PGTF
THE PEREZ-GUERRERO TRUST FUND FOR ECONOMIC AND TECHNICAL COOPERATION AMONG DEVELOPING COUNTRIES

FINAL REPORT
2010 - 2012

Code of the project: 00060682

Title of the project: "Development of the Cleaner Production in the Sugar and Byproducts Industries"

Coordinator: Cuban Research Institute for Sugar Cane By-products (ICIDCA).

Description of the consortium:

ICIDCA	ICIDCA	Cuba
PROIMI	PROIMI	Argentina
CPML	CPML	Nicaragua

Head of the Project: Dra. Georgina L. Michelena Alvarez, ICIDCA

Index

page

I. Organization of the ISPLI (Phase II) Project

a) Project objectives:

The objectives of the work are, in principle, to apply the concept of the cleaner production in the sugar and byproduct factories, carrying out works of consultant ships initially in defined plants, extend this concept to the rest of the factories of the countries involved in this project. It was carried out the measurements and necessary studies to define the losses of water, energy, raw matters and products that make polluting and no profitable the processes. Also, It were carried the studies and the convenient recommendations to achieve a continuous improvement of the actual state of the factories and their wastewaters treatment.

Another hand, the conditions of existent laboratories with the necessary equipments (as much of laboratory as of field equipment) were increase, the characterizations of the wastewaters were determinate in order to take the internal measures in the factories, under the concepts of the Cleaner Production, and design the appropriate treatment systems of wastes.

This work allowed to quantify particular and general characteristics in the proposed outlines and facilitated to give a multiplier focus to the problem and to create a solution outline that adapts to any factory of cane sugar and byproducts coming from any country, for what is also sought with the project that processes an amplifier effect and to obtain a transferable technology toward any sugar country.

The results of the project will be applicable in a wide range of scenarios whose objective is to diminish the losses raw materials and products and produce an economic effect in the decrease of the costs with respectful solutions to the environment.

b) Project Outputs.

The outputs of the project were:

1. The personnel's of the factories training in the concepts of Cleaner Production. This aspect allowed knowing and understanding the importance and the benefits of the application of this concepts and it will facilitate the introduction of the same ones in the industries.

2. Optimization of the use of the water, the energy and raw matters in general. The consumptions were reduced therefore it will make less polluting the process and will decrease the production costs.

3. Designs of treatment systems and use of the wastewaters. It will be more compact and less expensive. The probabilities of their use will be analyzed.

Also, It were determinated: The characterization of the wastewaters of the Sugar Industry and byproducts, studies from the economic technical point of view of the alternatives of treatment of the wastes of the alcohol industry and the evaluation of plants of treatment of wastewaters after the application of the concept of cleaner productions.

The integrative nature of the project allowed that these results lead to the achievement of the proposed to medium term objectives that is in definitive, the decrease of the pollution from the sugar mill and the derivatives factories.

c) Project Activities

The activities of the project were distributed in 4 work packages, one of them being the coordination task.

Work packages.

Work Pack.	Work package title
0	Project Management
1	Laboratory complementation
2	Consultantships in factories of sugar and alcohol, for the cleaner productions.
3	Characterization of the waste waters before and after the application of the concept of cleaner productions.
4	Analysis of alternatives of treatment of waste waters for the sugar industry and byproducts. Preliminary technical - economic studies of the different treatment alternatives analyzed for factories of alcohol.

II. Evaluation of the objectives of the Project

All the objectives conceived have been achieved. Some dissemination activities have been done. National projects in each country were also supporting the project tasks. The collaboration of some institutions which are not part of the project consortium is well valued. These institutions are:

- University National of Colombia, UNC, Colombia
- University National of Tucumán, Argentina
- Federal University of Itabujá at the Center for Excellence in Thermoelectric and Distributed Generation (NEST), Minas Gerais, Brazil
- “La Gloria S.A. de C.V.” sugar company, Veracruz, Mexico
- Centro CENGICAÑA, Santa Lucía, Guatemala.

In the following pages the main technical activities of the Project are described.

WP 1 . Laboratory complementation

With invaluable support of UNIDO in the many activities promoted in the interests of development and sustainability of this national network, the ICIDCA has consolidated the work of the National Reference Center for Environmental Management of the Sugar Industry and Derivatives (CENGMA) (inaugurated in 2006), whose main objective is to achieve full integration and comprehensive concept of CP in policies and practices in the sugar industry, and allow sugar factories integrate all the sugar and derivatives in this objective.

Fig. 1. Areas of laboratories in the CENGMA, ICIDCA

Also as a result of the training received during the project, It is available in ICIDCA important for application software as Software COMFAR III and its update.

As a result of acquired knowledge has managed to increase the knowledge to other industries in Cuba, such as transport, services, urban agriculture, cement, sideromechanics and others.

The CENGMA acquired under the project the following equipment and accessories that enhance the ability to provide analysis and services to industry.

Descripción
Gaz detector CH4
Gaz detector O2 0-30%
Gaz detector H2S 0-100 ppm
Gaz detector CO 0-500ppm
Gaz detector CO2 0-9999ppm CO2
Bureta vidrio bosilicato 10 ml 0.02 ml
Bureta vidrio 25 ml 0.10 ml
Acura® 835 adjustable 1 - 10 mL
Natural macrotip, 10 mL 3x 100 /bag
Erlenmeyers de vidrio 1000 ml 6 x Pk
Crisol de porcelana con tapa, 100ml, (1200°C)
Cronometro Digital
Termómetro de mercurio -20 + 110°C
Pinzas para crisoles 300mm

Also, it was provided miscellaneous and equipment laboratory to EA Heriberto Duquesne factory, which integrating this project with value of 22 700 USD:

Description
Agitador Magnetico 150 - 1200 rpm / up to 450°C
Gaz detector CH4
Gaz detector O2 0-30%
Gaz detector H2S 0-100 ppm
Gaz detector CO 0-500ppm
Gaz detector CO2 0-9999ppm CO2
Balanza de Precisión 1200g / 0,1 g / Calibración Externa
Centrifuga de Mesa 230 V - 50/60 Hz
Angle Rotor 6x100 ml 9,000 RPM
Centrifuge glass tube 100 ml, Ø 44 x 100 mm
Campana de sobre mesa con ventilador*
FIVE Easy Conductímetro completo FE30-kit
Bureta vidrio bosilicato 10 ml 0.02 ml
Bureta vidrio 25 ml 0.10 ml
Beaker 500 ml Plástico 10 / PK
Beaker 1000 ml Plástico 5 / PK
Acura® 835 adjustable 1 - 10 mL
Natural macrotip, 10 mL 3x 100 /bag
Erlenmeyers de vidrio 1000 ml 6 x Pk
Crisol de porcelana con tapa, 100ml, (1200°C)
Probeta 1000 ml
Frasco gotero 150 ml 10 / PK
Cronometro Digital
Electrodo de vidrio combinado pH y temperatura BNC o S7 según modelo existente
Termómetro de mercurio -20 + 110°C
Pinzas para crisoles 300mm

WP 2 . Consultantships in factories of sugar and alcohol, for the cleaner productions.

The work was based on the qualification of productive, technician and directive personnel's of the sugar sector and other polluting sectors. Methodologies and work procedures were elaborated under the principles of Cleaning Production and sustainable consumption. The consultantships of Cleaning Production, characterization of the residual waters of the sugar sector were carried out by the technician.

The principal activities are summarized in this report for the period 2010-2012.

a) Main services performed: In-plant Cleaner Production (CP) assessments

Main installations assesed were:

Provinces	**Sugar Industry**
La Habana	Hector Molina
Matanzas	Jesús Rabí
Matanzas	Mario Muñoz
Cienfuegos	Glucosa Gydema
Villa Clara	Heriberto Duquesne
Villa Clara	Abel Santamaría
Santi Spiritus	Melanio Hernández"
Ciego de Ávila	Ecuador
Ciego de Ávila	Varona
Ciego de Ávila	Ciro Redondo
Camaguey	Carlos Manuel de Céspedes
Las Tunas	Antonio Guiteras
Las Tunas	Amancio Rodríguez

Holguín	Urbano Noris
Granma	Arquímedes Colina
Granma	Grito de Yara
Granma	Bartolomé Masó
Santiago de Cuba	Julio Antonio Mella
Guantánamo	Argeo Martínez

The plant assessments have allowed to show successful cases referenced in the application of CP in the sugar sector. The fundamental achievement lies in the change of mentality and good practices adopted by employers, technicians and workers, aimed at pollution prevention approach that has received the CP strategy.

Examples of the assessments:

b) Cleaning Production Consulting in Gydema Company

It was carried out consultancy firm CP Gydema the province of Cienfuegos. The company's mission is to develop raw materials and materials for industrial processes and food products from corn, in a wide range of kits for human and animal, with the best quality and efficiency, ensuring full customer satisfaction.

The company implements a quality management system for good performance. The opinions of the customers are friendly and there are few complaints about the quality of products produced by the company.

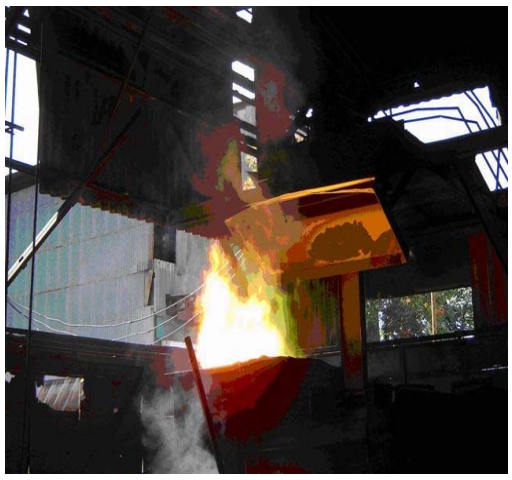
- Increased staff training. Courses related to the environment, tests for monitoring the contamination of sewage and applying the concept of Cleaner Production.
- Purchase and installation of flow meters. These are used to measure water consumption and the emission of liquid waste, which allows material balances and energy.
- Purchase of lighting to eliminate dark areas and better use of sunlight.
- The insulation of steam pipes.

- Repair of water pipelines.
- Use of all storm water and reuse in the production process.
- Repair of the floors.
- Roof repair.
- Study the use of other raw materials for the maceration step, and ways to eliminate the emission of sulfur dioxide into the environment (using ozone).
- Repair of filters to eliminate dust emission.
- Automation of the production process for better control.
- Monitoring of treated water in the sewage treatment plant of the company.
- Creation of a group of PML in the company.

c) The Company Cubana de Bronze

- Installation and purchase of the necessary parts to install the exhaust gases and dust in the most polluting.
- Repair of the oil pump had leaks.
- Repair of the collection systems of fine particles are carried by the air draft fan at each stage of the process necessary
- Settlement of the machining area to improve working conditions and reduce dust landslides in the area

Design of the proposed settlement of sewage.



Cubana de Bronze, located in the Havana

Specific technical support to companies

Activity	**2010**	**2011**	**2012**	**Total**
Specific technical support to companies	6	8	6	**20**

ICIDCA has provided technical assistance primarily in the priority issues in the sector as efficient water management, waste, energy efficiency audits and environmental assessments, these technical supports materialized into the following mains facilities:

1. Sugar industry "Antonio Guiteras", Las Tunas

2. Ethanol Destillery "Antonio Guiteras", Las Tunas
3. Torula Yeast Factory ”Antonio Guiteras”, Las Tunas
4. Sugar Industry "Heriberto Duquesne ", Villa Clara
5. Ethanol Distillery "Adela", Villa Clara
6. Biogas plant in Heriberto Duquesne sugar industry, Villa Clara
7. Biogas Plant cachaza, Las Tunas
8. Sugar Industry “Manuel Fajardo” Mayabeque
9. Sugar Industry "Hector Molina", Mayabeque
10. Ethanol Distillery "Hector Molina", Mayabeque
11. Sugar Industry "Amancio Rodriguez", Las Tunas
12. Ethanol destillery “Paradise” Sancti Spiritus
13. Sugar Industry "Melanie Hernandez. Sancti Spiritus
14. Biogas Plant “Enrique Varona” Ciego de Avila
15. GYDEMA glucose Industry. Cienfuegos
16. The Cuban foundry bronze. La Habana
17. Sugar Industry Uruguay, Sancti Spiritus

WP 3 . Characterization of the waste waters before and after the application of the concept of cleaner productions.

The characterization of water and wastewater were realized by CENGMA. It has worked in over 15 companies, processing 367 samples from Heriberto Dusquene, Jesus Rabí, Martinez Prieto Alquitex, Antonio Sanchez, Melanio Hernandez, Enrique Varona, Cuba 10, Hector Molina, Gydema Glucose Plant in Cienfuegos; Distillery Thailand; Bronze Cuban Company, Fitomas Plant and Distillery of Alficsa

New procedures have been standardized, modified and implemented based on the policy of continuous improvement. In relation with this: assays were validated for the determination of nitrogen and chloride in water and wastewater, it has been held annually the calibration and verification of instruments and equipment according to the plan. The level of customer satisfaction has been characterized by a systematic increase (85 and 89 %) in 2009 and 2011 in response to the policy of continuous improvement.

The table 1 a and b shows the results of the application of CP indication. In this case, with the characterization of wastewater by the DQO remotion in the biogas production.

Table 1a. Wastewater from derivative plant before the treatment

		Promedio	Desv. Estan	Xmáx	Xmín	n
DQOt	**g/L**	**71,20**	29,27	168,4	26,4	49
DQOt	**g/L**	49,94	7,68	63,3	38,4	14
pH		**4,47**	0,43	6,4	4	46
ST	**g/L**	52,67	4,15	60,46	45,47	14
STF	**g/L**	12,61	0,90	13,7	11,12	6
STV	**g/L**	38,67	4,29	44,25	33,05	6
SST	**g/L**	**10,70**	5,12	18,03	1,42	14
SSF	**g/L**	3,39	2,91	8,89	0,91	6
SSV	**g/L**	7,31	6,14	17,26	1,47	6
SDT	**g/L**	41,97	8,11	52,54	30,7	6
SDF	**g/L**	9,23	2,67	12,19	4,18	6
SDV	**g/L**	31,08	8,24	40,38	19,1	6
CE	**mS/cm**	**8,36**	2,86	13,41	6,6	5
Sulfatos	**g/L**	15,81	29,53	76	2,893	6
Nitrógeno	**g/L**	**0,21**	0,10	0,322	0,02	6
Fósforo	**g/L**	**0,11**	87,53	181,16	0,189	6
Calcio	**g/L**	0,55	0,34	1,2	0,26	6
STV/ST		0,75	0,02	0,77	0,73	6
SSV/SST		0,68	0,64	2,07	0,28	6

Table 1b. Wastewater from derivative plant after the treatment

	Promedio	Desv. Estand	n	Xmax	Xmin
DQOt g/L	**9,05**	8,78	67	61	0,18
DQOc g/L	7,64	8,35	68	58	0,18
ST g/L	6,58	4,50	39	23,1	0,94
STF g/L	1,31	2,40	28	11,6	0,12
STV g/L	5,27	3,15	17	14,5	1,44
SST g/L	**2,06**	2,66	27	12,6	0,11
SSF g/L	0,28	0,27	16	0,95	0,03
SSV g/L	1,37	1,67	16	5,75	0,02
SDT g/l	4,04	2,73	16	9,54	0,66
SDF g/L	0,52	0,43	16	1,77	0
SDV g/L	3,32	2,23	16	7,77	0,22
pH	**5,63**	1,43	56	11,44	2,79
CE mS/cm	0,77	0,39	26	1,7	0,08
Sulfatos g/L	0,34	0,21	15	0,95	0,11
Nitrógeno (g/L)	**0,04**	0,03	12	0,084	0
Fósforo (g/L)	**0,182**	0,29	16	0,85	0
Calcio (g/L)	0,27	0,09	8	0,38	0,14
STV/ST	0,8	0,08	17	0,98	0,66
SSV/SST	0,67	0,32	16	0,97	0,026

As can be seen the residual achieved the better indicators: there was a decreasing organic pollutant load expressed by 87% COD, pH was near to neutrality, nitrogen was removed in 80% and total solids decreased 5 times.

WP 4 . Analysis of alternatives of treatment of waste waters for the sugar industry and byproducts. Preliminary technical - economic studies of the different treatment alternatives analyzed for factories of alcohol

A study technological schemes for integrate environment was apply to an industrial complex derivatives. The closed cycle of liquid and gaseous effluents and solid by-products generated was considered.

A system composed of: cane processing plant - ethanol plant - fodder yeast plant - plant for the production of compost was considered.

The production of food for the stock from livestock development facilitated by the production of protein-based feed (Torula), the agro-industrial complex generates a variety of solid waste streams, liquid and gaseous, which are specified in quantity and composition define the solution of the same. The general conception of the solution of the residuals of the agroindustrial complex responds to design concepts that ensure reduced environmental impact and the consequent production and sustainable consumption.

With an integrated management of co-products and waste Agroindustrial Complex Derived from Sugarcane, it is possible to close the loop, making the sustainability of this industry and its compatibility with the environment.

The fundamental characteristics (flow, COD concentration, temperature, etc.) were defined.

Any proposed solutions to the waste solids, liquids and gases, respond to compliance with established environmental standards and completing the cycles of production.

Figura 1. Closed cycle in the sugar industry.

a) Options for the treatment of effluent liquid, gaseous and solid co - products.

Figure 2 shows the scheme of treatment and environmental integrated solution.

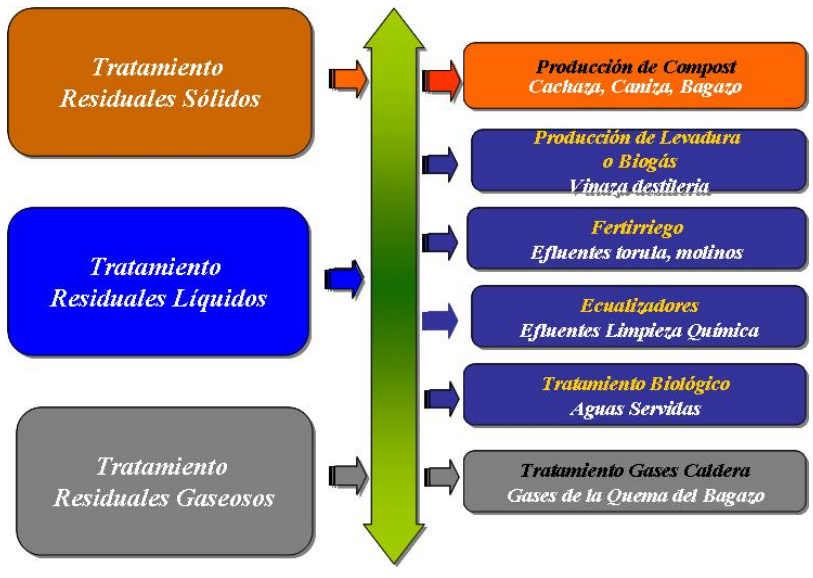


Figure 2. Treatments for the different effluents and by-products generated in the complex.

b) Treatment solid co - products

i. Production of Compost from Cachaza, ash and bagasse

The production of organic fertilizer (compost) is an alternative solution to the use of waste contributing to environmental sanitation and the improvement of the soil with a consequent positive impact on agricultural yields, provides solutions for the application of organic fertilizers, produce a fertilizing soil which allows to recycle a substantial fraction of the chemicals extracted by the rod, reducing the need for chemical fertilizers.

The proposed technology composting considers the total use of the Cachaza, the ashes and part of the bagasse generated in the process. These materials will be brought to the area by truck. It is applied directly in the field or is sold in bags.

c) Treatment liquid co – products

i. Torula yeast feed production from stillage of distillery.

This is the first treatment of distillery vinasse, among its advantages are: Reduce organic contaminant stillage up to 70%. Get fodder yeast with high nutritional value for animal feed and pharmaceutical and chemical applications.

ii. Production of biogas from stillage of distillery.

This is the first treatment of distillery vinasse, among its advantages are: Reduce organic contaminant stillage up to 70% through anaerobic digestion. Get biogas as renewable energy, high calorific value, which can be used for electric power generation.

iii. Laden liquid effluent organic pollutant (fertirrigation).

This alternative allows the soil to replace part of the organic and inorganic matter extracted from sugar cane. Furthermore, this solution has an economic purpose since, fertilizers and water replaced necessary for crops. To apply this technique, it is essential to consider the characteristics of soil and crop to define the rules of application. The main effect of fertirrigation of waste generated in sugar cane processing plant, distillery and biogas production of yeast or the ground include: Organic matter promotes improvement of the physical conditions of sandy soils, better development of microbial activity resulting from the humidification process and mobilization of nutrients according to the increased solubility provided by the liquid. The agglutination of the particles of soil and increase the structural stability of the product of the metabolism of short chain compounds by microorganisms. The vinasse incorporated into the soil is attacked by enzymes of these fungi allowing the formation of humus, neutralizing the acidity of the environment and sets the stage for the proliferation of bacteria to a count of the order of 25-335 million organisms per gram of soil (a low-fertile soil may contain from 10-40 million organisms per gram of soil). It also promotes the growth of nitrogen fixing bacteria Beijerinckia, and Azopirillium Azotabacter. The improvement of chemical properties such as elevation of potassium, phosphorus, calcium, magnesium. This improvement of these conditions is obtained in soils of low to medium fertility, high fertility soils with the addition of vinasse should be undertaken with caution. In hydromorphic soils characterized by having high contents of calcium, magnesium, sodium and potassium is not recommended the addition of large amounts of vinasse. The increasing salinity of soils poses no risk to plants at doses of 100 m^3/ha.año and if for doses of 1000 m^3/ha.año. It also helps increase the tenors of micronutrients such as Zn, Fe, Mn and Cu.

d) Environmental solutions gas streams.

Gaseous effluents emitted into the boiler: The burning of bagasse in the boilers of steam is a potential source of atmospheric pollutants. The problem of air pollution in

the sugar industry is intimately related to fuel characteristics (humidity, dust, etc.), with the characteristics of the furnace and boiler, and with the operation of such equipment. Lignocellulosic biomass, in this case the bagasse is formed largely by the plant cell walls of plants harvested. Chemically, the plant cell walls comprise three main constituents: cellulose, hemicellulose and lignin.

The emission factors express the amount of different pollutants emitted per unit of product or unit of fuel / energy. The key components of the gaseous emissions are particulate matter (fly ash), CO2, nitrogen oxides and polycyclic aromatic hydrocarbons uncontrolled among others. The fraction of ash entrained with the gases depends mainly on the type of combustion system and operating conditions as the air distribution. It is estimated that the concentration of ash in the combustion product gases varies between 1850 and 3285 mg/Nm^3 Emissions of the aforementioned compounds are significantly lower than those that emit the boiler employing fossil fuels for steam generation. The solution proposed for the removal of polluting compounds of the gases in the boiler will be the installation of particle separators, which may be dry or wet with washing. These machines are widely known and used in the sugar industry.

e) Proposed Solution Integrated Wastewater Treatment.

It was evaluated the primary treatment of distillery stillage being built adjacent to the mill, with the goal of producing biogas and electricity. Excess electricity will be sold to the joint venture.

Additionally, the enterprise considered in the study a post-treatment to anaerobic reactor effluent can be discharged to the river. It was proposed aerobic secondary treatment to reach levels of BOD maximum 60 mg BOD / L for the dumping of liquid waste to water sources.

The technology proposed as primary treatment of wastewater anaerobic digestion using a UASB reactor (tested industrially in the treatment of distillery waste). Its

configuration is rectangular, built of reinforced concrete, with the separation system gas-solid-liquid (separator GLS), also known as bells or gas dome, preferably constructed with reinforced resins and fibers (reinforced plastic). Inside the reactor is coated with epoxy paint, to provide greater security of chemical resistance, due to the high corrosiveness that occurs in the gas-liquid interface.

The proposed as secondary treatment two combined aerobic systems, which have high capacity to remove organic matter, high efficiency and low sludge production. The first stage consists of a Trickling Biological filter and the second stage by a filter with biofilm (film adhered) and forced aeration called Fixed Film Reactor Submerged. These are the latest systems and their main advantages over the conventional aerobic treatment, a compact, possible to be inserted into any system including areas populated by low environmental impact and be very resistant to shock loading, temperature and toxicity, reasons that are very stable in operation. Compared to the system of "Activated Sludge", have lower capital costs, although generally higher initial investment costs, which is due to their lower operating costs and maintenance while reducing the amount of sludge.

The results of the effectiveness of the inversion are shown in Table 2.

Indicators	Valor
Net Present Value (NPV) (USD)	2.278.865,82
Internal Rate of Return (%)	30,63
Recovery Period of Investment (years)	4,26
Recovery Period of Investment (years)	5,12
Reason NPV / Investment (RVAN)	1,47

The Net Present Value (NPV) is positive and the internal rate of return exceeds the discount rate used (10%), demonstrating the Economic Feasibility of Investment

Project. The result, in terms of recovery period indicated that the amount of the Total Investment is recovered in a reasonable time within the planning horizon of the project (when it reached 28.4% of the total time covered by the Planning Horizon. Likewise, the fact that the result obtained for the NAR indicator is positive and greater than unity, makes the project attractive, because for every dollar invested in the same get-date net income $ 1.47.

For the analysis of the case of the particular factory, the conclusions were:

It was proposed to the primary anaerobic treatment, the construction of a rectangular configuration UASB reactor, built of reinforced concrete, with the separation system gas-liquid-solid (GLS separator), preferably constructed of fiber reinforced resin (plastic reinforced) for safety chemical resistance due to the high corrosiveness that occurs in the gas-liquid interface.

It was proposes the use of a secondary aerobic treatment dual type, comprising a biological filter Trickling, in a first stage, and a filter with forced aeration biofilm and called Fixed Film Reactor Submerged in a second stage.

From the point of view of the financial evaluation, the conclusions are:

- The flow for financial planning shows a synchronization source and application of funds, demonstrating liquidity throughout the planning horizon.
- For the assumed discount factor, and using the criteria of NPV and IRR, the project proves to be economically feasible.
- The indicator NAR obtained indicates that for every dollar invested in the project results in a current net income of $ 1.47.
- Throughout the production planning horizon are obtained positive net income, representing 27.41% of sales in the reference year.
- The existence of reasons for high currents (greater than three) that increase over time, demonstrate that the project is short-term solvency.

- Obtained marketing efficiency of production, by reason Liquidity Income / Sales of 32%. This value is higher than the assumed opportunity cost of 10%, proving to be a good measure of the efficiency of the project.
- The investment project profitability is very sensitive to changes in the price of caustic soda used in the production of biogas.

III. Impact of the achieved result

As a result of plant evaluations were achieved following total environmental impact by implementing CP measures identified

Environmental parameter	2009	2010	2011	Total
Reduction in energy consumption (**GWh**)	10,3	25	20,3	**55,6**
Reduction greenhouse gases (**t CO_2**)	7725	18750	15225	**41700**
Reduction in water consumption (**Mm^3**)	230	265	223	**718**
Reduction of pollution (M**t DQO**)	6,78	6,86	7,34	**20,98**

a) Total economic benefits

savings (US$)	**2010**	**2011**	**Total**
By reduction energy consumption	362 500	294 350	**671 785**
By Reduction water consumption	13 250	11 150	**35 900**
Total	**375 750**	**305 500**	**706 685**

- The energy and water costs were recalculated on the same basis, assuming prices of $ 0.09/kWh and $ 0.30/m^3de water, except for cases where the water comes from wells themselves using the equivalent electrical pumping costs.

- Tons of CO_2 left in released into the atmosphere by way of fuel or electricity is obtained assuming a density of 0.991 kg of fuel oil /L to standardize the calculation basis.

Among the most important results achieved in the implementation of CP options in the sugar sector is:

- In the sugar sector have been identified 143 CP measures, of which 94 have been implemented which represent a 66% implementation of the proposed measures.

- Reduction of pollution load of effluents emitted by the sugar industry, because l compliance with current measures of segregation, handling and water treatment in oxidation ponds.

- Reduction of waste water from 0.55 m^3 / t cane (2007) to 0.43 m3 / t cane.

- Reduce total water consumption of 0.60 in business (2007) m^3 / t cane to 0.50 m^3 / t cane.

- Achievement and fertirrigation cycle as close to new 19 companies in the sector see table "Main installations asses."

- Production of single cell protein (Torula yeast) stillage from distilleries waste, with the consequent saving of molasses available for other uses. (2.5 t / t of yeast)

- There was more than 450.0 thousand tons of compost from waste.

- Conducted environmental investments - sugar companies to give solution to the full utilization of their waste by getting all the benefit from their residual sugar industry comprehensively, economically efficient and sustainable wellbeing of the environment.

- Elaboration of the methodology with measures to apply for the Cleaning Production in a biogas plant using stillages. The study embraced the economic and technological effect of the measures of CP introduced starting from the saving of the consumption of water and nutritious of the initial technology, using as analysis tool the software COMFAR III. Changes that were introduced to industrial scale in the plant of Biogas of the company Heriberto Duquesne unique of their type in Cuba.

- Application of the environmental audits in the Sugar Ministry. For they were made it the procedures and registrations to carry out the audits and reports of pursuit reports and control. The procedures were implemented and evaluated in two companies of the sugar Cuban sector it stops later on to generalize them. They were also enabled 10 specialists in the topic of environmental audit that at the moment form part of the team auditor of MINAZ carrying out this activity.

- Development of the "Methodology for reducing water consumption and reuse it within the sugar industry," making this process more in line with the concepts of cleaner production ". The document defines the water needs different qualities and availability of it in the technological process and establishing a detailed plan of action and concrete solutions to achieve a favorable balance and control this activity administratively.

- Characterization of wastewater from the sugar sector. A document which defined waste streams for reuse within the factory with the technological changes resulting

proposals, taking into account the use, reuse, recycling and saving water and other carriers. Also, procedures were defined analytical testing techniques and indicators of pollution, taking into account, the Cuban regulations dumping of wastewater. The personnel of reference laboratory of CENGMA LAGUAZUR were trained by the new techniques and equipment such as flame photometry, atomic absorption and other techniques that are currently implemented.

- Elaboration of the working methodology of Cleaner Production in the sugar sector. A detailed paper was produced by production area in sugar factories and derivatives under the main concepts of CP (use, reuse, recycling, treatment and prevention of pollution) and environmental management system measures that are controlled in environmental audits. Proposal feasible and necessary to achieve sustainable development and continuous improvement, identifying new processes to minimize waste and prevent relapse into our old business practices are not environmentally friendly.

IV. Dissemination activities

a) Capacitation:

Five training course consisted of five days of lectures/workshop were imparted by ICIDCA and consultants from Science Havana and Santiago de Cuba Bay Care State Commission. The topics discussed were: Cleaner production concepts, how to perform quick scans in the enterprises, how to apply the 14 001 ISO and presentation of the strategy of different industrial sectors. Actual situation of pollution at Havana Bay, energy efficiency and the environmental regulations was discussed by working groups through 5 case-studies presented. About 100 technical and directors of different enterprises were trained.

b) Training (workshops and courses)

- Training Workshop to 2 specialists Pioneer Palace of Havana "Ernesto Che Guevara." In June 2011.
- Workshop on water and wastewater specialists MINAZ Environment. Trained 30 participants in June 2010 and 35 participants in September 2011.
- Training of experts in the software point SIMAPRO 7.1 for studies of life cycle analysis Itabujá Federal University, Brazil.
- Training of 10 specialists point on Environmental Management System sponsored by the National Standards Institute (ININ).
- Certification of two specialists point as internal auditors of quality by the National Standards Institute (ININ).
- Formation of 2 experts point on the issue of environmental audits sponsored by the Ministry of audit and control of Cuba.
- One expert training focal point diploma in Advanced Techniques for the production of biogas from industrial waste, training provided by the “Instituto Superior Politécnico Jose Antonio Echeverría” in Cuba.

It was coordinated directly by the following training activities:

- Preparation of sector specialists through training and annual workshops on environmental strategy, management system and tools CP. Annually, more than 40 specialists trained in this area.
- Preparation of two specialists by sugar enterprise (60) on the use COMFAR III program and its application for the preparation of investment projects with existing keys ICIDCA.

c) Dissemination of information (events, conferences, seminars, lectures, interviews, promotions)

Activity	2010	2011	Total
Information dissemination activities (events, conferences, seminars)	2	2	6
Participating in activities to information disseminate	35	22	89

d) Main information dissemination activities

- Workshop about the impacts of Integration Technology, Energy and Environmental enterprise producing biofuels.
- Two Active asset management and environmental quality developed in the years 2010-2011.
- The National Seminar organized by the ICIDCA participation as teachers to accredit national experts in the field.

e) Assessments on environmental policies.

It is developed the National Environmental Strategy of the Sugar Ministry valid until 2015, which includes the concepts of CP to be implemented in each of the enterprise that are evaluated each year. It is implemented as a national project ICIDCA quality management, health and environment as integrated management system.

f) Location and information search.

Activity	2010	2011	Total
Requests for information electronically served	65	40	135

Requests for information were directed mainly towards topics such as CP, waste management, chemicals management, environmental certification and environmental management systems, all linked to food processing sector.

g) Promotion

Activity	2010	2011	Total
Investment project proposals	1	1	5

h) Other relevant results

Technological innovation as a successful tool in the industry CP.

Development of scientific investigations to minimize the content of H2S in the biogas. The influence of the content of sulfur was studied in the alcoholic fermentation and its impact in the content of H2S in the produced biogas, using the anaerobic digestion in UASB reactors with stillages of distillery at different concentrations of sulfates and the realization of the test Specific Metanogenic Activity with stillages of different contents

of sulfates and the mud of Heriberto Duquesne biogas plant. Investigations that it sustains 1 master thesis and 1 of doctorate and whose results are applied and in the industrial biogas plant of the company Heriberto Duquesne.

i) International framework

In 2011 in Colombia was a meeting in Medellin PML Center at the University of Antioquia and EAFIT in order to seek alliances in joint investigations and in the Catholic University of Manizales, and to create a center of CP in Manizales, located in this university. Now a days the ICIDCA and this university participates in the international network of renewable energy

In Colombia, in 2011 a meeting held at the Centre PML Medellin, Antioquia University and University EAFIT l in order to seek alliances in joint investigations and in the Catholic University of Manizales, Caldas. For creating a center of PML in Manizales, located in this university. Currently with the ICIDCA this university participates in the international network of renewable energy

In Brazil, it was conducted a training in the application of PML tool of Life Cycle Analysis (LCA) of products at the Federal University of Itabujá at the Center for Excellence in Thermoelectric and Distributed Generation (NEST), in the state of Minas Gerais in Brazil. This internship allowed to initiate the development of collaborative actions between this University and the ICIDCA focused on issues of energy savings in the sugar industry and its derivatives in both countries. This collaboration with the presentation of international projects for the preparation of libraries for the sugar sector and derivatives was hoped.

“La Gloria S.A. de C.V.” sugar company located in the States of Veracruz, in Mexico processes 12 000 t of sugar cane daily. Around 900 employees work at the facility. The quick scan was oriented toward the integral and rational use of the sugar cane, preserving the environment and generating employments with an important economic and social effect in the regions. The main aspects identified during CP quick scan were: Reduce water consumption using vegetable water to minimize actual index

from 1.769 m3/t to 1,25 m3/t. Formulate project to combine the “wastewater from cleaning processes”, and incorporate an anaerobic system for biogas production for renewable energies.

Havana, July 8th, 2012