MONITORING REPORT – Version 1.0

Project 0675: Vinasse Anaerobic Treatment Project - Compañía Licorera
de Nicaragua, S. A. (CLNSA)

Monitoring Period: June 3rd, 2003 – June 30th, 2008

Date: September 30th, 2009

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1. Project Background:

Project Number:	0675
Registration Date:	March 7th, 2007
Project Title:	Vinasse Anaerobic Treatment Project - Compañía Licorera de Nicaragua, S. A. (CLNSA)
Monitoring Period:	June 3rd, 2003 – June 30th, 2008
Methodology Used:	AM0013 – Avoided Methane Emissions from Organic Waste-Water Treatment – Version 3
ERs in Period:	286,848 tCO_{2eq}

Further information on this project can be found in the PDD and associated documents, which are available on the following UNFCCC website:

http://cdm.unfccc.int/Projects/DB/TUEV-SUED1159511157.97/view

The parties involved are Nicaragua (Host Country) and the Netherlands Ministry of Housing, Spatial Planning and the Environment (VROM) (Annex 1 Party). The project participants are Compañía Licorera de Nicaragua, S.A. (CLNSA) and Corporación Andina de Fomento (CAF).

2. Description of the Project Activity:

The purpose of the project is to treat the wastewater (vinasse) generated during the production of alcohol from sugar molasses by using the organic matter in the vinasse to produce clean, renewable energy. The project is made up of biodigesters where the vinasse is treated anaerobically. The methane generated from the anaerobic treatment is captured and combusted to produce energy. This energy substitutes the consumption of fuel oil and, in the future, will also substitute part of the electricity used during the alcohol production process. The project will substantially reduce CLNSA´s use of fuel oil and grid-supplied electricity.

3. Monitoring:

3.1. Monitoring Background:

The basis for the calculation of emission reductions is the Monitoring Plan in the Project Design Document. However, since the project activities started prior to the approval of methodology AM0013, and since the methodology itself was revised twice prior to the registration of the project, CLNSA was not able to foresee and fully implement the Monitoring Plan as required by methodology AM0013, Version 03 from the very beginning of the project activity. Due to this, a Request for Deviation is being presented by CLNSA through DNV.

3.2. Monitoring Methodology:

The monitoring methodology used for project 0675 is Methodology AM0013 – Avoided Methane Emissions from Organic Waste-Water Treatment – Version 3.

3.3. Monitoring Period:

The first monitoring period for project 0675 is the period ranging from June 3rd, 2003 – June 30th, 2008

4. Equations for the Calculation of Greenhouse Gas Emission Reductions:

4.1. Equations for Calculating Baseline Emissions:

Equation	Description
Lagoon Baseline Emissions	
$CH_{4\,lagoon\ baseline} = COD_{available,\ m} \times B_O \times MCF_{baseline}$	$CH_{4\ lagoon\ baseline}$ = CH_4 emissions from wastewater lagoon that would have occurred in the absence of the project (kg/month) $COD_{available,m}$ = The monthly Chemical Oxygen Demand available for conversion which is equal to the monthly COD entering the digester plus COD carried on from the previous month B_o = Maximum methane producing capacity (0.21 kg CH_4/kg COD) $MCF_{basleine}$ = Monthly methane conversion factor
$COD_{available,\ m} = COD_{baseline,\ m} \times AD + (1-MCF_{baseline,\ m-1}) \times COD_{available,\ m-1}$	$COD_{baseline,\ m}$ = Monthly Chemical Oxygen Demand of effluent entering Lagoons or directed to land application AD = Factor by which the COD is adjusted to account for the effluent present in the lagoon prior to the implementation of the project $MCF_{baseline,\ m-1}$ = The monthly methane conversion factor from the previous month $COD_{available,m}$ = The monthly Chemical Oxygen Demand available for conversion from the previous month
$AD = 1 - \left(\frac{COD_{a,out}}{COD_{a,in}}\right)$	$COD_{a,out}$ = COD that leaves the lagoon with the effluent $COD_{a,\ in}$ = COD that enters the lagoon
$MCF_{baseline} = f_d \times f_{t,monthly} \times 0.89$	f_d = the fraction of anaerobic degradation due to depth of the the sludge pit. Table 1 of AM0013 Version 03 shows that the fraction of degradation under anaerobic conditions due to a depth of 1.5 meters is 50%. $f_{t,monthly}$ = the fraction of anaerobic degradation due to temperature 0.89 = the uncertainty conservativeness factor (for uncertainty range of 30% to 50%) to account for the fact that the equation used to estimate $f_{t,monthly}$; assumes full anaerobic degradation at 30 °C.
$f_{t,monthly} = \exp\left[\frac{E \times (T_2 - T_1)}{R \times T_1 \times T_2}\right]$	E = The Activation energy constant (15,175 cal/mol) T_2 = Ambient temperature (Kelvin) T_1 = 303.16 (273.16° + 30°) R = Ideal gas constant (1.987 cal/ K mol)
$CO_{2e\ lagoon\ base} = CH_{4\ lagoon\ baseline} \times GWP_{CH4} / 1000$	$CO_{2e\ lagoon\ base}$ = The baseline metric tons of CO_2 equivalent emissions from lagoon that would take place in the absence of the project activity (tCO_{2eq}) GWP_{CH4} = Global warming potential of CH4 (21)
Electricity Baseline Emissions	
$BE_{elec/heat} = EG_y \times CEF_{Bl,elec,y} + EG_{d,y} \times CEF_{grid} + HG_{Bl,y} \times CEF_{bl,therm,y}$	$BE_{elec/heat}$ = The baseline electricity and thermal energy consumption that would take place in the absence of the project activity (tCO_{2eq}) EG_y = the amount of electricity in the year y that would be consumed at the project site in the absence of the project activity (MWh) $CEF_{Bl,elec,y}$ = the CO_2 emission factor for electricity consumed at the project site in the absence of the project activity (tCO_2/MWh) $EG_{d,y}$ = the amount of electricity generated utilizing the biogas collected during project activity and exported to the grid during year y (MWh) CEF_{grid} = the CO_2 emission factor for the grid where electricity is exported (tCO_2/MWh) $HG_{BL,y}$ = the quantity of thermal energy that would be consumed in year y at the project site in the absence of the project activity using fossil fuel (MJ) $CEF_{Bl,therm,y}$ = the CO_2 emissions intensity for thermal energy generation

	(tCO_2 e/MJ)
EG_y	Prior to 2008, EG_y is equal to zero. Starting in 2008, EG_y is equal to the project activity electric generation since the electricity that is consumed in the baseline situation is the same as the net generation of the project activity. This holds true because the electric generation will be consumed entirely on-site and will only displace grid imported electricity.
$EG_y = \left[\frac{VB \times CECF}{CF_1}\right]$	VB = The volume of biogas recovered from the biodigester process and used in the cogeneration unit (Nm^3) CECF = Cogeneration electric conversion factor (0.676 kWh /Nm^3 biogas) CF_1 = Conversion factor (1000 kWh / MWh)
$HG_{BL,y} = VB \times FOE \times HV$	$HG_{BL,y}$ = The quantity of thermal energy that would be consumed in year y at the project site in the absence of the project activity (MJ) VB = Volume of biogas recovered from the digester process and used to replace fuel oil (Nm^3) FOE = Bunker C fuel oil equivalent to biogas (0.145 gal/ Nm^3) HV = Heating value of Bunker C fuel oil (152.9 MJ/gal)
$HG_{BL,y} = \frac{EG_y \times TER}{\eta_{baseline\ boiler}} \times CF_2$	TER = The thermal to electric ratio of the cogeneration system $\eta_{baseline\ boiler}$ = Efficiency of the baseline boiler (80%) CF_2 = Conversion factor (3600 MJ/MWh)
$CM_{1stcreditingperiod} = \frac{OM_{year1} + BM_{historical\_(or\_year1-7)}}{2} = \frac{tCO_{2e}}{MWh}$	$CM_{1stcreditingperiod}$ = Combined Margin emission factor, which represents the carbon intensity (CI) of the grid and is the average of the Operating Margin (OM) and the Build Margin (BM). Since low-cost must-run resources comprise less than 50% of total electricity generation on the Nicaraguan grid, Option B (Simple OM) is allowed for determining the CM. Under Option B, the OM represents the weighted average of all resources except low-cost/must-run facilities.
$OM_{year\ i}$ = Sum (E_i) / Sum (EG_i) (tCO_2e/MWh)	$OM_{year\ i}$ = Operating Margin for year i, which needs to be calculated according to the proposed procedure of the baseline methodology E_i = Total tonnes of CO_2-equivalent emission per year of plant "i" including all plants except low-cost/must-run facilities (tCO_2e) EG_i = Total annual energy generated by plant "i" – including all plants except low-cost/must-run facilities (MWh)
$E_i = FC_i \times CV_i \times EF_i \times Ox$	FC_i =Annual fossil fuel consumption of thermal plant "i" (liters, t or m³) CV_i = Calorific value of fuel used in plant "i" (TJ/L, TJ/t or TJ/m³) EF_i = Fossil fuel emission factor (tCO_2e/TJ) Ox = Fraction of carbon oxidized
OM can be calculated using the equation above and the following values for the variables are attributed: E_i =1.470.291 tCO_2e in 2002 + 1,486,190 tCO_2e in 2003 + 1,547470 $mtCO_2e$ in 2004 EG_i = 1.946.000 MWh in 2002 + 1,991,000 MWh in 2003 + 2,078,000 MWh in 2004 Thus, OM = 4,503,951 tCO_2e / 6,015,000 MWh OM = 0.749 tCO2e/MWh BM emission factor is BM = 2,490,459 $mtCO_2e$ / 3,773,000 MWh = 0.660 tCO_2/MWh Combined Margin CM = 0.5*OM + 0.5*BM CM = 0.5*0.749 + 0.5*0.660 CM = $CEF_{Bl,elec,y}$ = 0.705 tCO_2/MWh	
$CEF_{Bl,therm,y}$ is the CO_2 emissions intensity for thermal energy generation. Thermal energy generation in the project activity displaces Bunker C fuel oil in the baseline. Therefore, $CEF_{Bl,therm,y}$ is equal to 0.00007652 tCO_2/MJ.	
Total GHG Emissions Attributable to the Baseline	
$BE = CO2e_{lagoon\ base} + BE_{elec/heat}$	BE = Total baseline emissions (tCO_{2eq})

4.2. Equations for Calculating Project Emissions:

Equation	Description
Methane Emissions From Lagoon	
$CH_{4\ lagoon\ project} = (COD_{enter\ lagoon} + COD_{dig\ out}) \times B_O \times MCF_{baseline}$	$CH_{4\ lagoon\ project}$ = CH_4 emissions from wastewater lagoon (kg/month) $COD_{enter\ lagoon}$ = The COD of effluent sent directly to the lagoon (kg COD/yr) $COD_{dig\ out}$ = The COD of effluent leaving the digester and entering the lagoon (kg COD/yr)
$CO_{2e\ lagoon\ project} = CH_{4\ lagoon\ project} \times GWP_{CH4} / 1000$	$CO_{2e\ lagoon\ project}$ = The metric tons of CO_2 equivalent emissions from lagoon (tCO_{2eq}) GWP_{CH4} = Global warming potential of CH4 (21)
Physical Leakage from Biodigesters	
$BDL = VB \times MF \times VM \times LF_{digester} \times GWP_{CH4}$	BDL = Physical leakage from the biodigesters (tCO_2) VB = Volume of biogas recovered from the digester process (Nm^3) $COD_{available,y}$ = Annual organic waste treated by digester $BF_{digester}$ = COD-to-biogas conversion factor (0.364 Nm3 biogas/kg COD) MF = Methane (CH_4) fraction of biogas (55%) VM = Volume-to-mass conversion factor (0.0007176 tCH_4/ Nm^3 CH_4) $LF_{digester}$ = Percentage of biogas leaking from digester (5%) GWP_{CH4} = Global warming potential of CH4 (21)
Stack Emissions From Energy Generation	
$SEEG = VB_{EG} \times MF \times VM_{EG} \times (1 - LF_{digester}) \times GWP_{CH4} \times (1 - DEF_{EG})$	SEEG = Stack emissions from energy generation (tCO_2) DEF_{EG} = Destruction efficiency factor (99%)
Stack Emissions From the Flare	
$SE_{flare} = MF \times VB_{flare} \times (1 - DEF_{flare}) \times VM_{flare} \times GWP_{CH4}$	SE_{flare} = Stack emissions from the flare (tCO_2) DEF_{flare} = Destruction efficiency factor (50%)
Emissions From Heat Use and Electricity Use due to the Project Activity	
$PE_{elec/heat} = EL_{p,y} \times CEF_d$	$PE_{elec/heat}$ = The project activity emissions from heat and electricity use due to the project activity (tCO2) $EL_{p,y}$ = The amount of electricity in the year y that is consumed at the project site for the project activity (MWh) CEF_d = The CO_2 emissions factors for the electricity consumed at the project site during the project activity. This value is equal to the $CEF_{Bl,elec,y}$ = variable established above
Emissions from land application of sludge	
No sludge is present in the project activity as the sludge from the digester is re-injected back into the digester.	
Emissions from wastewater removed in the dewatering process	
The project activity does not include the removal of wastewater from the dewatering process and therefore no emissions are estimated for this section.	
Total GHG Emissions Attributable to the Project are the Sum of Each of the Emissions Components Established Above.	
$PE = CO_2e_{lagoon-project} + BDL + SEEG + PE_{elec/heat}$	PE = Total project emissions (tCO_{2eq})

4.3. Equations for Calculating Leakage:

No leakage is associated with the project activity.

4.4. Equations for Calculating Emission Reductions:

Equation	Description
Emission Reductions	
$ER = BE - PE$	ER = Total emission reductions (tCO_{2eq}) BE = Total baseline emissions (tCO_{2eq}) PE = Total project emissions (tCO_{2eq})

5. Greenhouse Gas Emission Reductions:

5.1. Baseline Emissions:

Year	$CO2_{lagoon\ baseline}$ (tCO_2)	$BE_{elec/heat}$ (tCO_2)	BE (tCO_2)
2003	20,151	3,963	**24,114**
2004	69,430	13,774	**83,204**
2005	80,571	14,942	**95,514**
2006	82,784	14,618	**97,402**
2007	82,598	21,613	**104,211**
2008	49,094	12,231	**61,325**
Total	**384,628**	**81,141**	**465,769**

5.2. Project Emissions:

Year	$CO2_{lagoon\ project}$ (tCO_2)	BDL (tCO_2)	SEEG (tCO_2)	SE_Flare (tCO_2)	PE_elec (tCO_2)	PE (tCO_2)
2003	7,546	1,518	207	4,850	587	**14,707**
2004	24,267	3,848	650	5,866	1,006	**35,637**
2005	22,861	4,401	731	7,458	1,006	**36,456**
2006	22,074	4,511	725	8,862	1,006	**37,178**
2007	17,651	6,801	1,134	11,317	1,006	**37,909**
2008	11,007	3,309	629	1,649	439	**17,033**
Total	**105,406**	**24,389**	**4,075**	**40,003**	**5,048**	**178,921**

5.3. Leakage Emissions:

No leakage is associated with the project activity.

5.4. Emission Reductions:

Year	BE (tCO_2)	PE (tCO_2)	ER (tCO_2)
2003	24,114	14,707	**9,406**
2004	83,204	35,637	**47,567**
2005	95,514	36,456	**59,057**
2006	97,402	37,178	**60,224**
2007	104,211	37,909	**66,302**
2008	61,325	17,033	**44,291**
Total	**465,769**	**178,921**	**286,848**

The total emissions reductions generated by the project during the monitoring period that goes from June 3rd 2003 to June 30th 2008 is 286,848 tCO_{2eq}.