CLEAN DEVELOPMENT MECHANISM
PROJECT DESIGN DOCUMENT FORM (CDM-PDD)
Version 03 - in effect as of: 28 July 2006

CONTENTS

Annexes

SECTION A. General description of project activity

A.1 Title of the project activity:

Ingenio Magdalena S.A. cogeneration project (for simplicity hereafter referred to as the "Magdalena Project").

PDD version number: 4

Date: 12/03/2007

A.2. Description of the project activity:

The primary objective of the Magdalena Cogeneration Project is to supply renewable energy to power Guatemala's economic growth. Magdalena will also contribute to the country's social and economic sustainability by improving the supply of electricity, by increasing the share of renewable technologies in the generation and by reducing Guatemala's dependency on fossil fuels. The project will also make use of bagasse, an indigenous resource.

IMSA, developers of the Magdalena cogeneration project, is the second largest sugar mill in Central America. Its operation started in 1976. After twenty years Magdalena was still one of the smallest sugar mills in Guatemala. Since then, Magdalena has undergone important changes that have increased the competitiveness of the sugar mill, and diversified its revenue stream to include non traditional activities such as energy sale.

As the sugar business has increased over the years, Magdalena has upgraded its cogeneration equipment to take advantage of the greater amount of bagasse available. As the expansion plans for Magdalena are expected to continue, the cogeneration equipment is also expected to continue being upgraded and more renewable energy is expected to be generated and delivered to the grid.

The Magdalena project comprises four phases. Phase one was completed in 2005 with the installation of a 825 Psig boiler and a 16.5MW generator (condensing). The second phase of the project is under construction and is expected to be completed for the 2006-2007 crop. The equipment being installed in this second stage consists of a 900Psig boiler and 30MW turbo-generator (back pressure). The third stage is to be completed by the end of 2007 and it will consist of the installation of another 900 Psig boiler and a 35MW turbo-generator. The fourth stage will consist of the installation of a 45 MW turbo-generator.

Magdalena will use bagasse, a by product in the production of sugar to produce clean energy that would displace energy that otherwise the State would have provided with a strongly fossil dependant generation system. The use of an indigenous and cleaner source of electricity thus contributes to environmental sustainability by avoiding electricity generation from fossil fuel sources, reducing greenhouse gases (GHG) emissions and the dependency of the country of imported and costly fuels. The cogeneration project also eliminates the bagasse in a controlled way, thus eliminating emissions from the traditional methods of elimination (uncontrolled burning or methane production from decay). In absence of the project, Magdalena would have had to supply its energy needs with electricity from the grid, an

activity that would have contributed to increased emissions due to Guatemala's dependency on fossil fuels.

Magdalena also contributes with Guatemala's sustainable development with the creation of several direct and indirect jobs. In the construction of the project, 95 workers were employed: 10 electrical workers, 10 mechanical workers, 30 welders and 45 general constructors. For the operation of the cogeneration project, 27 workers are required: 3 boiler's operators, 3 operators for the turbo, 3 boiler analyzers, 3 electrical workers, 3 mechanical workers and 12 general workers.

The revenues obtained from the sale of the CERs will also help IMSA to continue supporting the community. The revenue distribution and social efforts intended to be continued with the contributions of CDM, must be added to the environmental benefits when evaluating the contribution to sustainable development of this project activity.

A.3. Project participants:

Name of Party involved (*) ((host) indicates 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 (Yes/No)
Guatemala (host)	Ingenio Magdalena S.A.	No
(*) In accordance with the CDM modalities and procedures, at the time of making the CDM-PDD public at the stage of validation, a Party involved may or may not have provided its approval. At the time of requesting registration, the approval by the Party(ies) involved is required.		

A.4. Technical description of the project activity:

A.4.1. Location of the project activity:

Figure 1 - Political division of Guatemala showing the Department of Escuintla (source: www.global-children.org/ programs_guatemala.html)

A.4.1.1. Host Party(ies):

Guatemala

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

Department of Escuintla

A.4.1.3. City/Town/Community etc:

La Democracia

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

The project's complete address is: Finca Buganvilia, Jirisdiction of Municipio, La Democracia. Finca Buganvilia is identified as No.2553, Folio 35, Libro 166.

The coordinates to the Magdalena Project are: Latitude 14° 7' 13" North, Longitude 90° 55' 42" West.

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

Type: Energy and Power.

Sectoral Scope: Energy industries (renewable / non renewable sources).

Category: Renewable electricity generation for a grid (energy generation, supply, transmission and distribution).

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

Biomass power conversion technologies for power production can be classified into one of the three following categories: direct combustion technologies, gasification technologies, and pyrolysis. Direct combustion technologies, such as the used in Magdalena, are probably the most widely known option for simultaneous power and heat generation from biomass. It involves the oxidation of biomass with excess air in a process that yields hot gases that are used to produce steam in boilers. The steam is used to produce electricity in a Rankine cycle turbine. Rankine cycle configurations could also be classified into two: condensing and backpressure, depending on the proportion of the steam used for industrial processes and where in the turbine that steam is obtained. Typically, electricity only is

produced in a “condensing” steam cycle, while electricity and steam are co-generated in an “extracting” steam cycle.

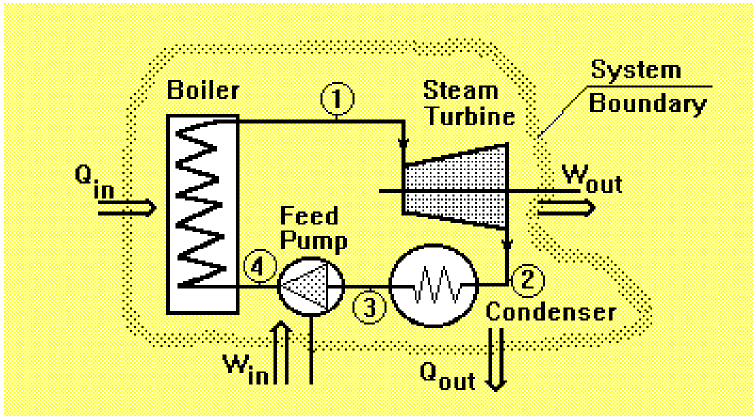

Figure 2 - Rankine Cycle

The Magdalena project is divided into three phases that are shown in the following Table. It uses the following configuration (See Tables 2 and 3).

Phase	Installed equipment		Equipment Phased Out
	Boilers	Turbo generators	
Before Project	2 x 400 PSI	1 X 5 MW	
	4 X 600 PSI	1 X 6 MW 1 X 10 MW 1 X 12.5 MW 1 X 20 MW	
1 (March 2005)	1 x 825 PSI	1 X 53.5 MW (old turbos)	
		1 x 16.5 MW	
2 (December 2005)	1 x 825 PSI	1 X 53.5 MW	
	1 x 900 PSI	1 x 16.5 MW 1 x 30 MW	
3 (2007)	1 x 825 PSI 2 x 900 PSI	1 x 16.5 MW 1 x 30 MW 1 x 35 MW	The following equipments will be kept as stand by: old turbos and boilers
4 (2008)	1 x 825 PSI	1 x 16.5 MW	The following equipments

	2 x 900 PSI	1 x 30 MW 1 x 35 MW 1 X 45 MW	will be kept as stand by: old turbos and boilers

Table 2a – Project phases

Phase	Starting date	Additional Installed capacity (in MW)
1	March 2005	16.5
2	December 2005	30
3	December 2007	35
4	December 2008	45

Table 2b – Project phases

Phase	Boiler	Steam (ton/h)	Pressure	Steam enthalpy (KJ/Kg)	Specific production (kgsteam/ kgbagasse)
1 (Boiler 9)	CALDEMA APU-25-3GR-PSE	75	825 Psig	3,380.5	2.24
2 (Boiler 10)	CALDEMA APU-53-6GI-PSE	160	900 Psig	3,376.1	2.05
3 (likely configuration)	CALDEMA APU-53-6GI-PSE	160	900 Psig	3,376.1	2.05

Table 2c – Project boilers configuration

Phase	Turbo generator	Type
1	16.5 MW	Condensing
2	30 MW	Backpressure
3	35 MW	Backpressure
4	45 MW	Backpressure

Table 2d – Project turbos configuration

Boiler	Steam (pounds/h)	Pressure (Psig)	Temperature (ºF)	Steam enthalpy (KJ/Kg)	Specific production kgsteam/ kgbagasse	Year of installation
3	75,000	400	600	3,040	2.14	1981
4	90,000	400	600	3,040	2.14	1988
5	100,000	600	750	3,209	2.13	1990
6	150,000	600	750	3,209	2.08	1991
7	225,000	600	750	3,209	2.08	1996
8	300,000	600	750	3,209	2.08	1999

Table 3a- Baseline boilers

Turbo generator	Type	Year of installation
5 MW	Backpressure	1998
6 MW	Backpressure	1989
10 MW	Backpressure	1997
12.5 MW	Condensing	1996
20 MW	Backpressure	2001

Table 3b - Baseline turbos

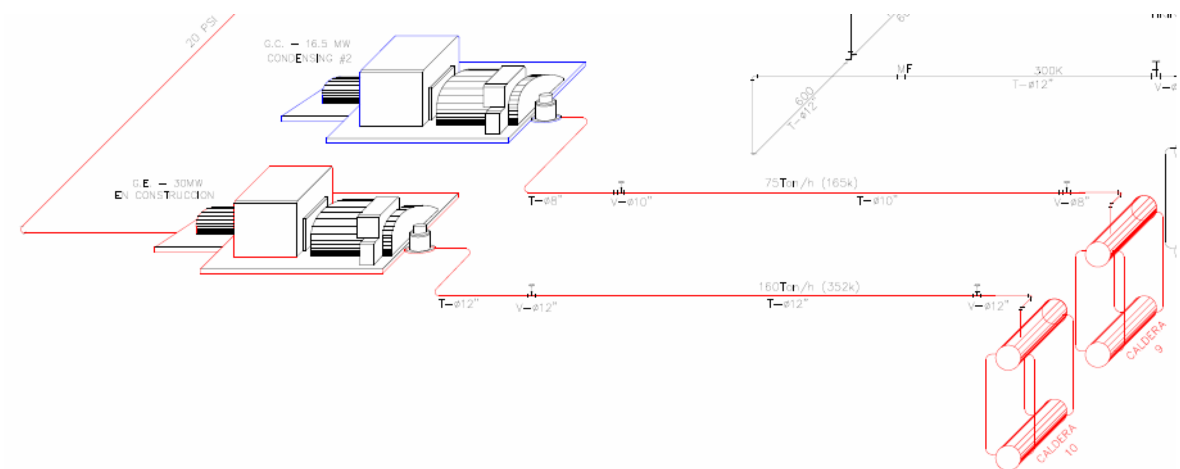

Figure 2 – Project configuration

A.4.4 Estimated amount of emission reductions over the chosen crediting period:

Magdalena is expected to generate 144,350 carbon credits per year for a total of 1,010,448 tons of CO_2 for the first 7-year period:

Years	Annual estimation of emissions reductions (tonnes of CO2e)
2005 (starting on March 1)	14,300
2006	72,421
2007	88,570
2008	142,340
2009	180,255
2010	220,536
2011	220,536
2012 (until February 29)	71,492
Total estimated reductions (tonnes of CO2e)	**1,010,448**
Total number of crediting years	7
Annual average over the crediting period of estimated reductions (tonnes of CO2e)	144,350

Table 4 – Estimated emission reductions of the Magdalena Project over the first 7-year crediting period

A.4.5. Public funding of the project activity:

There is no public funding involved on the Magdalena Project.

SECTION B. Application of a baseline methodology

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

ACM0006 – “Consolidated baseline methodology for grid-connected electricity generation from biomass residues”, version 4, 02/11/2006.

ACM0002 - “Consolidated baseline methodology for grid-connected electricity generation from renewable sources”, Version 6, dated on 19/05/2006.

Tool for the demonstration and assessment of additionality, Version 2, dated on 28/11/2005.

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

The ACM0006 methodology is applied to the Magdalena Project because it complies with all the conditions limiting the applicability of the methodology:

(i) No other biomass types than biomass residues are used in the project plant and these biomass residues are the predominant fuel used in the project plant. Biomass is defined as a by-product, residue or waste stream from agriculture, forestry and related industries.

Magdalena uses sugar cane bagasse that comes from the production of sugar carried on the same facility where the project is located.

(ii) The implementation of the project shall not result in an increase of the processing capacity of raw input or other substantial changes in the process:

Any increases in the bagasse production are due to Ingenio Magdalena's natural expanding business (as it was explained in Section A.2) and could not be attributed to the implementation of the cogeneration project. "*Costos y precios para etanol combustible en America Central*" (Costs and prices for ethanol in Central America), a study prepared by CEPAL (*Comisión Económica para América Latina y Caribe*) in May/2006 (copy under request) shows that there has been recently a "notable advance in the consciousness on the potentiality of ethanol in Central America". According to CEPAL, in Guatemala, El Salvador and Costa Rica is already operating a "relatively important installed capacity for the production of ethanol" and new projects will be implemented, directed mainly for the export of ethanol to the U.S. and Europe. CEPAL adds: "In terms of productive capacity to produce larger quantities of cane for ethanol production, Guatemala, El Salvador and Costa Rica are at an advantage". Cengicaña (*Centro Guatemalteco de Investigación y Capacitación de la Caña de Azúcar* – Guatemalan Sugar Cane Research Center) established, in their strategic plan 2005-2010 (see http://www.cengicana.org/Portal/Documents/Documents/2005-08/219/70/InformeAnualComprimido20042005.pdf), the increase of productivity of sugar cane per planted area, and the increase of global productivity, through research, use of new equipment and transfer of technology. This shows an unequivocal trend for the expansion of the production of sugar cane in Guatemala. In a meeting held on 15/05/2002 Magdalena planned an expansion of their sugar production, from 2,600,000 tones in harvest 2003-2003, to 4,000,000 tones, in harvest 2006-2007, as shown in annexed file "Magdalena Strategic Plan 2002.doc". The graph below shows that the production for the sugar mill has had an incrementing trend for years, long before the implementation of the project activity. The increase of production during the implementation of the project is very conservative when compared to the last years increase in production.

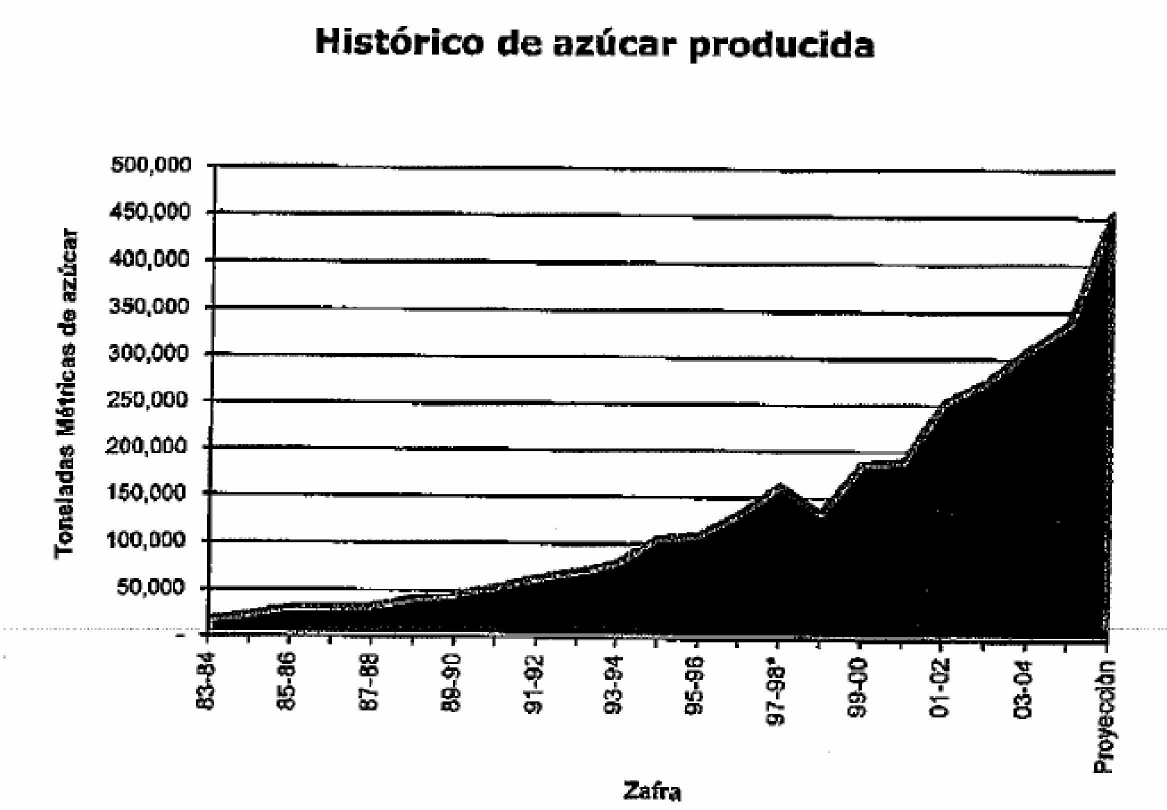

Figure 3 – Ingenio Magdalena sugar production grown

(iii) The biomass used by the project facility should not be stored for more than one year:

It is of general practice for sugar mills to keep some bagasse until the beginning of the next season to facilitate the start of operation of the cogeneration system. This practice avoids the consumption of fossil fuels or electricity from the grid. Nevertheless the amount of bagasse stored between seasons is minimal as it accounts for less than 5% of total bagasse generated in a regular season. Most importantly, this bagasse is always stored less than a year: from the end of the crop in mid June until mid November, the start of the new crop.

(iv) No significant energy quantities, except for transportation of the biomass, are required to prepare the biomass residues for fuel consumption:

The biomass used in this project is not transformed in any way before its use as a fuel. The bagasse is taken directly from the mills of the sugar cane production facility and no further processing of this biomass is present.

B.3. Description of how the sources and gases included in the project boundary

	Source	Gas		Justification/Explanation
Baseline	Grid electricity generation	CO_2	Included	Main emission source
		CH_4	Excluded	Excluded for simplification. This is conservative
		N_2O	Excluded	Excluded for simplification. This is conservative
	Heat generation	CO_2	Included	Main emission source
		CH_4	Excluded	Excluded for simplification. This is conservative
		N_2O	Excluded	Excluded for simplification. This is conservative
	Uncontrolled burning or decay of surplus biomass residues	CO_2	Excluded	It is assumed that CO_2 emissions from surplus biomass residues do not lead to changes of carbon pools in the LULUCF sector
		CH_4	Excluded	Project participants decided to not include this emission source, because cases B1, B2 and B3 of ACM0006 are not the most likely baseline scenarios
		N_2O	Excluded	Excluded for simplification. This is conservative. Note also that emissions from natural decay of biomass are not included in GHG inventories as anthropogenic sources
Project Activity	On-site fossil fuel consumption	CO_2	Included	There are emissions due to fossil fuel consumption during the plant start up
		CH_4	Excluded	Excluded for simplification. This emission source is assumed to be very small
		N_2O	Excluded	Excluded for simplification. This emission source is assumed to be very small
	Off-site transportation of biomass residues	CO_2	Excluded	Bagasse is produced inside the mills. No off-site transportation of bagasse is necessary
		CH_4	Excluded	Excluded for simplification. This emission source is assumed to be very small
		N_2O	Excluded	Excluded for simplification. This emission source is assumed to be very small
	Combustion of biomass residues for electricity and / or heat generation	CO_2	Excluded	It is assumed that CO_2 emissions from surplus biomass do not lead to changes of carbon pools in the LULUCF sector
		CH_4	Excluded	This emission source is not included because CH_4 emissions from uncontrolled burning or decay of biomass in the baseline scenario are not included
		N_2O	Excluded	Excluded for simplification. This emissions source is assumed to be very small
	Storage of biomass residues	CO_2	Excluded	It is assumed that CO_2 emissions from surplus biomass residues do not lead to changes of carbon pools in the LULUCF sector
		CH_4	Excluded	Excluded for simplification. Since bagasse is stored for not longer than one year, this emission source is assumed to be small
		N_2O	Excluded	Excluded for simplification. This emissions source is assumed to be very small

B.4 Description of how the baseline scenario is identified and description of the identified baseline scenario:

Magdalena uses bagasse for the generation of heat and electricity. The project activity replaces less efficient equipment that used the biomass to generate electricity to the sugar mill. This corresponds to scenario #14, considering the replacement of equipment for more efficient technology.

The alternatives to the project activity are as follows: a) power generation: in the absence of the project, energy would have been generated partially in existing and new grid-connected power plants (alternative P4) and partially in the existing cogeneration plant using the same biomass until the end of the lifetime of the existing plant. The project activity would have been in that case not implemented as a CDM project activity at the end of the lifetime of the existing plant (alternative P5); b) biomass: in the absence of the project, the biomass would have been used for heat and electricity generation in the project site (alternative B4); c) Heat: in the absence of the project activity, heat would have been generated in boilers using the same type of biomass until the existing plant would have been replaced without the incentives of the CDM (alternative H5). The identified alternatives for the different components of the project activity correspond to scenario 14, an energy efficiency project, obtained by the replacement of the existing biomass power units by new highly efficient ones.

Scenario 14 is valid because the old and less efficient equipment is replaced by the new and more efficient one. This change would have occurred without the incentives of the CDM at the end of the lifetime of the old equipment. For Magdalena Cogeneration Project, it was estimated that the replaced equipment at the time of the replacement still had over 30 years of life. This corresponds to typical average technical lifetime of this type of equipment in this industry in Guatemala According to the manufacturers, this kind of equipment has a technical lifetime of 30 years, and common practice in Guatemala shows that sugar mill equipment can be used, with good maintenance, for over 60 years. Technical literature (Babcock & Wilcox Corporation. “Our boilers and enviroment equipment. (catalog); Perez, G. L. “La remodelación de la caldera alemana de 25t/h”. Energia, no. 5, pp. 14-27, 1985; Foster Wheeler Corporation. “Heat engineering. CFB technology aids in redevelopment”, 1999).
states that boilers with good maintenance can work for periods over 50 years.

It can be added that the equipments are used at most 5 months per year, during the harvest period. The oldest boiler was installed in 1981. The oldest turbo was installed in 1989 (see section A.4.3 for all dates). All equipments will continue to be used as stand-by.

Emission reductions from heat are not considered because the heat efficiency of the new plant is larger than the heat efficiency of the pre-project equipment and, for conservativeness reasons, they are excluded, i.e., ERheat,y = 0. Heat efficiency for the boilers of the baseline is, on average, 6,646 kJ/kg bagasse; for the boilers of the project, heat efficiency, on average, is 7,247 kJ/kg bagasse.

Biomass decay was non-existent, nor have biomass been burned in an uncontrolled manner, as biomass was used in the past to generate electricity for internal use. For scenario #14, BEbiomass, y=0.

B.5. 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 (assessment and demonstration of additionality):

In order to determine if the project activity is additional the additionality tool approved by the Executive Board is applied[1]. The following the steps are applied:

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

a) The starting date of the CDM project activity, February 19, 2004, falls between 1 January 2000 and the date of the registration of a first CDM project activity, 18 November 2004.

b) Evidence demonstrates that CDM incentives were seriously considered in the development of the Magdalena Project.

Magdalena Project started its cogeneration project on February 19, 2004. Prior to this date, the owners of the project were introduced to the Clean Development Mechanism and its incentives for projects that reduce greenhouse gases emissions through seminars. It is a fact that the sugarcane industry sector has been informed about the Clean Development Mechanism and has been proactive in participating in the CDM in last years.

Although the owners of Magdalena were fully aware of the incentives of the CDM when developing the cogeneration project, their inclusion in official project documents is rare; a circumstance motivated by the uncertainty of the implementation of the Kyoto Protocol and its flexibility mechanisms. Nevertheless, the minute of the meeting held by IMSA's Board on January 21, 2003 mentions the incentives of the CDM as a form of financing of the project. This document precedes the start date of the project, thus providing strong evidence of the serous consideration of CDM in the development of the cogeneration project.

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

Sub-step 1a. Define alternatives to the project activity

To define alternatives to the project activity, we must complete a two-sided analysis, taking into consideration the perspective of the project owner and the perspective of the country. From the project owner's perspective, the cogeneration project provides the company with electricity and heat for the production of sugar. It also provides excess electricity to be exported to the grid.

From the country's perspective, the alternative for producing a similar amount of energy as the one Magdalena is to provide is to use current generation system; a system that continuously increases its dependency on thermal plants (using diesel and bunker).

[1] http://cdm.unfccc.int/EB/Meetings/016/eb16repan1.pdf

From the project owner’s perspective, the cogeneration project provides the company with electricity and heat for sugar production. It also provides excess electricity to be exported to the grid. In the absence of the project, bagasse would have been inefficiently burned in old generation boilers, eliminating the possibility of additional energy to be generated and delivered to the grid.

From an investment point of view, the alternative to the project activity for the sponsors is the continuation of the previous situation, i.e., no project activity.

Sub-step 1b. Enforcement with applicable laws and regulations

The project activity and the alternative scenario are in compliance with the legal and regulatory requirements.

Step 2. Investment analysis

Sub-step 2a. Determine appropriate analysis method

Additionality is demonstrated through an investment benchmark analysis (option III)

Sub-step 2b and 2c– Option III - benchmark analysis

The process of funding a project such as the cogeneration project for Magdalena is a very challenging task. Guatemala suffers from weak local economy and local banks charged high interest rates at the time the investment decision was made (13.5% in 2004 for loans based in Quetzales, see below)

YEAR	LENDING
1980	11.0
1981	15.0
1982	12.0
1983	12.0
1984	12.0
1985	12.0
1986	14.0
1987	14.0
1988	16.0
1989	16.0
1990	22.6
1991	22.1
1992	21.2
1993	25.7
1994	20.2
1995	22.2
1996	22.4
1997	16.4
1998	18.1
1999	20.6
2000	20.0
2001	17.9
2002	16.2
2003	14.1
2004	13.5
2005	12.7
2006	12.9

Guatemalas' Interest Rate Domestic Currency

Source:Guatemala's Central Bank

(http://www.banguat.gob.gt/inc/ver.asp?id=/en/pim/in.pim03)

Magdalena's cash flow (see annexed spreadsheet "Magdalena_IRR_2007.03.12.xls") shows that the IRR of the project, 8.9%, is lower than the average bank active rates at the time the investment decision was made.

Sub-step 2d: Sensitivity analysis

A sensitivity analysis was conducted by altering the following parameters:

• Increase in project revenue

• Reduction in running costs

Those parameters were selected as being the most likely to fluctuate over time. Financial analyses were performed altering each of these parameters by 10%, and assessing what the impact on the project IRR would be (see results in the Table below. For the calculation, see annexed spreadsheet "Magdalena_IRR_2007.03.12.xls"). As it can be seen, the project IRR remains lower than its alternative even in the case where these parameters change in favor of the project.

Table: Sensitivity analysis

Scenario	**% change**	**IRR without CERs(%)**
Original		8.9%
Increase in project revenue	10%	13.0%
Reduction in project costs	10%	11.7%

We can conclude therefore that Magdalena project could not be implemented without the CER revenue.

Step 3. Barrier Analysis

Sub-step 3a. Identify barriers that would prevent the implementation of type of the proposed project activity

Institutional Barrier

Although there were some incentives (Decree 52-2003, 28.10.2003) in place by the Guatemalan Government, at the time of the project's start, to promote the development of renewable energy projects, the results had been very modest. Since 1999, there were no increases in geothermal electric installed capacity whereas the coal thermo generation increased into about 7% of the total Guatemalan electric installed capacity in 2004. This amount was about the same to bagasse fuel thermo generation, which were installed from 1992 to 1996[2].

This can be summarized by: OLADE, 1997, "Waste from the wood, paper, and cellulose, and sugar industries are highly appropriate for the cogeneration of electricity and heat for own use and sale to the electric power grid. In Guatemala, Jamaica, Brazil, and other countries of the region, important steps have been taken in the sugar industry. The economic conditions for cogeneration have not improved in the course of the reforms (energy sectors restructurings), owing to the relative depreciation of electricity supplied to the public grid. Thus, the significant potential for cogeneration in sugar mills has taken time to materialize."

Technological and Logistic Barrier

[2] *Administrador del Mercado Mayorista, statistic annual reports, www.amm.org.gt*

Even though the technology used in the cogeneration project is well known in Guatemala, there are barriers of technological and logistical nature associated with its application. Rankine Cycle steam turbines are not produced in Guatemala, so they must be imported mostly from Brazil and the US. This represents a problem to the project developer since they must depend on outside know-how to set up and maintain the new facility. The development of cogeneration project also required engineers and technical personnel from abroad, thus making this logistic barrier extensive to manpower as well as equipment.

Besides the Rankine-cycle technology, Magdalena also utilizes equipment to deliver electricity to the grid and complex control systems for the new facility. This is not the typical traditional equipment of sugar cane producing and its usage represents also a technological barrier. This control equipment is also imported, thus increasing the importance of the barrier mentioned in the paragraph above.

To ensure the proper function of the project, Magdalena had also to acquire new knowledge in electric transmission and the sale of electricity in the spot market. Such knowledge acquisition could not be achieved without important investments. The incentives of the CDM would help to ease the acquisition of this knowledge.

Core Business Barrier

In addition to all those barriers mentioned above, the sugar mill does not have an incentive to invest in electricity in their own power plants since in general; the revenue of selling electricity in a cogeneration project represents around 6% of the total revenues of a sugar mill. Therefore, the sugar mills tend to invest in their core business, which is sugar, instead of investing in electricity generation for the grid.

Sub-step 3 b. Show that the identified barriers would not prevent the implementation of at least one of the alternatives.

As described above, the main alternative to the project activity is continuing the current situation without the expansion, i.e., no project activity. This alternative would not be prevented by the barriers identified above.

Step 4. Common Practice Analysis

Sub-step 4a. Analyze other activities similar to the proposed project:

Although cogeneration is a widespread practice among sugar cane producers, it is worth mentioning that only a few of those producers generate excess energy to be sold to the grid. The traditional goal of a cogeneration project has been first, to produce enough energy to maintain the

companies independent from the grid and second, to eliminate (burn) the bagasse, sugar cane's byproduct. There is currently another cogeneration project in Guatemala: San Diego, which is also participating in CDM.

Sub-step 4b. Discuss any similar options that are occurring:

Some traditional sugar producers prefer concentrating investments on their traditional business (mainly sugar and molasses) than venturing in new projects (see above Core Business Barrier, in step 3, barrier analysis).

The intention of the Magdalena Project to diversify its revenues and hedge against the volatility of sugar and ethanol prices was fundamental for the company to set up this pioneer project. The company has also been a pioneer in looking for CER revenues to increase the project IRR and consequently making it economically feasible.

Step 5. Impact of CDM Registration

As described above, the reliability of Guatemala on fossil thermal generation had increased in the years before the project start and it was expected to increase more. The usage of this technology to produce electricity has a strong impact on the environment and the economy (fossil fuel has increased in prices dramatically in the last two years) since also this fuel is major imported.

Guatemala has tried to reduce its dependency on fossil fuels but the efforts implemented until the project start had not proved very useful. The registration of the CDM project activity will contribute to solve this situation, giving incentives to clean energy cogeneration.

The CERs would increase the project's Internal Rate of Return and contribute to it to overcome other barriers, thus making the project a better investment option and a sound option.

Moreover, the registration might influence other sugar cane producers in Guatemala to set up new cogeneration plants (or expand old ones). The registration of the proposed project activity will have a strong impact in paving the way for similar projects to be implemented in Guatemala. This would help promote sustainable development of this Central American country.

B.6. Emission reductions:

B.6.1. Explanation of methodological choices:

a) ACM0006 - "Consolidated baseline methodology for grid-connected electricity generation from biomass residues", version 4, October 2006, was chosen.

ACM0006 is applicable to biomass-based cogeneration projects connected to the grid. The methodology considers emission reductions generated from cogeneration projects using sugarcane bagasse. This fits perfectly the operation at Magdalena, so the choice of methodology is justified.

The equations which will be used in calculating emission reductions are the following:

$ER_y = ER_{thermal,y} + ER_{electricity,y} - PE_y – L_y$	**Equation 1**

Where:

ER_y are the emission reductions of the project activity during year y
$ER_{electricity,y}$ are the emissions reductions due to displacement of electricity in year y
$ER_{thermal,y}$ are the emissions reductions due to displacement of thermal energy in year y. As stated in section B.4, this term is zero.
PE_y are project emissions in year y (zero for this project activity)
L_y are the leakage emissions in year y (zero for this project activity)

Estimate of project emissions:

The Magdalena Project is expected to consume some fossil fuel to assure an efficient operation of the biomass power plant. Project emissions are therefore generated by the consumption of this fossil fuel as per formula below:

$$PEFF_y = \sum_i \left(FF_{project\ plant,i,y} + FF_{project\ site,i,y}\right) \cdot NCV_i \cdot COEF_i$$

where:

$FF_{project\ plant,i,y}$ = Quantity of fossil fuel type *i* combusted in the biomass residue fired power plant during the year *y* (mass or volume unit per year)[9]
$FF_{project\ site,i,y}$ = Quantity of fossil fuel type *i* combusted at the project site for other purposes that are attributable to the project activity during the year *y* (mass or volume unit per year). This item is zero.
NCV_i = Net calorific value of fossil fuel type *i* (GJ / mass or volume unit)
$COEF_{CO2,FF,i}$ = CO_2 emission factor for fossil fuel type *i* (tCO_2/GJ)

Estimated leakage emissions:

The main source of leakages in the ACM0006 methodology is considered to be the increase of fossil fuel consumption due to the diversion of the biomass. No diversion of biomass occurs, therefore no leakages are present. For the reasons explained, leakages (L_y) are considered to be zero.

Estimated emissions reductions due to the displacement of electricity:

The amount of electricity to be considered for the displacement of power from the grid is calculated using the equation below. This equation corresponds to the chosen scenario #14 of the ACM0006 methodology:

$$EG_y = EG_{projectplant,y} * \left(1 - \frac{\varepsilon_{el,preproject}}{\varepsilon_{el,projectplant,y}}\right)$$ **Equation 2**

EG_y is determined based on the average net efficiency of electricity generation in the project plant prior to project implementation, $\varepsilon_{el,pre\ project}$, and the average net efficiency of electricity generation in the project plant after project implementation, $\varepsilon_{el,project\ plant,y}$, shown in Equation 2, where:

EG_y is the net quantity of increased electricity generation as a result of the project activity (incremental to baseline generation) during the year *y* in MWh,
$EG_{project\ plant,y}$ is the net quantity of electricity generated in the project plant during the year *y* in MWh,
$\varepsilon_{el,project\ plant,y}$ is the average net energy efficiency of electricity generation in the project plant, expressed in $MWh_{el}/MWh_{biomass}$. by dividing the electricity generation during the year *y* by the sum of all fuels (biomass residue types *k* and fossil fuel types *i*), expressed in energy units, as follows:

$$\varepsilon_{el,project\ plant,y} = \frac{EG_{project\ plant,y}}{\sum_k NCV_k \cdot BF_{k,y} + \sum_i NCV_i \cdot FF_{project\ plant,i,y}}$$

where:

εel,project plant,y = Average net energy efficiency of electricity generation in the project plant
EGproject plant,y = Net quantity of electricity generated in the project plant during the year *y* (MWh)
BFk,y = Quantity of biomass residue type *k* combusted in the project plant during the year *y*
(tons of dry matter or liter)
NCVk = Net calorific value of the biomass residue type *k* (GJ/ton of dry matter or GJ/liter)
NCVi = Net calorific value of fossil fuel type *i* (GJ / mass or volume unit)
FFproject plant,i,y = Quantity of fossil fuel type *i* combusted in the biomass residue fired power plant during the year *y* (mass or volume unit per year)9

For the first crediting period, the emissions reductions due to displacement of electricity ($ERelectricity_y$ in tCO_2e) will be calculated as follows:

$$ERelectricity_y = 0.705 \times EG_y$$ **Equation 3**

The emission reduction by the project activity (ER_y in tCO_2e) during a given year (*y*) is the difference between the emissions reductions due to displacement of electricity ($ERelectricity_y$), project emissions (PE_y) and due to leakage (L_y), as follows:

$$ER_y = ERelectricity_{,y} - PE_y - L_y = 0.705x\ EG_y - PE_y - 0$$ **Equation 4**

b) ACM0002 - "Consolidated baseline methodology for grid-connected electricity generation from renewable sources", Version 6, dated on 19/05/2006.

Since the power generation capacity of the project plant is of more than 15 MW, *EFgrid,y* should be calculated as a combined margin (CM), following the guidance in the section "Baselines" in the "Consolidated baseline methodology for grid-connected electricity generation from renewable sources" (ACM0002, version 6, May 19, 2006).

The calculation of emissions reductions from the displacement of electricity form the grid includes a calculation for baseline emission factor (EF_y) that is equal to a combined margin (CM) consisting of a weighted average of the operating margin (*OM*) and build margin (*BM*) factors. The methodology thus starts with the calculation of the OM and BM emission factors and concludes with the calculation of the electricity baseline emission factor. ACM0002 follows a three-step approach, namely:

- **STEP 1 -** Calculate the operating margin emission factor(s), based on one of the following methods
  - Simple operating margin
  - Simple adjusted operating margin
  - Dispatch data analysis operating margin
  - Average operating margin.

In the absence of available data to use the prefer choice appointed by the methodology (Dispatch data analysis OM), the Simple OM method was chosen because of the fact that less than 50% of total grid generation comes from low-cost/ must-run resources in average for the past 5 years.

The Simple OM emission factor ($EF_{OM,simple,y}$ in tCO_2/MWh) is calculated as the generation-weighted average emissions per electricity unit (in tCO_2/MWh) of all generating sources except low-cost/ must-run power plants:

$$EF_{OM,simple,y} = \frac{\sum_{i,j} F_{i,j,y} \cdot COEF_{i,j}}{\sum_{j} GEN_{j,y}}$$

Where:

- $\sum_{i,j} F_{i,j,y}$ is the amount of fuel *i* (in mass or volume unit) consumed by relevant power sources *j* in year(s) *y*,
- $COEF_{i,j}$ is the CO_2e coefficient of fuel *i* (tCO_{2e}/mass or volume unit of the fuel), taking into account the carbon dioxide equivalent emission potential of the fuels used by relevant power sources *j* and the percent oxidation of the fuel in year(s) *y* and,

- $\sum_{j} GEN_{j,y}$ is the electricity (MWh) delivered to the grid by source *j*,

The calculation of the Simple OM was done using the most recent numbers for Guatemala's national interconnected system obtained from the Spot Market Administrator (Administrador de Mercado Mayorista; http://www.amm.org.gt). The calculation included data from 48 power plants; comprising 20,790 TWh of electricity generation for the years 2003 to 2005.

In Guatemala's national interconnected system, the non-low-cost/must-run resources consist of thermo power plants fueled with diesel, bunker and coal.

The product $\sum_{i,j} F_{i,j,y} \cdot COEF_{i,j}$ for each one of the plants was obtained from the following formulae:

$$F_{i,j,y} = GEN_{i,j,y} \cdot \eta_{i,j,y} \qquad \text{(Equation 8)}$$

Where,

$$\eta_{i,j,y} = \frac{DEN_i \cdot NCV_i \cdot 1000}{TE_{i,j}} \qquad \text{(Equation 9)}$$

$$COEF_{i,j} = EF_{CO2,i} \cdot 44/12 \cdot OXID_i \qquad \text{(Equation 10)}$$

Hence,

$$F_{i,j,y} \cdot COEF_{i,j} = GEN_{i,j,y} \cdot EF_{CO2,i} \cdot 44/12 \cdot OXID_i \cdot \eta_{i,j,y} \qquad \text{(Equation 11)}$$

Where variable and parameters used are:

- $\sum_{i,j} F_{i,j,y}$ is given in TJ, $COEF_{i,j}$ in tCO_2e/TJ and $F_{i,j,y} \cdot COEF_{i,j}$ in tCO_2e
- $GEN_{i,j,y}$ is the electricity generation for plant *j*, with fuel *i*, in year *y*, obtained from the Spot Market Administrator, in MWh.
- $\eta_{i,j}$ is the fuel consumption factor of plant *j*, operating with fuel *i*, in TJ/MWh.
- DEN_i is the density of fuel *i* in tonnes/Gallon.
- NCV_i is the net calorific value of fuel *i*, obtained from the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, in TJ/10^3 tonnes.
- 1,000 is the conversion factor from MWh to KWh.
- $TE_{i,i}$ is the thermal efficiency of plant *j*, operating with fuel *i*, obtained from the Spot Market Administrator in KWh/Gallon (KWh per ton for coal fired plants).
- $EF_{CO2,i}$ is the emission factor for fuel *i*, obtained from the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, in tC/TJ.
- 44/12 is the carbon conversion factor from tC to tCO_2.
- $OXID_i$ is the oxidization factor for fuel *i*, obtained from the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, in %.

- $\sum_{j,y} GEN_{j,y}$ is obtained from the Spot Market Administrator, as the sum of non-low-cost/must-run resources electricity generation, in MWh.

B.6.2. Data and parameters that are available at validation:

Data / Parameter:	***EF***
Data unit:	tCO_2/MWh
Description:	Emission factor for Guatemala interconnected grid
Source of data used:	Spot Market Administrator (Administrador de Mercado Mayorista – AMM)
Value applied:	0.705, at the start of the project activity. For the first crediting period, the emission factor $EF_{OM,y}$ will be calculated *ex-ante.*
Justification of the choice of data or description of measurement methods and procedures actually applied :	According to ACM0002, version 6, May 19, 2006, the calculation of emissions reductions from the displacement of electricity form the grid included a calculation for baseline emission factor (EF_y) that is equal to a combined margin (CM) consisting of a weighted average of the operating margin (*OM*) and build margin (*BM*) factors. The methodology thus starts with the calculation of the OM and BM emission factors and concludes with the calculation of the electricity baseline emission factor.
Any comment:	*EF* is the value used for $CEF_{electricity,y}$

Data / Parameter:	$EFBM_{grid,y}$
Data unit:	tCO_2/MWh
Description:	CO_2 build margin emission factor for grid electricity during the year *y*
Source of data used:	The latest approved version of ACM0002 to calculate the grid emission factor: version 6, May 19, 2006.
Value applied:	0.584
Justification of the choice of data or description of measurement methods and procedures actually applied :	
Any comment:	

Data / Parameter:	$EFOM_{grid,y}$
Data unit:	tCO_2/MWh
Description:	CO_2 operating margin emission factor for grid electricity during the year *y*
Source of data used:	The latest approved version of ACM0002 to calculate the grid emission factor: version 6, May 19, 2006.
Value applied:	0.825
Justification of the choice of data or description of	

measurement methods and procedures actually applied :	
Any comment:	

Data / Parameter:	**εel, pre project**
Data unit:	MWh_{el} / $MWh_{biomass}$
Description:	Average net efficiency of electricity generation in the project plant prior to project implementation.
Source of data used:	On-site measurements conducted prior to the implementation of the project activity.
Value applied:	0.063
Justification of the choice of data or description of measurement methods and procedures actually applied :	Measure the quantity of fuels fired and the electricity generation during a representative time period and divide the quantity of electricity generated by the energy quantity of the fuels fired. The three most recent historical years should preferably be used to determine the average efficiency, where such data is available and where this time period is reasonably representative.
Any comment:	Applicable to scenario 14

Data / Parameter:	**$BF_{Bagasse, pre project}$**
Data unit:	Metric tones
Description:	Quantity of bagasse that has been fired in boilers for heat generation during the most recent three years at the project site
Source of data used:	On-site measurements
Value applied:	See annexed spreadsheet "Magdalena_CERs_calculation_scenario14_2007.03.12.xls"
Justification of the choice of data or description of measurement methods and procedures actually applied :	Use weight or volume meters. Adjust for the moisture content in order to determine the quantity of dry biomass. The quantity shall be crosschecked with the quantity of electricity (and heat) generated and any fuel purchase receipts (if available).
Any comment	

B.6.3 Ex-ante calculation of emission reductions:

The Tables below show data on energy exported, consumed internally and bagasse consumption of the Project since year 2002.

Since the values for 2005 belong part to the baseline and part to the project period, the values in the Tables were taken here considering only the project period. All the values used below for year 2005 were calculated making a proportion between the project period and the total number of harvest days in 2005 (182 days). From March 1, 2005 (starting date of the crediting period) until the end of the year,

there were 123 harvest days. The values shown below for year 2005 are related to these 123 days in proportion to the total number of harvest days in 2005, 182..

Year	Energy exported (MWh)
2002	51,239
2003	64,511
2004	69,726
2005 (from March 1 on)	64,076
2006*	164,117
2007*	180,397
2008*	225,151
2009	269,990
2010	316,366
2011	316,366
2012 (until Feb 29)	102,558

Year	Energy consumed (MWh)
2002	45,903
2003	55,005
2004	65,555
2005 (from March 1 on)	50,694
2006*	113,782
2007*	128,383
2008*	162,172
2009	177,829
2010	189,790
2011	189,790
2012 (until Feb 29)	61,525

Year	Bagasse consumption (tones)
2002	647,768
2003	724,768
2004	758,837
2005 (from March 1 on)	533,058
2006*	974,318

2007*	974,318
2008*	974,318
2009	974,318
2010	974,318
2011	974,318
2012 (until Feb 29)	315,850

Year	Bagasse NCV (MWh/tones)
2002	2.58
2003	2.58
2004	2.58
2005	2.58
2006*	2.58
2007*	2.58
2008*	2.58
2009	2.58
2010	2.58
2011	2.58
2012	2.58

From these values, EGy is calculated as shown below:

Year	EG projectplant, y (MWh)	$\varepsilon_{el, project, y}$ (non dimensional)	EGy (MWh)
2005 (from March 1 on)	29,369	0.082	27,002
2006*	51,755	0.110	117,888
2007*	47,647	0.120	143,609
2008*	54,508	0.151	222,152
2009	99,783	0.175	282,648
2010	122,757	0.198	340,985
2011	122,757	0.198	340,985
2012 (until Feb 29)	81,259	0.198	110,538

εel, preproject = 0.063

Project emissions are calculated as follows, considering $COEF_{CO2}$ for bunker oil is 3.12 kgCO2/litre

Year	FFproject plant,i,y Consumption of bunker oil (gallons)	Consumption of bunker oil (litres)	PEFF y (tonnes of CO2e)
2005 (from March 1 on)	593,310 (total of the harvest – 182 days); 400,973 (from March 1 on – 123 days)	1,517,685	4,736
2006*	905,255	3,426,388	10,690
2007*	1,073,287	4,062,390	12,675
2008*	1,208,938	4,575,832	14,277
2009	1,609,904	6,093,487	19,012
2010	1,681,683	6,365,171	19,859
2011	1,681,683	6,365,171	19,859
2012 (until Feb 29)	1,681,683 (total of the harvest); 545,161 (until February 29 – 59 days)	2,063,435	6,438

Finally, according to the equations in section B.6.1, emissions reductions will be as follows:

Year	EGy (MWh)	ERy (t CO2)
2005 (from March 1 on)	27,002	14,300
2006*	117,888	72,421
2007*	143,609	88,570

2008*	222,152	142,340
2009	282,648	180,255
2010	340,985	220,536
2011	340,985	220,536
2012 (until Feb 29)	110,538	71,492
Total		**1,010,448**

(*) estimated

B.6.4 Summary of the ex-ante estimation of emission reductions:

The full implementation of the Magdalena project connected to the Guatemala grid will avoid an average estimated yearly emission of around 144,350 tCO2e, and a total reduction of about 1,010,448 tCO2e over the first 7 years crediting period (up to and including 2012, see Table 2 below). Note: the calculation of the baseline emissions is not required, as per methodology ACM0006, version 4.

Years	Estimation of project activity emissions	Estimation of baseline emissions	Estimation of leakage	Estimation of overall emissions reductions
	(tonnes of CO_2e)	(tonnes of CO_2e)	(tonnes of CO_2e)	(tonnes of CO_2e)
2005 (from March 1 on)	4,736	0	0	14,300
2006*	10,690	0	0	72,421
2007*	12,675	0	0	88,570
2008*	14,277	0	0	142,340
2009	19,012	0	0	180,255
2010	19,859	0	0	220,536
2011	19,859	0	0	220,536
2012 (until Feb 29)	6,438			71,492
Total (tonnes of CO_2e)	**107,546**	0	0	**1,010,448**

Table 2 - Summary of the ex-ante estimation of emission reductions

B.7 Application of the monitoring methodology and description of the monitoring plan:

B.7.1 Data and parameters monitored:

Data / Parameter:	**EGproject plant$_y$**
Data unit:	MWh
Description:	Net quantity of electricity generated in the project plant during the year y
Source of data to be	Readings of the energy metering connected to the project plant

used:	
Value of data applied for the purpose of calculating expected emission reductions in section B.5	498,596 MWh at the end of the crediting period
Description of measurement methods and procedures to be applied:	Meter should be calibrated regularly according to CNEE's (National Electrical Energy Company) normss. Measurement results for the energy exported should be cross-checked with the quantity of invoices from the grid operator. Data is being archived and administered by Magdalena. Data will be archived during the crediting period and two years after.
QA/QC procedures to be applied:	Data on the energy exported to the grid is being monitored by Magdalena and AMM (*Administrador del Mercado Mayorista*–Energy Market Regulator). This duplicity of counting will ensure the accuracy of the amount of electricity delivered to the grid. The utility company will also perform audits to the measurement equipments of the plant to assure correct monitoring.
Any comment:	

Data / Parameter:	**EG_y**
Data unit:	MWh
Description:	Net quantity of increased electricity generation as a result of the project activity during the year y
Source of data to be used:	Calculated according to equation 2, in section B.6.1
Value of data applied for the purpose of calculating expected emission reductions in section B.5	340,985 MWh at the end of the first crediting period
Description of measurement methods and procedures to be applied:	Calculated quarterly. Data will be archived during the crediting period and two years after.
QA/QC procedures to be applied:	
Any comment:	

Data / Parameter:	**εel,project plant,y**
Data unit:	Non dimensional
Description:	Electric energy efficiency
Source of data to be used:	Net energy efficiency of electricity generation in the project plant
Value of data applied for the purpose of calculating expected emission reductions in	0.063 at the end of the crediting period

section B.5	
Description of measurement methods and procedures to be applied:	Data is being archived and administered by Magdalena. Data will be archived during the crediting period and two years after.
QA/QC procedures to be applied:	Data is being calculated by Magdalena, as in annexed spreadsheet “Magdalena_CERs_calculation_scenario14_2007.03.12.xls”
Any comment:	

Data / Parameter:	**$FC_{bagasse}$**
Data unit:	Metric tones
Description:	Quantity of bagasse combusted in the project plant during the year *y*
Source of data to be used:	Weight measurements
Value of data applied for the purpose of calculating expected emission reductions in section B.5	See annexed spreadsheet “Magdalena_CERs_calculation_scenario14_2007.03.12.xls”
Description of measurement methods and procedures to be applied:	Monitored continuously, with an annual energy balance. Adjust for the moisture content in order to determine the quantity of dry biomass. The quantity shall be crosschecked with the quantity of electricity (and heat) generated and any fuel purchase receipts (if available). Data will be archived during the crediting period and two years after.
QA/QC procedures to be applied:	Crosscheck the measurements with an annual energy balance that is based on purchased quantities and stock changes.
Any comment:	

Data / Parameter:	**$NCV_{bagasse}$**
Data unit:	MWh/tones
Description:	Net calorific value
Source of data to be used:	Net calorific value of bagasse
Value of data applied for the purpose of calculating expected emission reductions in section B.5	See annexed spreadsheet “Magdalena_CERs_calculation_scenario14_2007.03.12.xls”
Description of measurement methods and procedures to be applied:	Data will be measured every six months by Magdalena. The net calorific value should be determined separately for all types of biomass. Measurements shall be carried out at reputed laboratories and according to relevant international standards. Data will be archived during the crediting period and two years after.
QA/QC procedures to be applied:	Check consistency of measurements and local / national data with default values by the IPCC. If the values differ significantly from IPCC default values, possibly collect additional information or conduct measurements.
Any comment:	

Data / Parameter:	**FFproject plant,i,y**
Data unit:	Volume unit per year
Description:	Quantity of bunker oil in the biomass residue fired power plant during the year *y*
Source of data to be used:	On-site measurements
Value of data applied for the purpose of calculating expected emission reductions in section B.5	See section B.6.3
Description of measurement methods and procedures to be applied:	Continuously measured. Data will be archived during the crediting period and two years after.
QA/QC procedures:	Cross-check the measurements with an annual energy balance that is based on purchased quantities and stock changes.
Any comment:	This should include fossil fuels co-fired in the project plant but not any other fuel consumption at the project site that is attributable to the project activity (e.g. for mechanical preparation of the biomass residues)

Data / Parameter:	**EF CO2, FF,i**
Data unit:	Kg CO2/litre
Description:	CO2 emission factor for the bunker oil
Source of data to be used:	IPCC default values used
Value of data applied for the purpose of calculating expected emission reductions in section B.5	3.12 kgCO2/litre
Description of measurement methods and procedures to be applied:	This data will be reviewed yearly.
QA/QC procedures to be applied:	Check consistency of measurements and local / national data with default values by the IPCC. If the values differ significantly from IPCC default values, possibly collect additional information or conduct measurements.
Any comment:	

B.7.2 Description of the monitoring plan:

Data that has to be monitored during the life of the contract are the net quantity of electricity generated in the project plant ($EG_{project\ plant,y}$) and the quantity of bagasse (and its NCV) used yearly. The

project owner will continuously measure these values.

The electricity export data will be monitored by Magdalena's and AMM's (*Administrador del Mercado Mayorista*–Energy Market Regulator) meters installed at the substation of the cogeneration system and compiled in a spreadsheet. The amount of electricity will be corroborated with the invoices to be electrical company and in case of discrepancies, the latter will prevail.

The project sponsor will proceed with the necessary measures for the power control and monitoring, according to the information produced by CNEE (National Electrical Energy Company)

Magdalena is responsible for the project registration, monitoring, measurement and reporting.

The calibration of the monitoring instruments will be done according to the regulations of CNEE (National Electrical Energy Company)

The plant has a DCS (Distributed Control System) that monitors, reports and records all relevant process variables and manages corrective actions.

There is a training program for the technical personnel regarding new equipment used in the sugar mill and in the power plant.

B.8 Date of completion of the application of the baseline study and monitoring methodology and the name of the responsible person(s)/entity(ies)

The baseline and monitoring studies were conducted according to approved methodology ACM0006 – "Consolidated baseline methodology for grid-connected electricity generation from biomass residues". They were completed on 31/10/2006 by Ricardo Besen of Ecoinvest Carbon S.A.

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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:

The starting date of the CDM project is 19/02/2004.

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

25y-0m

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

C.2.1. Renewable crediting period

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

01/03/2005

C.2.1.2. Length of the first crediting period:

7y-0m

C.2.2. Fixed crediting period:

C.2.2.1. Starting date:

This section is left blank on purpose.

C.2.2.2. Length:

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SECTION D. Environmental impacts

D.1. Documentation on the analysis of the environmental impacts, including transboundary impacts:

Even though the Guatemalan Government recognizes the environmental benefits of the cogeneration project (the reduction of GHG), Magdalena had to undergo an environmental impact assessment customary for all constructions and energy projects in Guatemala. Such analysis was completed successfully in regards to the fact that Magdalena obtained from the Ministry of Environment all necessary environmental licenses for operation. The environmental impact assessment of Magdalena cogeneration project included:

- Usage of Resources
- Legislation to be observed
- Impacts to climate and air quality
- Geological and soil impacts
- Hydrological impacts (surface and groundwater)
- Impacts to the flora and animal life
- Socio-economic (necessary infra-structure, legal and institutional, etc.)
- Local stakeholders comments
- Mitigation measures

- Monitoring plan

The Magdalena cogeneration project also has all operational licenses to sell electricity to the grid and has signed a power purchase agreement that is contingent to the compliance of all environmental regulations. This provides additional evidence that the environmental impact of this project has been properly assessed and deemed insignificant.

The Environmental Impact Assessment was approved by the Ministry of Environment in May 24th 2004, under resolution 494-2004/MAGC/EM, for phase 1, and in February 1st, 2005 under resolution number 251-2005/MAGC/LL, for phase 2.

D.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:

No significant environmental issues aroused from the Environmental Impact Assessment undergone by Magdalena. This process concluded successfully leading to the granting of Environmental License by the Ministry of Environment.

Sugar production has some environmental impact such as bagasse burning. Nevertheless, those activities were conducted prior to the implementation of the project and thus could not be attributed to the CDM project activity. Furthermore, the implementation of the project does not increment these activities or their environmental impact.

SECTION E. Stakeholders' comments

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

As part of the process for obtaining the Environmental License, Magdalena published in a national newspaper one call for a 20 business-day period for receiving stakeholders' comments. If any comment is received during this period, the issuance of the Environmental License would be delayed until the base for the comment is fully investigated.

Additionally to this publication, IMSA hired a private consultant to perform a survey among the surrounding communities on the impacts of the operation of Magdalena Cogeneration project. Any comments received were incorporated into the document of the Environmental Assessment.

E.2. Summary of the comments received:

No comments were received from the call made via national newspaper. From the survey, all comments received were positive as the community recognized the importance of creating local sources of power (see annexed document "Magdalena_local stakeholders comments.jpg". Guatemala is a country where distribution of energy is not very effective and the construction of electrical lines combined with the creation of new endogenous forms of energy was praised by local stakeholders.

Local stakeholders, among them local political authorities and environmental officers, were also invited to make comments on the project.

E.3. Report on how due account was taken of any comments received:

IMSA attended the call from the community to create new sources of energy in the area using locally available resources. No other comment required action from the developer of the project.

Annex 1

CONTACT INFORMATION ON PARTICIPANTS IN THE PROJECT ACTIVITY

Organization:	Ingenio Magdalena S.A.
Street/P.O.Box:	22 Av. 11-00, Zona 15 Vista Hermosa III
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Represented by:	
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Annex 2 – Information regarding public Funding

No public funding is involved in the development or operation of the Magdalena cogeneration project.

Annex 3 – Baseline Information

BASELINE INFORMATION

Year	Installed capacity (MW)	Additional Installed capacity (MW)	Total Generation (MWh)	Internal Consumption (MWh)	Sold energy (MWh)	Auxiliary (MWh)
2002	53.5		97,142	45,903	51,239	
2003	53.5		121,913	55,006	64,511	2,397
2004	53.5		138,725	65,555	69,726	3,444
2005	70.0	16.5	116,309	50,694	64,076	1,538
2006	100.0	46.5	271,576	110,439	161,137	2,400
2007 (*)	135.0	81.5	321,986	127,048	194,938	7,560
2008 (*)	180.0	126.5	362,682	142,250	220,432	7,560
2009 (*)	180.0	126.5	482,971	167,128	315,843	7,560
2010 (*)	180.0	126.5	504,505	171,446	333,059	7,560
2011 (*)	180.0	126.5	504,505	171,446	333,059	7,560
2012 (*)	180.0	126.5	504,505	171,446	333,059	7,560

Please refer to section B.6.1 for a complete description of the calculation of the baseline emission factor of Guatemala.

The results of these calculations follow:

The resulting operating margin using the Simple OM method was:

- $EF_{OM,simple,2003\text{-}2005} = 0.825\ tCO_2e/MWh.$

- **STEP 2** – The build margin emission factor ($EF_{BM,y}$) is calculated *ex ante* (Option 1) as the generation weighted average emission factor (tCO_{2e}/MWh) of a sample of power plants *m*, as follows:

$$EF_{BM,y} = \frac{\sum_{i,m} F_{i,m,y} \cdot COEF_{i,m}}{\sum_{m} GEN_{m,y}}$$

Where $F_{i,m,y}$, $COEF_{i,m}$ and $GEN_{m,y}$ are analogous to the variables described for the Simple OM method (ACM0002) for plants *m*, based on the most recent information available on plants already built . The sample group m consists of either

- The five power plants that have been built most recently, or
- The power plants capacity additions in the electricity system that comprise 20% of the system generation (in MWh) and that have been built most recently.

Project participants should use from these two options that sample group that comprises the larger annual generation. For Magdalena project, the group of the five most recently built plants was chosen as it comprises the larger generation for 2005.

The Build Margin emission factor was calculated *ex-ante* based on the most recent available information from the Guatemalan national dispatch center. The resulting number is as follows:

- $EF_{BM,2005} = 0.584\ tCO_{2e}/MWh.$

- **STEP 3** – Calculate the baseline emission factor EF_y, as the weighted average of the operating margin factor ($EF_{OM,y}$) and the build margin factor ($EF_{BM,y}$):

$$EF_y = w_{OM} \cdot EF_{OM,y} + w_{BM} \cdot EF_{BM,y}$$

For the weights w_{OM} and w_{BM} the default values of 50% were used.

- $EF_{2005} = 0.705\ tCO_{2e}/MWh.$

Information used for the baseline calculation:

TABLE A1 - Generating units connected to the grid as apparent fuel consumption.

Apparent Fuel consumption per plant	Energy produced (GWh) 2003	Energy produced (GWh) 2004	Energy produced (GWh) 2005	Fuel	Fuel Consumption 2003 TJ/year	Fuel Consumption 2004 TJ/year	Fuel Consumption 2005 TJ/year	Fuel Consumption 3 years average TJ/year
STEAM TURBINES	**894.97**	**1,029.96**	**979.1**		**10,117.70**	**11,681.70**	**11,104.90**	**10,968.10**
SAN JOSÉ	892.06	1,029.96	979.1	Coal	10,117.70	11,681.70	11,104.90	10,968.10
ESCUINTLA VAPOR 2	0.08	-	-	Fuel oil No.6	-	-	-	-
LAGUNA VAPOR 3	2.81	-	-	Fuel oil No.6	-	-	-	-
LAGUNA VAPOR 4	0.01	-	-	Fuel oil No.6	-	-	-	-
GAS TURBINES	**84.78**	**7.02**	**19.17**		**1,226.10**	**93.6**	**261.4**	**527.1**
TAMPA	15.25	1.87	3.36	Diesel	153.1	18.7	33.7	68.5
GGG STEWART & STEVENSON	12.85	2.11	6.86	Diesel	162.3	26.6	86.7	91.9
ESC.GAS 5	6.41	0.52	1.84	Diesel	100.1	8.1	28.8	45.7
LAG. GAS 4	16.03	-	-	Diesel	262.1	-	-	87.4
ESC.GAS 3	8.99	0.95	3.21	Diesel	135.8	14.4	48.5	66.2
ESC.GAS 4	-	-	-	Diesel	-	-	-	-
LAGUNA GAS 2	22.52	-	-	Diesel	368.2	-	-	122.7
ESCUINTLA GAS 2	-	-	-	Diesel	-	-	-	-
LAGUNA GAS 1	2.72	1.58	3.9	Diesel	44.4	25.9	63.8	44.7
INTERNAL COMBUSTION MOTORS	**2,605.17**	**2,621.56**	**2,427.24**		**24,209.10**	**24,113.50**	**22,376.20**	**23,566.20**
ELECTROGENERACIÓN	3.89	82.37	69.53	Fuel oil No.6	35.3	748.1	631.4	471.6
ARIZONA	561.4	1,147.03	1,024.83	Fuel oil No.6	5,098.30	10,416.70	9,306.90	8,274.00
AMATEX	20.25	8.45	8.36	Fuel oil No.6	183.9	76.7	75.9	112.2
LA ESPERANZA	739.98	606.49	523.27	Fuel oil No.6	6,720.10	5,507.80	4,752.00	5,660.00
LAS PALMAS	460.91	307.16	291.85	Fuel oil No.6	4,144.10	2,761.70	2,624.10	3,176.60
GENOR	156.33	82.21	134.72	Fuel oil No.6	1,536.30	807.9	1,323.90	1,222.70
LAGOTEX	96.61	87.77	71.76	Fuel oil No.6	949.4	862.5	705.2	839
SIDEGUA	86.93	78.79	94.52	Fuel oil No.6	835.7	757.5	908.7	834
PQPC	444.78	174.8	154.5	Fuel oil No.6	4,370.90	1,717.80	1,518.30	2,535.60
GENERADORA PROGRESO	34.11	46.48	53.91	Fuel oil No.6	335.2	456.8	529.8	440.6
COGENERATORS (Non harvest)	**48.35**	**14.05**	**1.15**		**644.2**	**209**	**16.6**	**289.9**
PANTALEÓN	14.19	-	0.12	Fuel oil No.6	153.1	-	1.3	51.5
SANTA ANA	5.16	3.2	0.14	Fuel oil No.6	76.7	47.6	2.1	42.2
LA UNIÓN	5.71	0.08	0.16	Fuel oil No.6	84.9	1.2	2.4	29.5
CONCEPCIÓN	13.38	9.73	0.04	Fuel oil No.6	199	144.8	0.6	114.8
MADRE TIERRA	3.99	0.01	0.08	Fuel oil No.6	59.3	0.1	1.3	20.2
MAGDALENA	4.16	-	0	Fuel oil No.6	44.8	-	0	14.9
TULULA	0.02	-	0.02	Fuel oil No.6	0.4	-	0.4	0.2
DARSA	1.74	1.02	0.58	Fuel oil No.6	25.9	15.2	8.6	16.6
COGENERATORS (Harvest Season)	**556.01**	**595.26**	**726.59**		**1,546.70**	**1,655.90**	**2,021.00**	**1,741.20**
Trinidad (testing activities)	-	-	0.08		-	-	-	-
San Diego	-	-	5.33	70% Bagasse, 20% fuel oil	-	-	14.8	4.9
PANTALEÓN II	-	11.4	34.98	"	-	31.7	97.3	43
MAGDALENA II	-	0.7	23.66	"	-	1.9	65.8	22.6
PANTALEÓN	130.1	144.95	161.3	"	361.9	403.2	448.7	404.6
SANTA ANA	105.36	97.7	103.12	"	293.1	271.8	286.9	283.9
LA UNIÓN	116.74	117.51	130.76	"	324.7	326.9	363.7	338.5
CONCEPCIÓN	94.35	87.64	108.64	"	262.5	243.8	302.2	269.5
MADRE TIERRA	38.63	48.52	66.4	"	107.5	135	184.7	142.4
MAGDALENA	60.36	69.03	67.75	"	167.9	192	188.5	182.8
TULULA	9.53	16.25	22.07	"	26.5	45.2	61.4	44.4
DARSA	0.95	1.58	2.49	"	2.6	4.4	6.9	4.7
Geothermal	**195.02**	**194.23**	**146.24**		-	-	-	-
Orzunil	162.33	160.04	120.7	geothermal ste	-	-	-	-
Calderas	32.69	34.19	25.55	geothermal ste	-	-	-	-
Hydroelectrics	**2,176.59**	**2,547.17**	**2,920.28**		-	-	-	-
Palín II	-	-	5.95	water	-	-	-	-
RENACE	-	160.12	278.97	water	-	-	-	-
CANADÁ	36.23	142.92	174.43	water	-	-	-	-

TABLE 2A - Operation Margin

Operating Margin	A	B	C	D	E	F
	TJ/year	tC/TJ	fraction carbon oxidised	tC02/year	GWh	tCO2 / MWh
	See table A1	2006 IPCC Guidelines for National Greenhouse Gas Inventories	2006 IPCC Guidelines for National Greenhouse Gas Inventories	(= A * B *D) * 44/12	See Table A3	(= D / E)
Bunker	17,322	21.1	0.99	1,326,775	1,788	0.742
Orimulsion	8,274	21.1	0.99	633,730	911	0.696
Diesel	527	20.2	0.99	38,650	36	1.067
Coal	10,968	26.8	0.98	1,056,243	968	1.091
	37,092			**3,055,398**	**3,703**	**0.825**

TABLE 3A - Build Margin

Build Margin	A	B	C	D	E	F
	fuel consumption	carbon content	fraction carbon oxidised	emissions	generation	emissions rate
	TJ/year	tC/TJ		tC02/year	GWh	tCO2 / MWh
	See table A1	2006 IPCC Guidelines for National Greenhouse Gas Inventories	2006 IPCC Guidelines for National Greenhouse Gas Inventories	(= A * B *D) * 44/12	See Table A1	(= D / E)
		Option 1. Most recent plants				
Palín II	0	0	0	0	5.95	0
San Diego	15	21.1	0.99	1,134	5.33	0.213
Pantaleon II	97	21.1	0.99	7,452	34.98	0.213
Magdalena II	0	0	0	0	0	0.000
Renace	0	0	0	0	278.97	0.000
Canada	0	0	0	0	0	0.000
Electrogeneracion	631	21.1	0.99	48,361	69.53	0.696
	744	0		56,947	394.76	**0.144**
Option 2. Additions represents 20% of the system generation		1444	MWh			
Palín II	0	0	0	0	5.95	0.000
San Diego	15	21.1	0.99	1,134	5.33	0.213
Pantaleon II	97	21.1	0.99	7,452	34.98	0.213
Magdalena II	0	0	0	0	0	-
Renace	0	0	0	0	278.97	-
Canada	0	0	0	0	0	-
Electrogeneracion	631	21.1	0.99	48,361	69.53	0.696
Amatex	76	21.1	0.99	5,813	8.36	0.695
Arizona	9,307	21.1	0.99	712,843	1,024.83	0.696
La Esperanza	4,752	21.1	0.99	363,970	523.27	0.696
	14,878	-	-	1,139,574	1,951	**0.584**

TABLE A4. Emission factor calculation

TABLE A4		units	equation or source	
A	Estimated operating margin emission rate	tCO2/MWh	Table A2	**0.825**
B	Estimated build margin emission rate	tCO2/MWh	Table A3	**0.584**
C	Estimated baseline emission rate*	tCO2/MWh	(= (A + B) / 2)	**0.705**

Annex 4 – Monitoring Plan

This section is intentionally left blank (see section B.7.2 for monitoring plan).