_{digester}$ = amount of methane physically leaked from digester (kg CH_4/yr)

The following table summarizes the equations and data presented above.

Emissions from digester, Project Case

	COD to digester (kg COD/yr)	$BF_{digester}$ (m^3 biogas/kg COD)	Biogas produced (Nm^3/yr)	MF (%)	Digester leakage (%)	Digester leakage (kg CH4/yr)	Digester leakage (mtCO2e/yr)
Project Case in 2004	26,146,379	0.36	9,516,982	55%	15%	562,718	11,817
Project Case in 2005-2007	26,146,379	0.36	9,516,982	55%	15%	562,718	11,817
Project Case after 2007	26,146,379	0.36	9,516,982	55%	15%	562,718	11,817

$CO2e_{digester}$ = 11,817 mtCO2e/yr in 2004;
$CO2e_{digester}$ = 11,817 mtCO2e/yr in 2005 and 2006;
$CO2e_{digester}$ = 11,817 mtCO2e/yr after 2006

GHG Emissions related to parasitic power consumption by digester equipment

There are emissions associated with the grid-supplied electricity consumed by 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 to as the parasitic loads. If the parasitics are powered by site-generated electricity derived from the combustion of biogas, parasitic-related emissions are considered to be zero and the net electricity generated on-site is reduced by the parasitic electricity consumption. Conversely, if the parasitics are powered by grid electricity, parasitic-related emissions are a function of the carbon intensity of grid-supplied electricity and the consumption of grid supplied electricity consumed by parasitics. Quantification of parasitic-related emissions is accomplished with the following formulae. It is instructive to note that the carbon intensity of grid-supplied electricity was determined using the Combined Margin method and the calculations are delineated below.

IF

$$\frac{MWh}{yr_{on\text{-}site}} \geq \frac{MWh}{yr_{parasitics}} \qquad \textbf{[Equation 6]}$$

WHERE

$$\frac{MWh}{yr_{parasitics}} = \frac{MWh}{yr_{digester}} + \frac{MWh}{yr_{condenser}}$$

THEN

$$\frac{MWh}{yr_{parasitics,grid}} = 0$$

ELSE

$$\frac{MWh}{yr_{parasitics,\ grid}} = \frac{MWh}{yr_{parasitics}} - \frac{MWh}{yr_{on\text{-}site}}$$

Where
$MWh/yr_{on\text{-}site}$ = self-generated electricity consumed on-site by the host facility
$MWh/yr_{parasitics}$ = electricity consumed by the parasitics
$MWh/yr_{digester}$ = electricity consumed by the digester
$MWh/yr_{condenser}$ = electricity consumed by the condenser
$MWh/yr_{parasitics,\ grid}$ = grid-supplied electricity consumed by parasitics

$$CO2e_{parasitics} = \frac{MWh}{yr_{parasitics,\ grid}} \times CI \qquad \textbf{[Equation 7]}$$

Where
$CO2e_{parasitics}$ = quantity of CO_2-equivalent emissions associated with electricity consumption by parasitics (mtCO2e/yr)
$MWh/yr_{parasitics,\ grid}$ = grid-supplied electricity consumed by parasitics
CI = carbon intensity of grid-supplied electricity as determined using the Combined Margin method (mtCO2e/MWh)

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:

$$CM_{1stcreditingperiod} = \frac{OM_{year1} + BM_{historical\_(or\_year1-7)}}{2} \text{ (tCO}_2\text{e/MWh)}$$ **[Equation 8]**

The first step is then to calculate the OM_{year1} according to the proposed procedure of the baseline methodology. The OM represents the weighted average of all resources *except* low-cost/must-run facilities. The OM can be calculated as follows:

$$OM_{year1} = \frac{\sum E_i}{\sum EG_i + \lambda.\left(EG_{low-cost/must-run}\right)} \text{ (tCO}_2\text{e/MWh)}$$ **[Equation 9]**

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;

$EG_{low-cost/must-run}$ = Total annual energy (MWh) produced by low-cost/must-run power plants;

λ = Fraction of time when low-cost/must-run is at the margin of the electric system during the period of the year the Project is operational.

E_i is calculated as follows:

$$E_i = FC_i \times CV_i \times EF_i \times Ox$$ **[Equation 10]**

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. The results are presented in the table 3. .

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**

Table – 3 Data, used to calculate the OM emission factor (source INE)

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/year;
EG_i = 1.946.000 MWh/year;
$EG_{low\text{-}cost/must\text{-}run}$ = 0 MWh/year (low-cost/must-run facilities are excluded from analysis since these facilities are not a significant enough presence in the generating mix to ever operate at the margin);
λ = 0%

Thus,

OM = 1.470.291 tCO_2e/year / (1.946.000 MWh/year + 0 x 0 MWh/year)

OM = 0.755 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, $BM_{year1\text{-}7}$, can be directly obtained.

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**

Table 4 Five most recent power plants data, used to calculate BM emission factor.

Thus, BM emission factor is **0.628 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*0.755 + 0.5*0.628

CM = 0.692 tCO_2/MWh

Because a future phase of the project may involve displacement of grid-supplied electricity with electricity generated on-site, the emissions attributable to the electricity generation component of the project depend on the carbon intensity of the electricity
IF

$$\frac{MWh}{yr_{on\text{-}site}} > 0 \qquad \textbf{[Equation 11]}$$

THEN

$$CI = 0$$

ELSE

$$CI = CM$$

Where $MWh/yr_{on\text{-}site}$ = electricity generated by project activities
CM = carbon intensity of grid-supplied electricity as determined using the Combined Margin method (mtCO2e/MWh)
CI = carbon intensity of electricity consumed

The GHG emissions associated with the consumption of electricity are then:

The following table summarizes the formulae and data for this section.

Emissions from electricity, Project Case

	Electricity generated on-site (MWh/yr)	Electricity consumed by digester parasitics (MWh/yr)	Electricity consumed by condenser parasitics (MWh/yr)	Net electricity imported from grid (MWh/yr)	CI (mtCO2/MWh)	Electricity emissions (mtCO2e/yr)
Project Case in 2004	0	1,176	0	1,176	0.692	814
Project Case in 2005-2007	0	1,176	0	1,176	0.692	814
Project Case after 2007	6,320	1,619	443	0	0.692	0

$CO2e_{parasitics}$ = 814 mtCO2e/yr in 2004;
$CO2e_{parasitics}$ = 814 mtCO2e/yr in 2005 - 2007;
$CO2e_{parasitics}$ = 0 mtCO2e/yr after 2007

Total GHG Emissions Attributable to the Project

Total project emissions attributable to project activities are the sum of each of the emissions components (lagoon emissions plus leakage from the digester plus emissions from grid supplied parasitic electricity consumption).

$$PE = CO2e_{lagoon\_project} + CO2e_{digester} + CO2e_{parasitics}$$ **[Equation 12]**

Therefore, for the CLNSA project,

Period	$CO2e_{lagoon\_project}$ (mtCO2e)	$CO2e_{digester}$ (mtCO2e)	$CO2e_{parasitics}$ (mtCO2e)	PE (mtCO2e)
2004	36,686	11,817	814	49,317
2005 – 2007	0	11,817	814	12,631
After 2007	0	11,817	0	11,817

E.2. Estimated leakage:

Indirect off-site emissions, like shifts in demand of electricity or import/export will not be taken into account in the quantification of emissions, as these are very difficult to measure and are not within the control of the project developer.

Consequently, **L=0**.

E.3. The sum of E.1 and E.2 representing the project activity emissions:

Project Emissions = PE + L

Period	PE (mtCO2e)	L (mtCO2e)	Project Emissions (mtCO2e)
2004	49,317	0	49,317
2005 – 2007	12,631	0	12,631
After 2007	11,817	0	11,817

E.4. Estimated anthropogenic emissions by sources of greenhouse gases of the baseline:

Baseline emissions are the CH_4 emissions from open lagoon wastewater treatment systems, 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.

GHG Emissions Reduction related to wastewater lagoon

The Base Case emissions from the wastewater 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 (Bo) and a methane conversion factor (MCF) that expresses what proportion of the effluent would be anaerobically digested in the open lagoons. These CH_4 emissions from wastewater are calculated according to the IPCC Guidelines specified in AM0013.

Note that 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 recommends that project participants should use a maximum value of 0.21 kg CH_4/kg COD as a conservative assumption for B_o.

Also note that the IPCC guidelines do not provide a single default factor for MCF, but provide a value of 0.9 for MCF in Africa, Asia and Latin America & Caribbean[2]. In order to reflect the uncertainty of this key parameter and for the purpose of providing conservative estimates of emission reductions, a conservativeness factor must be applied to the default value, assuming an uncertainty range of 50-100%. The MCF default value to be adopted for projects in these area will be then 0.738. Quantification of emissions from the wastewater lagoon is accomplished with the following formulae.

$$WLE_{lagoon\_base} = COD_{lagoon\_base} \times B_O \times MCF$$ **[Equation 13]**

Where

WLE_{lagoon_base}	= CH_4 from wastewater lagoon; (kg/yr)
COD_{lagoon_base}	= Chemical Oxygen Demand of effluent entering lagoons (kg COD/yr)
B_o	= Maximum methane producing capacity; (0.21 kg CH_4/kg COD)
MCF	= Methane conversion factor; (0.738)

$$CO2e_{lagoon\_base} = \frac{WLE_{project}}{1{,}000} \times 21$$ **[Equation 14]**

Where $CO2e_{lagoon\_base}$ = quantity of CO_2-equivalent emitted from lagoon (mtCO2e/yr)

The following table summarizes the equations and data presented above.

Emissions from Lagoon, Base Case

	COD direct to lagoon (kg COD/yr)	COD leaving digester sent to lagoon (kg COD/yr)	COD total to lagoon (kg COD/yr)	B0 (kg CH4/kg COD)	MCF	CO2e lagoon (mtCO2e/yr)
Project Case in 2004	20,350,333	na	20,350,333	0.210	0.738	66,232
Project Case in 2005-2007	20,350,333	na	20,350,333	0.210	0.738	66,232
Project Case after 2007	20,350,333	na	20,350,333	0.210	0.738	66,232

$CO2e_{lagoon\_base}$ = 66,232 mtCO2e/yr in 2004;
$CO2e_{lagoon\_base}$ = 66,232 mtCO2e/yr in 2005 -2007;
$CO2e_{lagoon\_base}$ = 66,232 mtCO2e/yr after 2007;

GHG Emissions Reduction related to on-site electricity generation

For the CLNSA baseline, all electricity consumed by the distillery plant is provided by grid-supplied electricity. For 2004 through 2007, the project activity will not generate electricity and therefore there is no GHG emission reductions associate with on-site electricity generation during these years.

Beginning in 2008 the project activity will include on-site cogeneration of steam and electricity using biogas fuel and therefore creating GHG emission reductions. The electricity generated on-site in the Project Case via the combustion of biogas displaces grid-supplied electricity consumed in the Base Case. The quantity of baseline grid-supplied electricity displaced equals the total on-site generation in the Project Case less the amount of electricity consumed by the cooling system pumps and fans associated with the engine-generator. GHG emissions attributable to the Base Case are then the net on-site generation of the project multiplied by the carbon intensity factor for grid-supplied electricity.

The project has reported that cogeneration system has an electric generation rate of 0.028 MWh per m^3 of wastewater. This figure takes into account the biogas recovery of the biodigester and the efficiency of the cogeneration system. The annual electricity displaced by the cogeneration system is, therefore, established by the following formula.

$$ADEE = \frac{VB \times CECF}{1{,}000} - \frac{MWh}{yr_{parasitics,\ grid}}$$ **[Equation 15]**

where,

ADEE	= annual displaced electric energy; (MWh)
VB	= Volume of biogas recovered from the digester process and combusted in the boiler; (Nm^3)
CECF	= cogeneration electric conversion factor; (kWh/Nm^3)
$MWh/yr_{parasitics,\ grid}$	= grid-supplied electricity consumed by parasitics: (MWh)

$$VB = COD_{digester} \times BF_{digester} \times (1 - LF_{digester})$$ **[Equation 16]**

where

$COD_{digester}$	= total organic waste treated by digester; (26,146,379 kg COD/yr)
$BF_{digester}$	= COD-to-biogas conversion factor (0.364 Nm^3 biogas/kg COD)
$LF_{digester}$	= physical leakage from digester (15%)

$$CECF = \frac{EGR_{cogen}}{BF_{digester} \times CF_{wastewater}}$$ **[Equation 17]**

where

EGR_{cogen}	= electric generation rate of cogeneration system; (0.028 MWh/m^3WW)
$CF_{wastewater}$	= wastewater-to-COD conversion factor; (115 kg/m^3WW)

$$CO2e_{electricity} = ADEE \times CI$$ **[Equation 18]**

Where	$CO2e_{electricty}$	= quantity of CO_2-equivalent emissions associated with electricity displaced (mtCO2e/yr)
	CI	= carbon intensity of grid-supplied electricity using the Combined Margin method (mtCO2e/MWh)

Emissions from electricity, Base Case

	Biogas used by cogeneration system (Nm^3)	Cogeneration electric conversion factor (kWh/Nm^3)	Electricity consumed by parasitics (MWh/yr)	Displaced electric energy (MWh/yr)	CI (mtCO2/MWh)	Electricity emissions (mtCO2e/yr)
Project Case in 2004	0.0	0.676	1,176	0	0.692	0
Project Case in 2005-2007	0.0	0.676	1,176	0	0.692	0
Project Case after 2007	8,089,434	0.676	2,062	3,409	0.692	2,359

$CO2e_{electricity}$ = 0 mtCO2e/yr in 2004;
$CO2e_{electricity}$ = 0 mtCO2e/yr in 2005 - 2007;
$CO2e_{electricity}$ = 2,359 mtCO2e/yr after 2007

GHG Emissions related to fossil fuel combustion

The baseline steam boilers burn Bunker C fuel oil to generate hot water. Therefore, for the baseline there are emissions associated with the production of the portion of steam generated by the project activity. Thus, an estimate of the project's annual thermal energy output is used as the basis for determining the baseline energy used by the steam boilers.

Note that due to the addition of electric generating capacity planned for late in 2007, the steam displaced by the project activity is calculated using two separate methodologies. The first methodology applies for the 2004 through 2007 period and the second methodology applies for after 2007.

For 2004 through 2007 the emissions associated with Bunker C fuel oil combustion in the industrial process heating equipment are determined considering the volume of biogas combusted in the Project Case, the energy content of the biogas and the carbon content of Bunker C fuel oil. It is instructive to note that the industrial process heating emissions treated by this 2004 through 2007 methodology are not the total emissions produced in the Base Case. Rather, they are only the emissions associated with that portion of Base Case fossil fuel that is displaced by the Project Case biogas.

In 2008, the project will incorporate a cogeneration system that will use the biogas to displace both Bunker C fuel oil and grid electricity. Therefore the Project Case will no longer be a one for one fuel switch between Bunker C fuel oil and biogas used to produce steam. Thus a new methodology is used in these years to determine the emissions associated with Bunker C fuel oil that is displaced by the project.

As was estimated for the baseline electricity generation, the Bunker C fuel oil displaced is a function of the volume of wastewater generated in the process. The project has reported that cogeneration system has an electric generation rate of 0.028 MWh per m^3 of wastewater. A cogeneration system of this type will typically have approximately a 4.3 to one heat to electric ratio. Therefore it is estimated that the thermal output of the cogeneration system is 0.1204 MWh per m^3 of wastewater divided by the thermal efficiency of the baseline boiler. The baseline boiler efficiency is considered because this accounts for the Bunker C fuel oil that is required to input to the baseline boilers in order to achieve the an identical thermal generation.

The annual bunker C displaced by the boiler and cogeneration system is, therefore, established by the following formula.

<u>*2004 through 2007 Methodology*</u>

$$CO2e_{boiler} = VB \times FOE \times CC_{Bunker\,C} \qquad \textbf{[Equation 19]}$$

Where $CO2e_{boiler}$ = Baseline emissions from the portion of Bunker C fuel displaced by biogas used in the boiler; (mtCO2e/yr)
VB = Volume of biogas recovered from the digester process and combusted in the boiler; (Nm^3)
FOE = Bunker C fuel oil equivalent of biogas; (gal/ Nm^3)
$CC_{Bunker\,C}$ = Carbon dioxide content of Bunker C fuel oil ($mtCO_2$/gal)

$$VB = \left(COD_{digester} \times BF_{digester}\right) \times \left(1 - LF_{digester}\right) \qquad \textbf{[Equation 20]}$$

Where $COD_{digester}$ = total organic waste treated by digester (kg COD/yr)
$BF_{digester}$ = COD-to-biogas conversion factor (Nm^3 biogas/kg COD)
$LF_{digester}$ = percentage of biogas leaking from digester (15%)

After 2007 Methodology

$$CO2e_{boiler} = DFO_{bunker\,C} \times CC_{Bunker\,C} \quad \textbf{[Equation 21]}$$

where,

$CO2e_{boiler}$ = baseline emissions from the portion of Bunker C fuel displaced by biogas used in the cogeneration system; (mtCO2e/yr)
$DFO_{bunker\,C}$ = volume of bunker C fuel oil displaced by biogas used in the cogeneration system; (gal/yr)
$CC_{Bunker\,C}$ = carbon dioxide content of Bunker C fuel oil ($mtCO_2$/gal)

$$DFO_{bunker\,C} = \frac{\frac{VB \times CECF}{1{,}000} \times COR \times ECF1 \times ECF2}{\eta_{baselineboiler}} \quad \textbf{[Equation 22]}$$

where,

VB = Volume of biogas recovered from the digester process and combusted in the boiler; (Nm^3)
CECF = cogeneration electric conversion factor; (kWh/Nm^3)
COR = cogeneration system thermal to electric output ratio;
ECF1 = first energy conversion factor ; (3,413,000 Btu/MWh)
ECF2 = second energy conversion factor ; (144,900 Btu/gal)
$\eta_{baseline\,boilers}$ = thermal efficiency of baseline boiler; (%)

Emissions from fosil fuel, Base Case

	COD to digester (kg COD/yr)	$BF_{digester}$ (m^3 bg/kg COD)	Digester leakage (%)	Biogas used by project (Nm^3/yr)	Bunker C equivalent of biogas (gal/Nm^3)	Bunker C carbon content (mtCO2e/gal)	Fossil fuel emissions (mtCO2e/yr)
Project Case in 2004	26,146,379	0.364	15%	8,089,434	0.145	0.0117	13,747
Project Case in 2005-2007	26,146,379	0.364	15%	8,089,434	0.145	0.0117	13,747

	Cogeneration system electric output (MWh)	Cogeneration system thermal to electric output ratio	Thermal output on-site (MWh/yr)	Baseline boiler efficiency (%)	Displaced Bunker C fuel oil (gal/yr)	Bunker C carbon content (mtCO2e/gal)	Fossil fuel emissions (mtCO2e/yr)
Project Case after 2007	5,471	4.3	23,526	80%	692,663	0.0117	8,104

$CO2e_{boiler}$ = 13,747 mtCO2e/yr in 2004;
$CO2e_{boiler}$ = 13,747 mtCO2e/yr in 2005 - 2007;
$CO2e_{boiler}$ = 8,104 mtCO2e/yr after 2007

Total GHG Emissions Attributable to the Baseline

Total Base Case emissions are the sum of each of the emissions components (lagoon emissions + emissions from boiler fuel + emissions from electricity consumption).

$$BE = CO2e_{lagoon\_base} + CO2e_{electricty} + CO2e_{boiler} \quad \textbf{[Equation 23]}$$

Therefore, for the CLNSA Base Case,

Period	$CO2e_{lagoon\_base}$ (mtCO2e)	$CO2e_{delectricty}$ (mtCO2e)	$CO2e_{boiler}$ (mtCO2e)	BE (mtCO2e)
2004	66,232	0	13,747	79,979
2005 – 2007	66,232	0	13,747	79,979
After 2007	66,232	2,359	8,104	76,695

E.5. Difference between E.4 and E.3 representing the emission reductions of the project activity:

For the CLN project, **ER = 30,662 mtCO2e/yr in 2004**;
ER = 67,348 mtCO2e/yr in 2005 - 2007;
ER = 64,878 mtCO2e/yr after 2007

E.6. Table providing values obtained when applying formulae above:

Emissions from Project Case

	CO2e lagoon (mtCO2e)	CO2e digester (mtCO2e)	CO2e parasitics (mtCO2e)	Project Emissions (mtCO2e)
Project Case in 2004	36,686	11,817	814	49,317
Project Case in 2005-2007	0	11,817	814	12,631
Project Case after 2007	0	11,817	0	11,817

Emissions from Base Case

	CO2e lagoon (mtCO2e)	CO2e electric (mtCO2e)	CO2e fossil fuel (mtCO2e)	Base Case Emissions (mtCO2e)
Base Case in 2004	66,232	0	13,747	79,979
Base Case in 2005-2007	66,232	0	13,747	79,979
Base Case after 2007	66,232	2,359	8,104	76,695

Emission Reduction

Credit Period	Emission Reduction (mtCO2e)
2004	30,662
2005	67,348
2006	67,348
2007	67,348
2008	64,878
2009	64,878
2010	64,878
2011	64,878
2012	64,878
2013	64,878
10 year credit period total	**621,973**

SECTION F. Environmental impacts

F.1. Documentation on the analysis of the environmental impacts, including transboundary 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)[5]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[6]), 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.

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[5] The EIA is available in Spanish up on request.

[6] National Assembly's website (2004): www.asamblea.gob.ni

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 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.

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

The 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, 4, 5, 6 and 7 shown the licenses and the respect compliance.

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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.

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

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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.

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Figure 5. Build and operate Environmental License (page 2 of 4)

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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.

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Figure 6. 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

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Figure 7. Build and operate Environmental license (page 4 of 4)

SECTION G. Stakeholders' comments

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

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.

G.2. Summary of the 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

G.3. Report on how due account was taken of any 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 odours. 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

Annex 1

CONTACT INFORMATION ON PARTICIPANTS IN THE PROJECT ACTIVITY

Project Participant (Sponsor)

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Annex 2

INFORMATION 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.

Annex 3

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)	Calculated from host facility operator data		
MCF_{lagoon},	methane conversion factor for lagoon	IPCC default		
$COD_{digester}$	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	IPCC default		
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

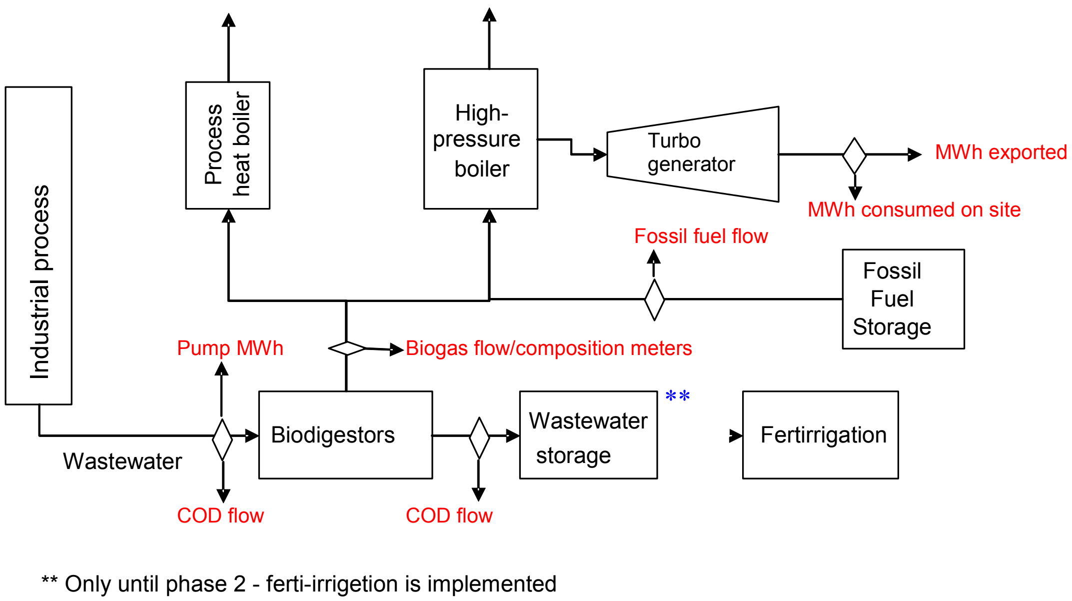
Please refer to part B of this PDD for complementary information.

Annex 4

MONITORING PLAN

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

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



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

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

[i] It should be adjusted, if for any reason the tool is modified.