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

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Annexes

SECTION A. General description of project activity

A.1 Title of the project activity:

USJ Açúcar e Álcool S/A – Usina São Francisco Cogeneration Project.

Version: 8.

Date : 13/09/2007.

A.2. Description of the project activity:

The primary objective of the Usina São Francisco Cogeneration Project is to supply Brazil's rising demand for energy due to economic growth and to improve the supply of electricity, while contributing to the environmental, social and economic sustainability by increasing renewable energy's share of total the Brazilian and the Latin America and the Caribbean region's electricity consumption. One fundamental goal of the project is the efficient use of resources, particularly indigenous resources, while minimizing impact on the environment.

Usina São Francisco Cogeneration Project consists in the construction of a sugar mill, which will be operational in April 2007, capable of generating power surplus for sale (Figure 1) and, at the same time, generating carbon credits contributing to the sustainable development. During the 2008 season, it's predicted an expansion that will increase the mill's generating capacity.

The cogeneration project will generate enough energy not only for powering the sugar mill (thus eliminating the consumption of energy from the grid for the expanding capacity of the facility), but also for delivering surplus energy to the national grid. This electricity given to the grid will displace energy that the government would have provided with a strong use of fossil fuels. This displacement of energy thus creates a reduction of greenhouse gases emissions. This project also creates social and economical benefits that constitute a real contribution to Brazil's sustainable development.

This renewable energy project is owned by U.S.J. – Açúcar e Álcool S/A, a sugar cane based distillery originally founded in 1944 and has more than 40,000 hectares harvest with sugar cane. Today, U.S.J. – Açúcar e Álcool S/A has two facilities: one in Quirinópolis, state of Goiás, where the project is going to be implemented, and the other in Araras, state of São Paulo. During the last 2004/2005 crop season, U.S.J. – Açúcar e Álcool S/A processed about 3,208,095 tonnes of sugar cane, produced 100,359 litters of alcohol and 260,350 tonnes of sugar, in Araras.

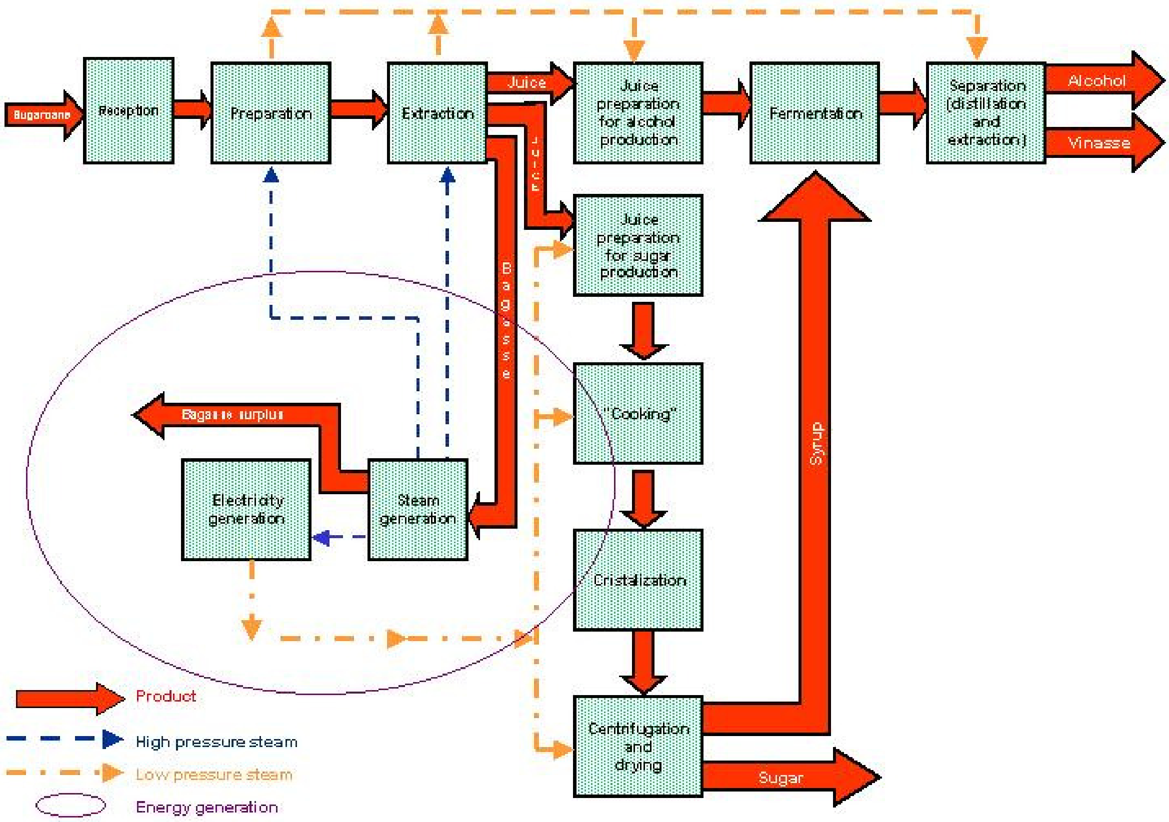

Figure 1 - Flowchart of the electricity generation inside a Sugar and Alcohol Production (Source: Codistil)

The Project can be seen as an example of a solution by the private sector to the Brazilian electricity crisis of 2001, contributing to the sustainable development of the country. Usina São Francisco Cogeneration Project thus comes to prove that with the commercialization of CERs, it is viable to develop a generation project in Brazil. This will have a positive effect for the country beyond the evident reductions in GHG.

The revenues obtained from the sale of the CERs will also help USJ Group, the owner of the project, to continue supporting the community. Usina São João has a strong social responsibility evidenced in numerous initiatives, including: promoting projects in partnership with Araras University, state of São Paulo, contributing in education, health, culture, sport and leisure areas. One example of these initiatives is "Usina do Saber". The project selects deprived children offering transportation to the schools with headquarters in the residential area of the company. Besides, the São João make donations to funds as Fundo Municipal dos Direitos da Criança e do Adolescente of Araras and Conchal cities. Usina São João also has the ISO 9.001/2000 – BVQI certification for sugar cane juice extraction and production, handling, storage, commercialization and dispatch of sugars. This revenue distribution and social efforts must be added to the environmental benefits when evaluating the contribution to sustainable development of this project activity. At Usina São Francisco in Quirinópolis (GO), it is in course the final stage definition of a partnership with SENAI. Such partnership will result in the implementation of technical courses related to agribusiness, with prominence in courses about "sugar and alcohol production", which will use the industrial labs of the Quirinópolis facility directly as integral part on the professional education process. Foment to regional contributions in health, culture, sport and leisure areas are also being developed. With the definitive structure and operation of Quirinópolis facility, many of the success projects describe above, already implemented in Araras facility, will have full adaptation to Quirinópolis facility.

A.3. Project participants:

Detailed contact information on party(ies) and private/public entities involved in the project activity is listed in Annex 1.

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)
Brazil (host)	U.S.J. – Açúcar e Álcool S/A (Private entity)	No
	Ecoinvest Carbon Brasil Ltda. (Private entity)	
(*) 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:

A.4.1.1. Host Party(ies):

Brazil

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

Goiás

A.4.1.3. City/Town/Community etc:

Quirinópolis

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

Usina São Francisco is located in Quirinópolis, state of Goiás, central of Brazil, at some 284 km from Goiania, capital of Goiás, Brazil. Quirinópolis has 37,913 inhabitants and 3,780 km^2.

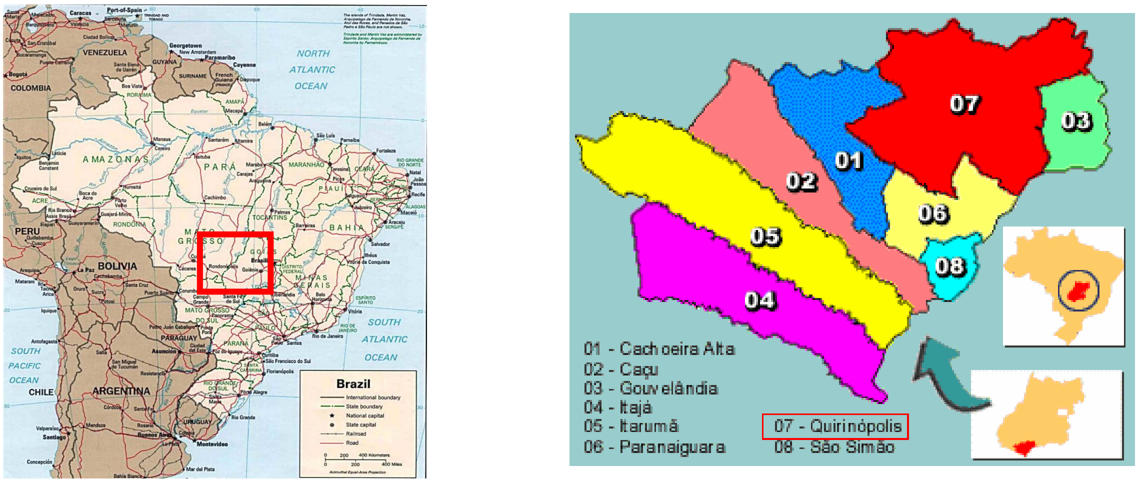

Figure 2 - Political division of Brazil showing the state of Goiás and the city of Quirinópolis

(Source: www.citybrazil.com.br)

The plant is located at:

Fazenda São Francisco

GO 206, km 18, Zona Rual, Goiás

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

Type: Energy and Power.

Sectoral Scope: 1 – 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. 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.

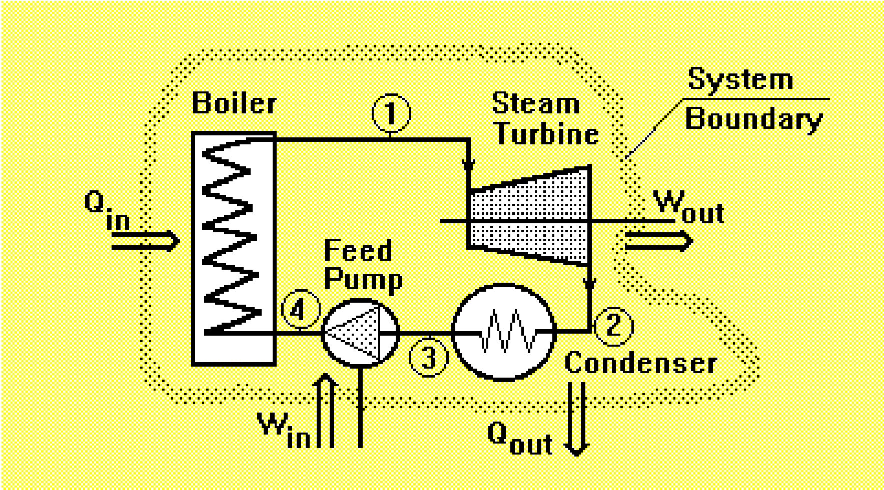

Figure 3 - Rankine Cycle

The project will operate with a configuration using 1 boiler, 1 generator and 1 turbo-generator. During the 2008 season, it's predicted an expansion through installation of more equipment, increasing Usina São Francisco capacity. Usina São Francisco is expected to generate an annual average of 236,500 MWh power surplus at the end of the first crediting period, operating at full capacity during the season. It will displace energy from the grid by both avoiding the consumption of power from the grid in the project and by delivering clean energy to the grid.

Technical Description:

Season from 2007 to 2008		**Season from 2008 to 2014**	
Boiler		***Boiler***	
Quantity	**1**	Quantity	**2**
Manufacturer	Caldema	Manufacturer	Caldema
Type	AMD-83-8GI-PSE	Type	AMD-83-8GI-PSE
Manufactured Year	2006	Manufactured Year	2006/2008
Pressure	67,6 Kgf/Cm2	Pressure	67,6 Kgf/Cm2
Temperature	480º C	Temperature	480º C
Leakage	250 TVH	Leakage	250 TVH
Generator		***Generator***	
Quantity	**1**	Quantity	**3**
Manufacturer	WEG	Manufacturer	WEG
Type	SPW 1250	Type	2 X SPW 1250 1 X SPW
Manufactured Year	2006	Manufactured Year	2006/2008
Generator Power	50 MVA	Generator Power	2 X 50 MVA 1 X 20 MVA
Frequency	1,800 rpm	Frequency	1,800 rpm
Nominal Tension	13,8 kV	Nominal Tension	13,8 kV

Turboredutor		*Turboredutor*	
Quantity	**1**	Quantity	**3**
Manufacturer	TGM/RENK	Manufacturer	TGM/RENK
Type	TM 35000 A	Type	2 X TM 35000 A 1 X TM
Manufactured Year	2006	Manufactured Year	2006/2008
Generator Power	40 MW	Generator Power	2 X 40 MW 1 X 16 MW
Temperature	480ºC	Temperature	480ºC
Pressure	65,0 Kgf/cm2	Pressure	65,0 Kgf/cm2

Direct combustion technologies, such as the one used in Usina São Francisco, is probably the most widely known option for simultaneous power and heat generation from biomass. Notwithstanding, the use of high pressure boilers in the cogeneration process with bagasse is not common. In order to increase boilers efficiency in the cogeneration plant it was necessary to research and adopt a new technology and consequently to upgrade all the equipment, to improve water treatment process and to train all personnel involved in the operation, *inter allia*.

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

The chosen crediting period for this project is the renewable crediting period of 7 years. The estimated amount of emission reductions of the project can be seen at Table 1.

Table 1 - Estimated emission reductions for the first crediting period

Years	**Annual estimation of emission reductions in tonnes of CO_2**
2007 (Starting on April 1)	20,522
2008	47,878
2009	64,846
2010	73,926
2011	73,926
2012	73,926
2013	73,926
2014 (Until March 31)	0
Total Estimated Emissions (tonnes of CO2e)	**428,950**
Total number of crediting years	7
Annual average over the crediting period of estimated reductions (tonnes of CO2e)	61,279

A.4.5. Public funding of the project activity:

There is no public funding involved on the Usina São Francisco Cogeneration Project.

The Project is being financed by the Brazilian Development Bank, BNDES - *Banco Nacional de Desenvolvimento Econômico e Social*, which is a federal owned company subordinated to the Ministry of Development, Industry and Foreign Trade, MDIC - *Ministério do Desenvolvimento, Indústria e Comércio Exterior*. Despite of being a state-owned bank, BNDES is one of the unique sources of long-term financing in the country and is the preferable debt source for the private sector in Brazil.

This project does not receive any public funding and it is not a diversion of ODA.

SECTION B. Application of a baseline and monitoring methodology

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

ACM0006 – "Consolidated baseline methodology for grid-connected electricity generation from biomass residues", version 4, November 2nd 2006.

ACM0002 - "Consolidated baseline methodology for grid-connected electricity generation from renewable sources", version 6, May 19th 2006.

"Tool for the demonstration and assessment of additionality", version 3, February 16th 2007.

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 Usina São Francisco Cogeneration Project because this is a greenfield power project: Usina São Francisco is a new biomass power generation plant at a site where currently no power generation occurs. It uses one type of biomass: bagasse, a byproduct of the production of sugar. The power generated by the project plant would in the absence of the project activity be purchased from the grid.

The project falls under methodology ACM0006 for grid-connected electricity generation using biomass. It reduces emissions by displacing electricity from the grid. 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.*

The primary fuel in the project plant is a biomass consisting of sugar cane bagasse. The bagasse used in the Usina São Francisco Cogeneration Project comes from the production of sugar carried in 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 will be due to Usina São Francisco Cogeneration Project natural expanding business and can not be attributed to the implementation of the cogeneration project. The Table below shows that the cogeneration project does not have an impact in processing capacity: in 2008/2009, it will process 3,200,000 tonnes of sugar cane, with 96 MW installed capacity. In 2009/2010, with the same capacity, it will process 4,000,000 tonnes of sugar cane. The expansion forecasted for 2009-2010 aims to attend the recent and remarkable expansion of the sugar market and ethanol market.

Harvest	Installed Capacity	Sugar cane processing (tonnes)
2008-2009	96 MW	3,200,000
2009-2010	96 MW	4,000,000

Usina São Francisco will generate approximately 60 MWh yearly (for sale and internal use) per million tonnes of sugar cane processed. See Table 6 in Annex 3 for Usina São Francisco's electricity generation evolution.

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

The sugar mills, generally, store a small amount of bagasse for the next season in order to start plant operations when the new crop season/ harvest begins. In Usina São Francisco, the bagasse will be stored from the end of the harvest season in the Brazilian Midwest region, in November, until the beginning of the following harvest season, in April. The volume of bagasse stored between seasons is foreseen to be insignificant, less than 5% of the total amount of bagasse generated during the year or during the harvest period.

(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 being used as a fuel.

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

Project boundaries

The project boundaries are defined by the emissions targeted or directly affected by the project activities, construction and operation.

The **spatial extent** of the project boundary encompasses the bagasse stocking area, the means for transportation of biomass from stock to power plant, the bagasse power plant at the project site and all power plants connected physically to the electricity system (interconnected grid) that the CDM project power plant is connected to. Please refer to Figure 4 to understand the project boundary and the activities included in it.

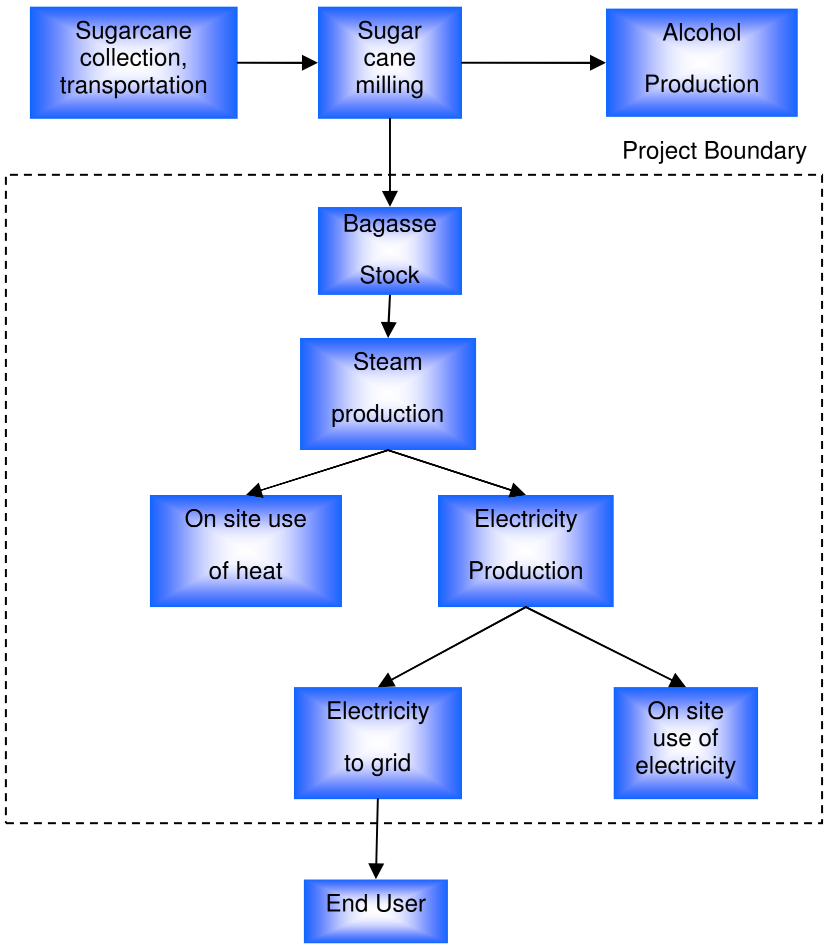

Figure 4 - Usina São Francisco Cogeneration Project Boundary

	Source	Gas	Included?	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 case B1, B2 and B3 of ACM0006 is not the most likely baseline scenario
		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	Excluded	There are no emissions due to fossil fuel consumption
		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:

Usina São Francisco Cogeneration Project uses bagasse for the generation of heat and electricity. The project activity is a new biomass power generation plant at a site where currently no power generation occurs. This corresponds to baseline scenario 4:

- In the absence of the project activity, a new biomass power plant ("reference plant") would be installed instead of the project activity at the same site and with the same thermal firing capacity, but with a lower electric efficiency than the project plant.
- The power generated by the project plant would in the absence of the project activity be generated (P2) in the reference plant and – since power generation is larger in the project plant than in the reference plant – (P4) partly in power plants in the grid.
- The biomass residues are used for heat and/or electricity generation at the project site (B4). In the absence of the project activity, the same quantity and type of biomass would be used in the reference plant.
- The heat generated by the project plant would, in the absence of the project activity, be generated by the reference plant, with a lower efficiency (H2). This is a common practice in the sugar cane sector in Brazil.
- Emission reductions from heat are not considered because the thermal efficiency of the project plant is larger than the heat efficiency of the reference plant. In relation to a reference plant, e.g Usina São João located in Araras (another plant owned by the Usina São João Group), the project generates more steam once it has a more efficient boiler. In this reference plant just part of the generated steam (approximately 25%) is utilized to generate electric energy and the remaining steam is used to generate thermal energy. In the project all steam (100%) is sent to electric energy generation and only after that the remaining steam is sent to the process. Considering this, it is demonstrated that the quantity of thermal energy generated in the project is bigger than the one generated in the reference plant. For conservativeness reasons, the emission reductions from heat are excluded, i.e., $BE_{thermal,y}=0$.

Please refer to section B.5, *step 2* for details about the choice of the most plausible baseline scenario.

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 steps are applied:

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

The identified realistic alternatives to the project activity are:

1. The plant would operate with low energy efficiency and could not export electricity to the grid;
2. The plant would operate with a high energy efficiency and could export electricity to the grid, as it is expected to happen when the plant begins to operate, without the CDM registration.

Sub-step 1b. Consistency with mandatory laws and regulations

The usage of electricity from the grid is in complete compliance with all applicable legal and regulatory requirements. The use of thermal electricity in the generation system is not only in compliance with regulations but also of increasing importance. The proposed project activity is not the only alternative in compliance with regulations.

SATISFIED/PASS – Proceed to Step 2

Step 2. Investment analysis

Sub-step 2a. Determine appropriate analysis method

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

[1] http://cdm.unfccc.int/EB/029/eb29_repan05.pdf

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

Financial indicator identified for cogeneration project as the case of São Francisco is the project IRR, and the benchmark is derived from the company internal benchmark (weighted average capital cost of the company - WACC). A second third-party benchmark identified is the minimum return considered by Brazilian Federal Government at the decision of Proinfa program launch.

Calculation of the Weighted Average Cost of Capital (WACC)

The rate used to discount the business cash flow is also known as the weighted-average cost of capital (WACC) and converts the future cash flow into a present value to all investors, considering that both creditors and shareholders expect compensation towards the opportunity cost of investing resources in an specific business instead of investing such resources in another business of equivalent risk.

The basic principle to be followed when calculating the WACC is consistency with the valuation method and with the definition of the discounted cash flow. The formula used to estimate the company's WACC after taxes is:

$$WACC = [(Kd \times (1-t) \times Pd)+(Ke \times (1-Pd))] \qquad \text{Equation A}$$

Where:

WACC= Weighted-average cost of capital

Kd= Cost of Debt (third-party capital)

t = Marginal corporate income tax

Pd= Debt as a percentage of total capitalization

Ke= Cost of Equity (own capital)

Considering that São Francisco is being financed with their own capital and with other debitors, we have adopted the case of a leveraged company to calculate the firm's WACC.

Cost of debt (Kd) is 13% per year. It is the financing line of BNDES offered to São Francisco (10% TJLP + 3% risk spread).

BNDES financing covers 80% (eighty percent) of the thermo power project. Therefore, *Debt as a percentage of total capitalization* (Pd) is 80%. São Francisco provided the other 20% (twenty percent). The average of the *marginal corporate income tax* (t) is 25% per year.

Estimating the *Cost of Equity* (Ke) was possible by using the parameters observed in global financial markets, allowing the application of the CAPM (Capital Asset Pricing Model) model. Given these assumptions, the cost of capital in Brazil should be close to a global cost of capital adjusted for local inflation and capital structure. It should be noted that as far as calculating the inflation differential we have used an estimate of the compounded difference between the local inflation rate and the US inflation rate over ten years. Also, for calculation purposes, we have used a Beta, which measures systemic equity risk within the company's industry, typical of the environmental services sector. Thus, in order to calculate São Francisco's cost of equity we have used the following parameters[2]:

Cost of Equity(Ke) – São Francisco		
Yield of Sovereign 20-year BB Debt	**Plus**	10%p.a.
10-year BB Credit risk premium over US Treasuries[3]	**Minus**	1.65%p.a.
10-year US/Brazil inflation differential	**Plus**	5%p.a.
International Market Equity Risk Premium	**Plus**	5%p.a.
Adjustment of Market Equity Risk with Beta of 0.795[4]	**Minus**	3.9%p.a.
São Francisco Cost of Equity with Brazilian Country Risk		14.45%p.a.

Applying Ke=14.45% to the Equation A above:

WACC = [(13% x (1 - 25%) x 80% + (14.45%p.a. x 20%)] = 10.69%p.a.

Thus, São Francisco's Weighted Average Cost of Capital is equal to 10.69%p.a., and this figure will be used to discount the company's cash flow throughout this study.

Financial Indicator, Internal rate of return (IRR)

São Francisco's cash flow (see annexed spreadsheet "USJ – Cash Flow_2007.07.18.xls") shows that the IRR of the project without CERs, 9.49%, is lower than the WACC 10.69%. This evidences that project activity is not financially attractive to investor.

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[2] Copeland et al.; Measuring and Managing the Value of Companies; Third Edition.

[3] Source: Bloomberg

[4] Considering that São Francisco is not listed in their stock exchanges, PPs decided to use similar sugar mills as the benchmark. Therefore PPs took the weighted average of the Beta of the two sugar mills listed in the Bovespa (Cosan and São Martinho).

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 5%, and assessing what the impact on the project IRR would be See results in the Table below. The 5% variation was chosen from the average annual Brazilian inflation.

For the calculation, see annexed spreadsheet "USJ – Sensitivity analysis_2007.09.13.xls"). As it can be seen, the project IRR remains lower than the benchmark even in the case where these parameters change in favor of the project.

Table: Sensitivity analysis

Scenario	**% change**	**IRR (%)**
Original	-	9.49
Increase in project revenue	5%	10.44
Reduction in project costs	5%	10.01

Outcome: The IRR of the project activity without being registered as a CDM project is below the WACC benchmark, even when applying the sensitivity analysis. This evidences that project activity is not financially attractive to investor and the knowledge of the CDM registering benefits was a key point to decision-making to implement the project activity.

Step 3. Barrier Analysis

Not applicable.

Step 4. Common Practice Analysis

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

Currently in Brazil there are more than 5 million hectares of land producing sugarcane and there are more than 320 sugar mills producing sugar, ethanol and electricity to supply their own energy consumption. Consequently the potential to generate electricity for commercialization (exporting to the grid), is estimated at around 6-8 GW in the short term and 15-22 GW in the long term. In 2003, only 619 MW were generated for commercialization[5].

This potential has always existed and has grown as the sugarcane industry has grown. However, the investments to expand the sugar mills' power plants have only occurred since 2000. Although a flexible legislation allowing independent energy producers has existed since 1995, it was only after 2000 that sugar producers started to study this proposed project activity as an investment alternative for their power plants in conjunction with the introduction of the CDM.

Some sugar mills have optimized their power plants in order to export electricity; but numerous risks and barriers have prevented the implementation of the proposed project activity among the majority of the sugar mills. In the Midwest Region, less than 20% of the mills have developed expansion programs for their power plants (Anuário da Cana (*Sugar Cane Annual Report*), Procana: 2003).

Usina São Francisco is a member of Coopersucar, one of the biggest cooperatives of the sector in Brazil (Jornal da Cana, October, 2006). Among Coopersucar member plants, considering the plants that have no CDM projects, only 10% have increased their capacity in order to export energy to the grid in 2006[6]. Thus, the project activity shall not be considered as common practice in Brazil.

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

As discussed above, the project activity shall not be considered as common practice.

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, November 2nd 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 Usina São Francisco, so the choice of methodology is justified.

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[5] http://www.portalunica.com.br (Union of the Sugar Industry in São Paulo)

[6] Copersucar - Cooperativa Produtores de Cana-de-açúcar, Açúcar e Álcool do Estado de São Paulo (São Paulo State Sugarcane, sugar and alcohol producers cooperatives). Data available only to cooperative member.

As explained in section B.4, the chosen baseline scenario is **scenario 4**. Thus, the equations which will be used in calculating emission reductions are the following:

$$ER_y = ER_{thermal,y} + ER_{electricity,y} - PE_y - L_y \qquad \textbf{Equation 1}$$

Where:

$\mathbf{ER_y}$ are the emission reductions of the project activity during year y

$\mathbf{ER_{electricity,y}}$ are the emissions reductions due to displacement of electricity in year y

$\mathbf{ER_{thermal,y}}$ are the emissions reductions due to displacement of thermal energy in year y. As seen in section B.4, this value is zero.

$\mathbf{PE_y}$ are project emissions in year y (zero for this project activity)

$\mathbf{L_y}$ are the leakage emissions in year y (zero for this project activity)

Estimate of project emissions:

No activities increasing GHG emissions were identified. Therefore, no calculation of estimate of GHG emissions is necessary. The project emissions (PE_y) are zero.

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.

Emissions reductions due to displacement of electricity:

$$ER_{electricity,y} = EG_y x EF_{grid,y}$$

EF is the CO_2 emission factor for grid electricity. For scenario 4, EG_y is determined as the difference between the electricity generation in the project plant and the quantity of electricity that would be generated by other power plant(s) using the same quantity of biomass residues that is fired in the project plant, as follows:

$$EG_y = EG_{project\ plant,y} - \varepsilon_{el,other\ plant(s)} \cdot \frac{1}{3.6} \cdot \sum_k BF_{k,y} \cdot NCV_k$$ **Equation 2**

Where:

EG_y = Net quantity of increased electricity generation as a result of the project activity (incremental to baseline generation) during the year *y* (MWh)

Net quantity is the exported energy plus the energy consumed internally in the sugar mill minus the energy consumed in the auxiliary systems

$EG_{project\ plant,y}$ = Net quantity of electricity generated in the project plant during the year *y* (MWh)

$\varepsilon_{el,other\ plant(s)}$ = Average net energy efficiency of electricity generation in (the) other power plant(s) that would use the biomass residues fired in the project plant in the absence of the project activity ($MWh_{el}/MWh_{biomass}$). For estimation, see Annex 3.

$BF_{k,y}$ = Quantity of biomass residue type *k* combusted in the project plant during the year *y* (tons of dry matter or liter)

NCV_k = Net calorific value of the biomass residue type *k* (GJ/ton of dry matter or GJ/liter)

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

$$ERelectricity_y = 0.2611 \times EG_y$$ **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 (ER_y), project emissions (PE_y) and due to leakage (L_y), as follows:

$$ER_y = ERelectricity,_y - PE_y - L_y = 0.2611\ x\ EG_y - PE_y - 0$$ **Equation 4**

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

The project activity displaces electricity from other grid-connected sources (P4) or from less efficient plants fired with the same type of biomass residue (P2). Apart from co-firing fossil fuels in the project plant, where relevant, electricity is not generated with fossil fuels at the project site. The emission factor for the displacement of electricity should correspond to the grid emission factor (*EFelectricity,y* = *EFgrid,y*) and *EFgrid,y* shall be determined as follows, 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).

According to ACM0002, version 6, May 19, 2006, baseline emission factor (EF_y) is calculated as a combined margin (*CM*), consisting of the combination of operating margin (*OM*) and build margin (*BM*) factors. The calculation of the operating margin emission factor(s) must be based on one of the following methods

- Simple operating margin
- Simple adjusted operating margin
- Dispatch data analysis operating margin
- Average operating margin.

Dispatch data analysis operating margin should be the first methodological choice. Since not enough data was supplied by the Brazilian national dispatch center, the choice is not currently available. The simple operating margin can only be used where low-cost/must-run resources[7] constitute less than 50% of total grid generation in: 1) average of 5 most recent years, or 2) based on long-term normals for hydroelectricity production. The share of hydroelectricity in the total electricity production for the Brazilian South-Southeast-Midwest interconnected system is much higher than 50%, resulting in the non-applicability of the simple operating margin to the project. The fourth alternative, an average operating margin, is an oversimplification and does not reflect at all the impact of the project activity in the operating margin. Therefore, the simple adjusted operating margin will be used in the project. See Annex 3 for more details.

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

Data / Parameter:	$EF_{grid,y}$
Data unit:	tCO_2/MWh
Description:	CO_2 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:	0.2611 (*ex-ante*)
Justification of the choice of data or description of	Apply procedures in ACM0002

[7] Low operating cost and must run resources typically include hydro, geothermal, wind, low-cost biomass, nuclear and solar generation (AM0015, 2004).

measurement methods and procedures actually applied :	
Any comment:	See details of the application of ACM0002 in Annex 3.

Data / Parameter:	**EF**BM**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:	0.0872 (*ex-ante*)
Justification of the choice of data or description of measurement methods and procedures actually applied :	Apply procedures in ACM0002
Any comment:	See details of the application of ACM0002 in Annex 3.

Data / Parameter:	**EF**OM**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:	0.4349 (*ex-ante*)
Justification of the choice of data or description of measurement methods and procedures actually applied :	Apply procedures in ACM0002
Any comment:	See details of the application of ACM0002 in Annex 3.

Data / Parameter:	$\boldsymbol{\varepsilon_{el,\ reference\ plant}}$
Data unit:	MWh_{el} / $MWh_{biomass}$
Description:	Average net energy efficiency of power generation in the reference power/cogeneration plant that would use the biomass residues fired in the project plant in the absence of the project activity.
Source of data used:	Regional sugar and alcohol producers cooperative – Copersucar
Value applied:	0.021
Justification of the choice of data or description of measurement methods and procedures actually applied :	Data from Copersucar were analyzed excluding plants with excess energy. that are CDM registered or in process for registration. See Annex 3 for details.
Any comment:	

B.6.3 Ex-ante calculation of emission reductions:

The Tables below show estimation data on energy export, internal energy consumption of the mill , auxiliary systems energy consumption and bagasse consumption of the Project. The calculation is done according to the formulas in section B.6.1.

Years	Energy exported to the grid (MWh)
2007 (From April 1 on)	55,076
2008	144,441
2009	205,345
2010	236,500
2011	236,500
2012	236,500
2013	236,500
2014 (until March 31)	0

Years	Energy consumed internally (MWh)
2007 (From April 1 on)	29,262
2008	50,814
2009	57,685
2010	63,085
2011	63,085
2012	63,085
2013	63,085
2014 (until March 31)	0

Years	Energy consumed by auxiliary systems (MWh)
2007 (From April 1 on)	905
2008	1,572
2009	1,784
2010	1,951
2011	1,951
2012	1,951
2013	1,951
2014 (until March 31)	0

Years	Bagasse consumption (metric tones)
2007 (From April 1 on)	396,486
2008	845,838
2009	1,057,297
2010	1,189,459
2011	1,189,459
2012	1,189,459
2013	1,189,459
2014 (until March 31)	0

Years	EGy (MWh)
2007 (From April 1 on)	78,599
2008	183,372
2009	248,356
2010	283,132
2011	283,132
2012	283,132
2013	283,132
2014 (until March 31)	0

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

The full implementation of the Usina São Francisco project connected to the Brazilian South-Southeast-Midwest electricity interconnected grid will avoid an average estimated yearly emission of around 61,279 tCO_2e, and a total reduction of about 428,950 tCO_2e over the first 7 years crediting period (up to and including 2014, see Table 2):

Table 2 - Yearly estimated emission reductions of the Usina São Francisco Project

Years	Estimation of project activity emissions reductions (tonnes of CO_2e)	Estimation of baseline emissions reductions (ER_y) (tonnes of CO_2e)	Estimation of leakage (tonnes of CO_2e)	Estimation of emissions reductions (tonnes of CO_2e)
2007 (from April 1 on)	0	20,522	0	20,522
2008	0	47,878	0	47,878
2009	0	64,846	0	64,846
2010	0	73,926	0	73,926
2011	0	73,926	0	73,926
2012	0	73,926	0	73,926
2013	0	73,926	0	73,926
2014 (until March 31)	0	0	0	0
Total (tonnes of CO2e)	0	**428,950**	0	**428,950**

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

B.7.1 Data and parameters monitored:

Data / Parameter:	**EGproject plant$_{yy}$**
Data unit:	MWh/year
Description:	Net quantity of electricity generated in the project 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 annexed spreadsheet “geração estimada creditos carbono USJ_2007.02.21.xls”
Description of measurement methods and procedures to be applied:	Measured and calculated. Continuously electronic measurement of the total generated amount and the energy consumed in the auxiliary system of cogeneration plant. Net quantity is calculated subtracting the auxiliary consumption from the total generated.
QA/QC procedures to be applied:	The consistency of metered net electricity generation should be cross-checked with receipts from electricity sales (if available) and the quantity of fuels fired (e.g. check whether the electricity generation divided by the quantity of fuels fired results in a reasonable efficiency that is comparable to previous years).
Any comment:	

Data / Parameter:	**$BF_{Bagasse,y}$**
Data unit:	Metric tones
Description:	Quantity of bagasse combusted in the project 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:	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).
QA/QC procedures:	Crosscheck the measurements with an annual energy balance that is based on purchased quantities and stock changes
Any comment:	

Data / Parameter:	Moisture content of the biomass residues
Data unit:	% water content
Description:	*Moisture content of each biomass residue type* k
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	50
Description of measurement methods and procedures to be applied:	Analysis are made each 4 hours in a composted sample.
QA/QC procedures to be applied:	
Any comment:	

Data / Parameter:	**$NCV_{bagasse}$**
Data unit:	MWh/tones
Description:	Net calorific value of bagasse
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:	2.09 MWh/ton
Description of measurement methods and procedures to be applied:	In case of measurements: At least every six months, taking at least three samples for each measurement.
QA/QC procedures:	
Any comment:	

B.7.2 Description of the monitoring plan:

As per the procedures set by the Approved monitoring methodology ACM0006 - Monitoring methodology for emissions reductions from grid connected bagasse cogeneration projects.

The project sponsor will proceed with the necessary measures for the power control and monitoring. Together with the information produced by CCEE, ANEEL and ONS, it will be possible to monitor the power generation of the project and the grid power mix.

The calibration of instruments will be done according to the internal procedures of Usina São Francisco and the regulations of CCEE.

The monitoring plan, for emissions reductions occurring within the project boundary, is based on monitoring the amount of net electricity generated by the plant. The reliability of this parameter is assured through second-party verification of the amount of electricity sold by Usina São Francisco. The electricity baseline emission factor is determined ex-ante and will only be updated at renewal of the crediting period.

Analyses are carried out every four hours to monitor the moisture content of the bagasse (these analyses are done by Usina São Francisco own laboratory). The net calorific value of bagasse is measured on site. The quantity of bagasse will be measured on-site and this amount can be cross-checked with the quantity of electricity generated. The recording frequency of the data is appropriate for the project.

Usina São Francisco are responsible for the project management, monitoring and reporting as well as for organising and training of the staff in the appropriate monitoring, measurement and reporting techniques.

The monitoring plan is straightforward and no specific procedures beyond the established QA/QC procedures will be necessary. The established procedures reflect good monitoring and reporting practices. The maintenance and installation of monitoring equipment will be done according to the internal procedures of Usina São Francisco.

Usina São Francisco will monitor the emission of SOx, NOx and CO and the production of solid residues at the combustion of bagasse in the boilers, following the CONAMA resolutions 005/89, 003/90 and 008/90.

Usina São Francisco will also monitor environmental aspects, such as water quality, erosion, noise level. Project "Margem Verde", a reforestation program, has already planted 70,000 trees, and its maintenance will be monitored.

There will be also monitoring of Social Programmes, such as the "Usina do Saber" project, which selects deprived children and offers transportation to the schools with headquarters in the residential area of the company. The health of their workers will also be monitored periodically.

All data collected as part of monitoring should be archived electronically and be kept at least for 2 years after the end of the last crediting period.

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)

Date of completing the final draft of this baseline section: 08/02/2007.

Ecoinvest Carbon Brasil Ltda.
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Ecoinvest Carbon Brasil Ltda. is the Project Advisor and also a Project Participant.

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:

27/06/2005.

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:

01/04/2007 or on the date of registration of the CDM project activity, whichever is later.

C.2.1.2. Length of the first crediting period:

7y-0m.

C.2.2. Fixed crediting period:

C.2.2.1. Starting date:

Not applicable.

C.2.2.2. Length:

Not applicable.

SECTION D. Environmental impacts

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

The growing global concern on sustainable use of resources is driving a requirement for more sensitive environmental management practices. Increasingly this is being reflected in government policy and legislation. In Brazil the situation is not different. Environmental rules and licensing policies are very demanding in line with the best international practices.

As the Usina São Francisco project is a power plant construction based on energy efficiency, the fast-track procedure can be used (Preparation of a Preliminary Environmental Report – “Relatório

Ambiental Preliminar," RAP). The process has been completed and a report containing an investigation of the following aspects has been produced:

- Resources usage
- 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-economical (necessary infra-structure, legal and institutional, etc.)
- Local stakeholders comments
- Mitigation measures
- Monitoring plan

In Brazil, the sponsor of a project that involves construction, installation, expansion or operation, even with no new significant environmental impact, must obtain new licenses. The licenses required by the Brazilian environmental regulation are (Resolution n. 237/97):

- The preliminary license ("*Licença Prévia*" or L.P.),
- The construction license ("*Licença de Instalação*" or L.I.); and
- The operating license ("*Licença de Operação*" or L.O.).

Usina São Francisco has the authorization issued by ANEEL to operate as an independent power producer (*ANEEL Resolution 359 of 14/11/2005).* This authorization was canceled in order to be substituted to one that authorizes Usina São Francisco to operate with a installed capacity of 96 MW (*ANEEL Resolution 84 of 18/05/2007*). Moreover, the power plant has the licenses emitted by *Agência Ambiental do Estado de Goiás*, the environmental agency of the state of Goiás (*Operating License – nº 366/2007*).

In 2009, it is predicted the conclusion of the expansion that will result in 96 MW of total installed power. At this time, the developer commits to attend all the legal requirements applicable.

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:

After the assessment of the preliminary environmental report by the state environmental authority some minor requirements were made in order to issue the licenses. The project sponsors are fulfilling all the requirements. In conclusion, the environmental impact of the project activity is not considered significant and no full environmental impact assessment, as EIA/RIMA, was required.

SECTION E. Stakeholders' comments

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

Public discussion with local stakeholders is compulsory for obtaining the environmental construction and operating licenses, and once the project already received the licenses, the project has consequently gone through a stakeholder comments process. The legislation also requests the announcement of the issuance of the licenses (LP, LI and LO) in the official journal (*Diário Oficial da União*) and in the regional newspaper to make the process public and allow public information and opinion.

Additionally, the Brazilian Designated National Authority for the CDM, *Comissão Interministerial de Mudanças Globais do Clima*, requires the compulsory invitation of selected stakeholders (copies of these invitations under request) to comment the PDD sent to validation in order to provide the letter of approval.

The organizations and entities invited for comments on the project were:

- *Prefeitura Municipal de Quirinópolis* (Quirinópolis City Hall)
- Câmara Municipal de Quirinópolis (Municipal Assembly of Quirinópolis)
- *Agência Ambiental de Goiás* (Environmental Agency of the State of Goiás)
- *Ministério Público do Estado de Goiás* (State Attorney for the Rights of Citizens of the State of Goiás)
- *Fórum Brasileiro de ONGs e Movimentos Sociais para o Desenvolvimento e Meio Ambiente* (Brazilian Forum of NGOs and Social Movements for the Development and Environment)
- *Secretaria do Meio Ambiente de Quirinópolis* (Environmental Agency of Quirinópolis)
- *Sindicato Rural de Quirinópolis* (Rural Workers' Union of Quirinópolis)

No concerns were raised in the public calls regarding the project.

E.2. Summary of the comments received:

No comments were received.

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

No comments were received.

Annex 1

CONTACT INFORMATION ON PARTICIPANTS IN THE PROJECT ACTIVITY

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Annex 2

INFORMATION REGARDING PUBLIC FUNDING

No public funding is involved in the present project.

This project is not a diverted ODA from an Annex 1 country.

Annex 3

BASELINE INFORMATION

Table 3 - Usina São Francisco – Electricity generation evolution

Years	Total installed capacity (MW)	Capacity factor of boilers	Electric generation (MW)	Installed Capacity (MW) to internal use	Installed Capacity (MW) to export to the grid	Capacity Factor %	Hours of operation during the year	MWh year exported to the grid	MWh consumerd internally (including auxiliary systems)
Year 1_2007	40	68%	27.23	8.58	18.65	84%	3,516	55,076	30,167
Year 2_2008	96	50%	48.20	12.04	39.52	84%	4,351	144,441	52,386
Year 3_2009	96	71%	68.22	12.04	56.18	84%	4,351	205,345	59,469
Year 4_2010	96	82%	78.50	13.69	64.81	84%	4,344	236,500	65,036
Year 5_2011	96	80%	76.53	14.36	62.17	84%	4,529	236,500	65,036
Year 6_2012	96	80%	76.53	14.36	62.17	84%	4,529	236,500	65,036
Year 7_2013	96	80%	76.53	14.36	62.17	84%	4,529	236,500	65,036
Year 7_2014	96	80%	76.53	14.36	62.17	84%	0	0	0

The Brazilian electricity system (Figure 5 below) has been historically divided into two subsystems: the North-Northeast (N-NE) and the South-Southeast-Midwest (S-SE-CO, From the Portuguese *Sul-SudEste-Centro-Oeste*). This is due mainly to the historical evolution of the physical system, which was naturally developed nearby the biggest consuming centers of the country.

The natural evolution of both systems is increasingly showing that integration is to happen in the future. In 1998, the Brazilian government was announcing the first leg of the interconnection line between S-SE-CO and N-NE. With investments of around US$ 700 million, the connection had the main purpose, in the government's view, at least, to help solve energy imbalances in the country: the S-SE-CO region could supply the N-NE in case it was necessary and vice-versa.

Nevertheless, even after the interconnection had been established, technical papers still divided the Brazilian system in two (Bosi, 2000):

"… where the Brazilian Electricity System is divided into three separate subsystems:

i) The South/Southeast/Midwest Interconnected System;

ii) The North/Northeast Interconnected System; and

iii) The Isolated Systems (which represent 300 locations that are electrically isolated from the interconnected systems)"

Moreover, Bosi (2000) gives a strong argumentation in favor of having so-called *multi-project baselines*:

"For large countries with different circumstances within their borders and different power grids based in these different regions, multi-project baselines in the electricity sector may need to be disaggregated below the country-level in order to provide a credible representation of 'what would have happened otherwise."

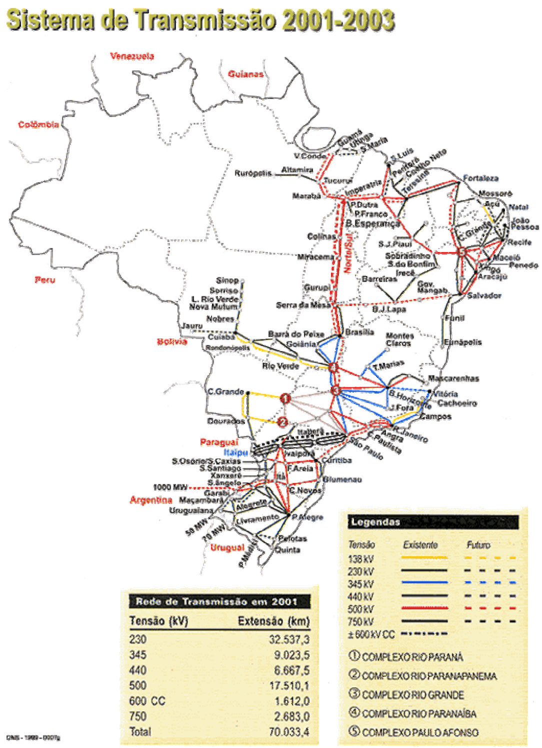

Figure 5 - Brazilian Interconnected System (Source: ONS)

Finally, one has to take into account that even though the systems today are connected, the energy flow between N-NE and S-SE-CO is heavily limited by the transmission lines capacity. Therefore, only a fraction of the total energy generated in both subsystems is sent one way or another. It is natural that this fraction may change its direction and magnitude (up to the transmission line's capacity) depending on the hydrological patterns, climate and other uncontrolled factors. But it is not supposed to represent a significant amount of each subsystem's electricity demand. It has also to be considered that only in 2004 the interconnection between SE and NE was concluded, i.e., if project proponents are to be coherent with the generation database they have available as of the time of the PDD submission for validation, a situation where the electricity flow between the subsystems was even more restricted is to be considered.

The Brazilian electricity system nowadays comprises of around 91.3 GW of installed capacity, in a total of 1,420 electricity generation enterprises. From those, nearly 70% are hydropower plants, around 10% are natural gas-fired power plants, 5.3% are diesel and fuel oil plants, 3.1% are biomass sources (sugarcane bagasse, black liquor, wood, rice straw and biogas), 2% are nuclear plants, 1.4% are coal plants, and there are also 8.1 GW of installed capacity in neighboring countries (Argentina, Uruguay, Venezuela and Paraguay) that may dispatch electricity to the Brazilian grid. (http://www.aneel.gov.br/aplicacoes/capacidadebrasil/OperacaoCapacidadeBrasil.asp). This latter capacity is in fact comprised by mainly 6.3 GW of the Paraguayan part of *Itaipu Binacional*, a hydropower plant operated by both Brazil and Paraguay, but whose energy almost entirely is sent to the Brazilian grid.

Approved methodologies ACM0002 asks project proponents to account for “all generating sources serving the system”. In that way, when applying the methodology, project proponents in Brazil should search for, and research, all power plants serving the Brazilian system.

In fact, information on such generating sources is not publicly available in Brazil. The national dispatch center, ONS – *Operador Nacional do Sistema* – argues that dispatching information is strategic to the power agents and therefore cannot be made available. On the other hand, ANEEL, the electricity agency, provides information on power capacity and other legal matters on the electricity sector, but no dispatch information can be got through this entity.

In that regard, project proponents looked for a plausible solution in order to be able to calculate the emission factor in Brazil in the most accurate way. Since real dispatch data is necessary after all, the ONS was contacted, in order to let participants know until which degree of detail information could be provided. After several months of talks, plants’ daily dispatch information was made available for years 2002, 2003 and 2004.

Project proponents, discussing the feasibility of using such data, concluded it was the most proper information to be considered when determining the emission factor for the Brazilian grid. According to ANEEL, in fact, ONS centralized dispatched plants accounted for 75,547 MW of installed capacity by 31/12/2004, out of the total 98,848.5 MW installed in Brazil by the same date (http://www.aneel.gov.br/arquivos/PDF/Resumo_Gráficos_mai_2005.pdf), which includes capacity available in neighboring countries to export to Brazil and emergency plants, that are dispatched only during times of electricity constraints in the system. Therefore, even though the emission factor calculation is carried out without considering all generating sources serving the system, about 76.4% of the installed capacity serving Brazil is taken into account, which is a fair amount if one looks at the difficulty in getting dispatch information in Brazil. Moreover, the remaining 23.6% are plants that do not have their dispatch coordinated by ONS, since: either they operate based on power purchase agreements which are not under control of the dispatch authority; or they are located in non-interconnected systems to which ONS has no access. In that way, this portion is not likely to be affected by the CDM projects, and this is another reason for not taking them into account when determining the emission factor.

In an attempt to include all generating sources, project developers considered the option to research for available, but non-official data, to supply the existing gap. The solution found was the International Energy Agency database built when carrying out the study from Bosi *et al.* (2002). Merging ONS data with the IEA data in a spreadsheet, project proponents have been able to consider all generating sources connected to the relevant grids in order to determine the emission factor. The emission factor calculated was found more conservative when considering ONS data only (Table 4).

Table 4 - Ex ante and ex-post operating and build margin emission factors (ONS-ADO, 2004; Bosi *et al.*, 2002)

Year	$EF_{OM\ non\text{-}low\text{-}cost/must\text{-}run}$ [tCO_2/MWh]		EF_{BM} [tCO_2/MWh]	
	Ex-ante	Ex-post	Ex-ante	Ex-post
2001-2003	0.719	0.950	0.569	0.096

Therefore, considering all the rationale explained, project developers decided for the database considering ONS information only, as it was capable of properly addressing the issue of determining the emission factor and doing it in the most conservative way.

The aggregated hourly dispatch data got from ONS was used to determine the lambda factor for each of the years with data available (2002, 2003 and 2004). The Low-cost/Must-run generation was determined as the total generation minus fossil-fuelled thermal plants generation, this one determined through daily dispatch data provided by ONS. All this information has been provided to the validators, and extensively discussed with them, in order to make all points crystal clear. The figures below show the load duration curves for the three considered years, as well as the lambda calculated.

Table 5 - Emission factors for the Brazilian South-Southeast-Midwest interconnected grid (simple adjusted operating margin factor)

Emission factors for the Brazilian South-Southeast-Midwest interconnected grid

Baseline (including imports)	EF_{OM} [tCO2/MWh]	Load [MWh]	LCMR [MWh]	Imports [MWh]
2003	0.9823	288,933,290	274,670,644	459,586
2004	0.9163	302,906,198	284,748,295	1,468,275
2005	0.8086	314,533,592	296,690,687	3,535,252
	Total (2003-2005) =	906,373,081	856,109,626	5,463,113
	$EF_{OM,simple\text{-}adjusted}$ [tCO2/MWh]	$EF_{BM,2005}$	Lambda	
	0.4349	0.0872	λ_{2003}	
	Alternative weights	Default weights	0.5312	
	w_{OM} = 0.75	w_{OM} = 0.5	λ_{2004}	
	w_{BM} = 0.25	w_{BM} = 0.5	0.5055	
	Alternative EF_y [tCO2/MWh]	Default EF_y [tCO2/MWh]	λ_{2005}	
	0.3480	0.2611	0.5130	

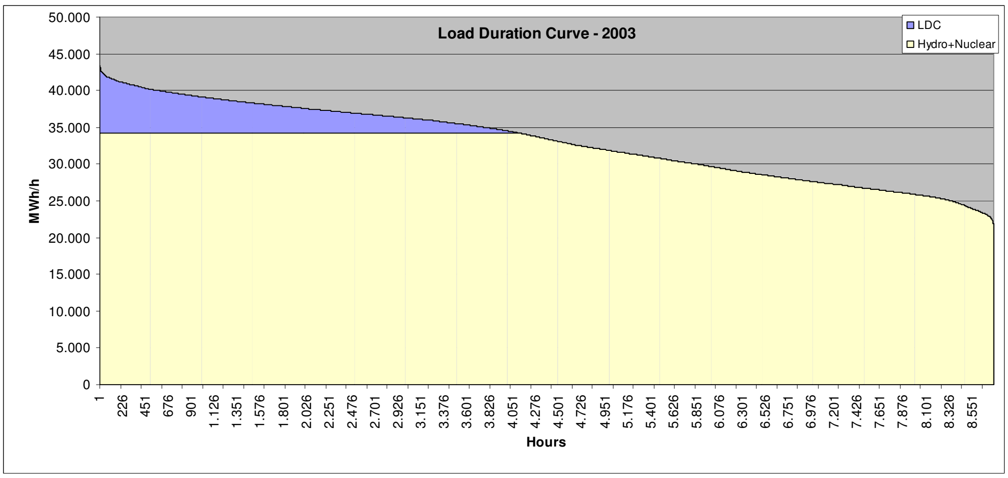

Figure 6 - Load duration curve for the S-SE-CO system, 2003

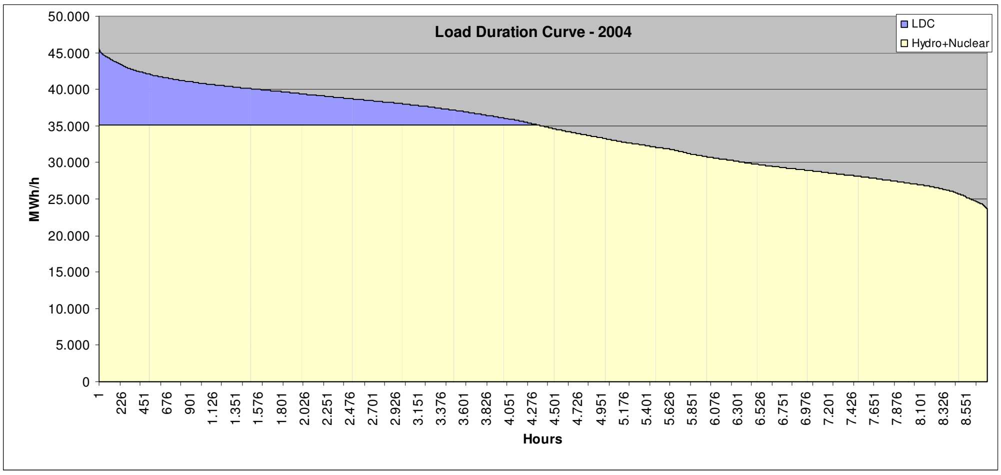

Figure 7 - Load duration curve for the S-SE-CO system, 2004

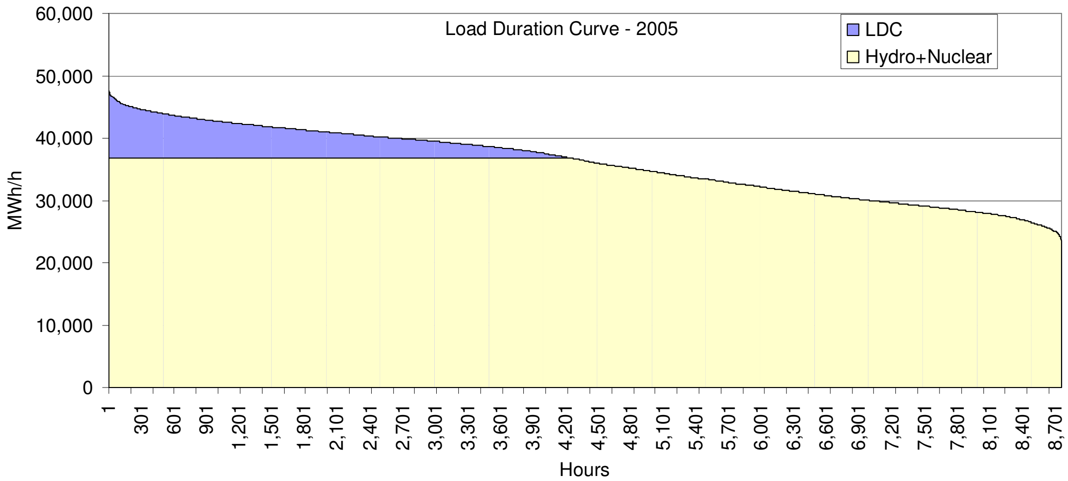

Figure 8 - Load duration curve for the S-SE-CO system, 2005

Table 6 - Power plants database for the Brazilian South-Southeast-Midwest interconnected grid, part 1

	Subsystem*	Fuel source**	Power plant	Operation start [2, 4, 5]	Installed capacity (MW) [1]	Fuel conversion efficiency (%) [2]	Carbon emission factor (tC/TJ) [3]	Fraction carbon oxidized [3]	Emission factor (tCO2/MWh)
1	S-SE-CO	H	Jauru	Sep-2003	121.5	1	0.0	0.0%	0.000
2	S-SE-CO	H	Gauporé	Sep-2003	120.0	1	0.0	0.0%	0.000
3	S-SE-CO	G	Três Lagoas	Aug-2003	306.0	0.3	15.3	99.5%	0.670
4	S-SE-CO	H	Funil (MG)	Jan-2003	180.0	1	0.0	0.0%	0.000
5	S-SE-CO	H	Itiquira I	Sep-2002	156.1	1	0.0	0.0%	0.000
6	S-SE-CO	G	Araucária	Sep-2002	484.5	0.3	15.3	99.5%	0.670
7	S-SE-CO	G	Canoas	Sep-2002	160.6	0.3	15.3	99.5%	0.670
8	S-SE-CO	H	Piraju	Sep-2002	81.0	1	0.0	0.0%	0.000
9	S-SE-CO	G	Nova Piratininga	Jun-2002	384.9	0.3	15.3	99.5%	0.670
10	S-SE-CO	O	PCT CGTEE	Jun-2002	5.0	0.3	20.7	99.0%	0.902
11	S-SE-CO	H	Rosal	Jun-2002	55.0	1	0.0	0.0%	0.000
12	S-SE-CO	G	Ibirité	May-2002	226.0	0.3	15.3	99.5%	0.670
13	S-SE-CO	H	Cana Brava	May-2002	465.9	1	0.0	0.0%	0.000
14	S-SE-CO	H	Sta. Clara	Jan-2002	60.0	1	0.0	0.0%	0.000
15	S-SE-CO	H	Machadinho	Jan-2002	1,140.0	1	0.0	0.0%	0.000
16	S-SE-CO	G	Juiz de Fora	Nov-2001	87.0	0.28	15.3	99.5%	0.718
17	S-SE-CO	G	Macaé Merchant	Nov-2001	922.6	0.24	15.3	99.5%	0.837
18	S-SE-CO	H	Lajeado (ANEEL res. 402/2001)	Nov-2001	902.5	1	0.0	0.0%	0.000
19	S-SE-CO	G	Eletrobolt	Oct-2001	379.0	0.24	15.3	99.5%	0.837
20	S-SE-CO	H	Porto Estrela	Sep-2001	112.0	1	0.0	0.0%	0.000
21	S-SE-CO	G	Cuiaba (Mario Covas)	Aug-2001	529.2	0.3	15.3	99.5%	0.670
22	S-SE-CO	G	W. Arjona	Jan-2001	194.0	0.25	15.3	99.5%	0.804
23	S-SE-CO	G	Uruguaiana	Jan-2000	639.9	0.45	15.3	99.5%	0.447
24	S-SE-CO	H	S. Caxias	Jan-1999	1,240.0	1	0.0	0.0%	0.000
25	S-SE-CO	H	Canoas I	Jan-1999	82.5	1	0.0	0.0%	0.000
26	S-SE-CO	H	Canoas II	Jan-1999	72.0	1	0.0	0.0%	0.000
27	S-SE-CO	H	Igarapava	Jan-1999	210.0	1	0.0	0.0%	0.000
28	S-SE-CO	H	Porto Primavera	Jan-1999	1,540.0	1	0.0	0.0%	0.000
29	S-SE-CO	D	Cuiaba (Mario Covas)	Oct-1998	529.2	0.27	20.2	99.0%	0.978
30	S-SE-CO	H	Sobragi	Sep-1998	60.0	1	0.0	0.0%	0.000
31	S-SE-CO	H	PCH EMAE	Jan-1998	26.0	1	0.0	0.0%	0.000
32	S-SE-CO	H	PCH CEEE	Jan-1998	25.0	1	0.0	0.0%	0.000
33	S-SE-CO	H	PCH ENERSUL	Jan-1998	43.0	1	0.0	0.0%	0.000
34	S-SE-CO	H	PCH CEB	Jan-1998	15.0	1	0.0	0.0%	0.000
35	S-SE-CO	H	PCH ESCELSA	Jan-1998	62.0	1	0.0	0.0%	0.000
36	S-SE-CO	H	PCH CELESC	Jan-1998	50.0	1	0.0	0.0%	0.000
37	S-SE-CO	H	PCH CEMAT	Jan-1998	145.0	1	0.0	0.0%	0.000
38	S-SE-CO	H	PCH CELG	Jan-1998	15.0	1	0.0	0.0%	0.000
39	S-SE-CO	H	PCH CERJ	Jan-1998	59.0	1	0.0	0.0%	0.000
40	S-SE-CO	H	PCH COPEL	Jan-1998	70.0	1	0.0	0.0%	0.000
41	S-SE-CO	H	PCH CEMIG	Jan-1998	84.0	1	0.0	0.0%	0.000
42	S-SE-CO	H	PCH CPFL	Jan-1998	55.0	1	0.0	0.0%	0.000
43	S-SE-CO	H	S. Mesa	Jan-1998	1,275.0	1	0.0	0.0%	0.000
44	S-SE-CO	H	PCH EPAULO	Jan-1998	26.0	1	0.0	0.0%	0.000
45	S-SE-CO	H	Guilmam Amorim	Jan-1997	140.0	1	0.0	0.0%	0.000
46	S-SE-CO	H	Corumbá	Jan-1997	375.0	1	0.0	0.0%	0.000
47	S-SE-CO	H	Miranda	Jan-1997	408.0	1	0.0	0.0%	0.000
48	S-SE-CO	H	Noav Ponte	Jan-1994	510.0	1	0.0	0.0%	0.000
49	S-SE-CO	H	Segredo (Gov. Ney Braga)	Jan-1992	1,260.0	1	0.0	0.0%	0.000
50	S-SE-CO	H	Taquaruçu	Jan-1989	554.0	1	0.0	0.0%	0.000
51	S-SE-CO	H	Manso	Jan-1988	210.0	1	0.0	0.0%	0.000
52	S-SE-CO	H	D. Francisca	Jan-1987	125.0	1	0.0	0.0%	0.000
53	S-SE-CO	H	Itá	Jan-1987	1,450.0	1	0.0	0.0%	0.000
54	S-SE-CO	H	Rosana	Jan-1987	369.2	1	0.0	0.0%	0.000
55	S-SE-CO	N	Angra	Jan-1985	1,874.0	1	0.0	0.0%	0.000
56	S-SE-CO	H	T. Irmãos	Jan-1985	807.5	1	0.0	0.0%	0.000
57	S-SE-CO	H	Itaipu 60 Hz	Jan-1983	6,300.0	1	0.0	0.0%	0.000
58	S-SE-CO	H	Itaipu 50 Hz	Jan-1983	5,375.0	1	0.0	0.0%	0.000
59	S-SE-CO	H	Emborcação	Jan-1982	1,192.0	1	0.0	0.0%	0.000
60	S-SE-CO	H	Nova Avanhandava	Jan-1982	347.4	1	0.0	0.0%	0.000
61	S-SE-CO	H	Gov. Bento Munhoz - GBM	Jan-1980	1,676.0	1	0.0	0.0%	0.000

* Subsystem: S - south, SE-CO - Southeast-Midwest

** Fuel source (C, bituminous coal; D, diesel oil; G, natural gas; H, hydro; N, nuclear; O, residual fuel oil).

[1] Agência Nacional de Energia Elétrica. *Banco de Informações da Geração* (http://www.aneel.gov.br/, data collected in november 2004).

[2] Bosi, M., A. Laurence, P. Maldonado, R. Schaeffer, A.F. Simoes, H. Winkler and J.M. Lukamba. *Road testing baselines for GHG mitigation projects in the electric power sector.* OECD/IEA information paper, October 2002.

[3] Intergovernamental Panel on Climate Change. *Revised 1996 Guidelines for National Greenhouse Gas Inventories.*

[4] Operador Nacional do Sistema Elétrico. Centro Nacional de Operação do Sistema. *Acompanhamento Diário da Operação do SIN* (daily reports from Jan. 1, 2001 to Dec. 31, 2003).

[5] Agência Nacional de Energia Elétrica. Superintendência de Fiscalização dos Serviços de Geração. *Resumo Geral dos Novos Empreendimentos de Geração* (http://www.aneel.gov.br/, data collected in november 2004).

Table 7 - Power plants database for the Brazilian South-Southeast-Midwest interconnected grid, part 2

	Subsystem*	Fuel source**	Power plant	Operation start [2, 4, 5]	Installed capacity (MW) [1]	Fuel conversion efficiency (%) [2]	Carbon emission factor (tC/TJ) [3]	Fraction carbon oxidized [3]	Emission factor (tCO2/MWh)
62	S-SE-CO	H	S.Santiago	Jan-1980	1,420.0	1	0.0	0.0%	0.000
63	S-SE-CO	H	Itumbiara	Jan-1980	2,280.0	1	0.0	0.0%	0.000
64	S-SE-CO	O	Igarapé	Jan-1978	131.0	0.3	20.7	99.0%	0.902
65	S-SE-CO	H	Itauba	Jan-1978	512.4	1	0.0	0.0%	0.000
66	S-SE-CO	H	A. Vermelha (Jose E. Moraes)	Jan-1978	1,396.2	1	0.0	0.0%	0.000
67	S-SE-CO	H	S.Simão	Jan-1978	1,710.0	1	0.0	0.0%	0.000
68	S-SE-CO	H	Capivara	Jan-1977	640.0	1	0.0	0.0%	0.000
69	S-SE-CO	H	S.Osório	Jan-1975	1,078.0	1	0.0	0.0%	0.000
70	S-SE-CO	H	Marimbondo	Jan-1975	1,440.0	1	0.0	0.0%	0.000
71	S-SE-CO	H	Promissão	Jan-1975	264.0	1	0.0	0.0%	0.000
72	S-SE-CO	C	Pres. Medici	Jan-1974	446.0	0.26	26.0	98.0%	1.294
73	S-SE-CO	H	Volta Grande	Jan-1974	380.0	1	0.0	0.0%	0.000
74	S-SE-CO	H	Porto Colombia	Jun-1973	320.0	1	0.0	0.0%	0.000
75	S-SE-CO	H	Passo Fundo	Jan-1973	220.0	1	0.0	0.0%	0.000
76	S-SE-CO	H	Passo Real	Jan-1973	158.0	1	0.0	0.0%	0.000
77	S-SE-CO	H	Ilha Solteira	Jan-1973	3,444.0	1	0.0	0.0%	0.000
78	S-SE-CO	H	Mascarenhas	Jan-1973	131.0	1	0.0	0.0%	0.000
79	S-SE-CO	H	Gov. Parigot de Souza - GPS	Jan-1971	252.0	1	0.0	0.0%	0.000
80	S-SE-CO	H	Chavantes	Jan-1971	414.0	1	0.0	0.0%	0.000
81	S-SE-CO	H	Jaguara	Jan-1971	424.0	1	0.0	0.0%	0.000
82	S-SE-CO	H	Sá Carvalho	Apr-1970	78.0	1	0.0	0.0%	0.000
83	S-SE-CO	H	Estreito (Luiz Carlos Barreto)	Jan-1969	1,050.0	1	0.0	0.0%	0.000
84	S-SE-CO	H	Ibitinga	Jan-1969	131.5	1	0.0	0.0%	0.000
85	S-SE-CO	H	Jupiá	Jan-1969	1,551.2	1	0.0	0.0%	0.000
86	S-SE-CO	O	Alegrete	Jan-1968	66.0	0.26	20.7	99.0%	1.040
87	S-SE-CO	G	Campos (Roberto Silveira)	Jan-1968	30.0	0.24	15.3	99.5%	0.837
88	S-SE-CO	G	Santa Cruz (RJ)	Jan-1968	766.0	0.31	15.3	99.5%	0.648
89	S-SE-CO	H	Paraibuna	Jan-1968	85.0	1	0.0	0.0%	0.000
90	S-SE-CO	H	Limoeiro (Armando Salles de Oliviera)	Jan-1967	32.0	1	0.0	0.0%	0.000
91	S-SE-CO	H	Caconde	Jan-1966	80.4	1	0.0	0.0%	0.000
92	S-SE-CO	C	J.Lacerda C	Jan-1965	363.0	0.25	26.0	98.0%	1.345
93	S-SE-CO	C	J.Lacerda B	Jan-1965	262.0	0.21	26.0	98.0%	1.602
94	S-SE-CO	C	J.Lacerda A	Jan-1965	232.0	0.18	26.0	98.0%	1.869
95	S-SE-CO	H	Bariri (Alvaro de Souza Lima)	Jan-1965	143.1	1	0.0	0.0%	0.000
96	S-SE-CO	H	Funil (RJ)	Jan-1965	216.0	1	0.0	0.0%	0.000
97	S-SE-CO	C	Figueira	Jan-1963	20.0	0.3	26.0	98.0%	1.121
98	S-SE-CO	H	Furnas	Jan-1963	1,216.0	1	0.0	0.0%	0.000
99	S-SE-CO	H	Barra Bonita	Jan-1963	140.8	1	0.0	0.0%	0.000
100	S-SE-CO	C	Charqueadas	Jan-1962	72.0	0.23	26.0	98.0%	1.462
101	S-SE-CO	H	Jurumirim (Armando A. Laydner)	Jan-1962	97.7	1	0.0	0.0%	0.000
102	S-SE-CO	H	Jacui	Jan-1962	180.0	1	0.0	0.0%	0.000
103	S-SE-CO	H	Pereira Passos	Jan-1962	99.1	1	0.0	0.0%	0.000
104	S-SE-CO	H	Tres Marias	Jan-1962	396.0	1	0.0	0.0%	0.000
105	S-SE-CO	H	Euclides da Cunha	Jan-1960	108.8	1	0.0	0.0%	0.000
106	S-SE-CO	H	Camargos	Jan-1960	46.0	1	0.0	0.0%	0.000
107	S-SE-CO	H	Santa Branca	Jan-1960	56.1	1	0.0	0.0%	0.000
108	S-SE-CO	H	Cachoeira Dourada	Jan-1959	658.0	1	0.0	0.0%	0.000
109	S-SE-CO	H	Salto Grande (Lucas N. Garcez)	Jan-1958	70.0	1	0.0	0.0%	0.000
110	S-SE-CO	H	Salto Grande (MG)	Jan-1956	102.0	1	0.0	0.0%	0.000
111	S-SE-CO	H	Mascarenhas de Moraes (Peixoto)	Jan-1956	478.0	1	0.0	0.0%	0.000
112	S-SE-CO	H	Itutinga	Jan-1955	52.0	1	0.0	0.0%	0.000
113	S-SE-CO	C	S. Jerônimo	Jan-1954	20.0	0.26	26.0	98.0%	1.294
114	S-SE-CO	O	Carioba	Jan-1954	36.2	0.3	20.7	99.0%	0.902
115	S-SE-CO	O	Piratininga	Jan-1954	472.0	0.3	20.7	99.0%	0.902
116	S-SE-CO	H	Canastra	Jan-1953	42.5	1	0.0	0.0%	0.000
117	S-SE-CO	H	Nilo Peçanha	Jan-1953	378.4	1	0.0	0.0%	0.000
118	S-SE-CO	H	Fontes Nova	Jan-1940	130.3	1	0.0	0.0%	0.000
119	S-SE-CO	H	Henry Borden Sub.	Jan-1926	420.0	1	0.0	0.0%	0.000
120	S-SE-CO	H	Henry Borden Ext.	Jan-1926	469.0	1	0.0	0.0%	0.000
121	S-SE-CO	H	I. Pombos	Jan-1924	189.7	1	0.0	0.0%	0.000
122	S-SE-CO	H	Jaguari	Jan-1917	11.8	1	0.0	0.0%	0.000
				Total (MW) =	**64,478.6**				

* Subsystem: S - south, SE-CO - Southeast-Midwest

** Fuel source (C, bituminous coal; D, diesel oil; G, natural gas; H, hydro; N, nuclear; O, residual fuel oil).

[1] Agência Nacional de Energia Elétrica. *Banco de Informações da Geração* (http://www.aneel.gov.br/, data collected in november 2004).

[2] Bosi, M., A. Laurence, P. Maldonado, R. Schaeffer, A.F. Simoes, H. Winkler and J.M. Lukamba. *Road testing baselines for GHG mitigation projects in the electric power sector.* OECD/IEA information paper, October 2002.

[3] Intergovernamental Panel on Climate Change. *Revised 1996 Guidelines for National Greenhouse Gas Inventories.*

[4] Operador Nacional do Sistema Elétrico. Centro Nacional de Operação do Sistema. *Acompanhamento Diário da Operação do SIN* (daily reports from Jan. 1, 2001 to Dec. 31, 2003).

[5] Agência Nacional de Energia Elétrica. Superintendência de Fiscalização dos Serviços de Geração. *Resumo Geral dos Novos Empreendimentos de Geração* (http://www.aneel.gov.br/, data collected in november 2004).

According to the approved methodology ACM0002 (May 19th, 2006, version 6), the baseline emission factor is calculated as (EF_y) as a combined margin (*CM*), consisting of the combination of operating margin (OM) and build margin (BM) factors. For the purpose of determining the build margin and the operating margin emission factors, the project electricity system is defined by the spatial extent of the power plants that can be dispatched without significant transmission constraints. Similarly the connected electricity system is defined as that electricity system that is connected by transmission lines to the project electricity system and in which power plants can be dispatched without significant transmission constraints.

From ACM0002, a baseline emission factor (EF_y) is calculated as a combined margin (*CM*), consisting of the combination of operating margin (*OM*) and build margin (*BM*) factors according to the following three steps:

- **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.

Dispatch data analysis operating margin should be the first methodological choice. Since not enough data was supplied by the Brazilian national dispatch center, the choice is not currently available. The simple operating margin can only be used where low-cost/must-run resources[8] constitute less than 50% of total grid generation in: 1) average of 5 most recent years, or 2) based on long-term normals for hydroelectricity production. The share of hydroelectricity in the total electricity production for the Brazilian South-Southeast-Midwest interconnected system is much higher than 50% (see Table 8 below), resulting in the non-applicability of the simple operating margin to the project.

Table 8 - Share of hydroelectricity generation in the Brazilian S-SE-MW interconnected system, 1999 to 2003 (ONS, 2004).

Year	Share of hydroelectricity (%)
1999	*94.0*
2000	*90.1*
2001	*86.2*
2002	*90.0*
2003	*92.9*

The fourth alternative, an average operating margin, is an oversimplification and does not reflect at all the impact of the project activity in the operating margin. Therefore, the simple adjusted operating margin will be used in the project.

The simple adjusted operating margin emission factor ($EF_{OM,adjusted,y}$ in tCO_2/MWh) is a variation on the simple operating margin, where the power sources (including imports) are separated in low-cost/must-run power sources (*k*) and other power sources (*j*):

[8] Low operating cost and must run resources typically include hydro, geothermal, wind, low-cost biomass, nuclear and solar generation (AM0015, 2004).

$$EF_{OM,simple-adjusted,y} = (1-\lambda_y)\frac{\sum_{i,j} F_{i,j,y} \cdot COEF_{i,j}}{\sum_j GEN_{j,y}} + \lambda_y \cdot \frac{\sum F_{i,k,y} \cdot COEF_{i,k}}{\sum_k GEN_{k,y}}$$ **Equation 5**

Where:

- λ_y is the share of hours in year *y* (in %) for which low-cost/must-run sources are on the margin.
- $F_{i,j,y}$ is the amount of fuel *i* (in mass or volume unit) consumed by relevant power sources *j* (analogous for sources *k*) in year(s) *y*,
- *j* refers to the power sources delivering electricity to the grid, not including low-operating cost and must-run power plants, and including imports to the grid. For imports from connected electricity system located in another country, the emission factor is 0 (zero).
- *k* refers to the low-operating cost and must-run power sources.
- $COEF_{i,j}$ 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* (analogous for sources *k*) and the percent oxidation of the fuel in year(s) *y* and,
- $GEN_{j,y}$ is the electricity (MWh) delivered to the grid by source *j* (analogous for sources *k*),

The most recent numbers for the interconnected S-SE-MW system were obtained from the Brazilian national dispatch center, ONS (from the Portuguese *Operador Nacional do Sistema Elétrico)* in the form of daily consolidated reports (ONS-ADO, 2004). Data from 120 power plants, comprising 63.6 GW installed capacity and around 828 TWh electricity generation over the 3-year period were considered. With the numbers from ONS, Equation 6 is calculated, as described below:

$$EF_{OM-LCMR,y} = \frac{\sum_{i,k} F_{i,k,y} \cdot COEF_{i,k}}{\sum_k GEN_{j,k}}$$ **Equation 6**

Where:

- $EF_{OM-LCMR,y}$ is emission factor for low-cost/must-run resources(in tCO_2/MWh) by relevant power sources *k* in year(s) *y*.

Low-cost/must-run resources in Brazilian S-SE-MW interconnected system are hydro and thermonuclear power plants, considered free of greenhouse gases emissions, i.e., $COEF_{i,j}$ for these plants is zero. Hence, the emission factor for low-cost/must-run resources results, $EF_{OM,y} = 0$.

$$EF_{OM,y} = (1-\lambda_y)\frac{\sum_{i,j} F_{i,j,y} \cdot COEF_{i,j}}{\sum_j GEN_{j,y}}$$ **Equation 7**

Where:

- $EF_{OM,y}$ is the simple operating margin emission factor (in tCO_2/MWh), or the emission factor for non-low-cost/must-run resources by relevant power sources j in year(s) y.

Non-low-cost/must-run resources in Brazilian S-SE-MW interconnected system are thermo power plants burning coal, fuel oil, natural gas and diesel oil. These plants result in non-balanced emissions of greenhouse gases, calculated as follows:

These plants result in non-balanced emissions of greenhouse gases. The product $\sum_{i,k} F_{i,k,y} \cdot COEF_{i,k}$ for each one of the plants was obtained from:

$$F_{i,k,y} = \frac{GEN_{i,k,y} \cdot 3.6\times10^{-6}}{\eta_{i,k,y} \cdot NCV_i}$$ **Equation 8**

$$COEF_{i,k} = NCV_i \cdot EF_{CO2,i} \cdot 44/12 \cdot OXID_i$$ **Equation 9**

$$\text{Hence, } F_{i,k,y} \cdot COEF_{i,k} = \frac{GEN_{i,k,y} \cdot EF_{CO2,i} \cdot OXID_i \cdot 44/12 \cdot 3.6\times10^{-6}}{\eta_{i,k,y}}$$ **Equation 10**

Where variable and parameters used are:

- $\sum_{i,j} F_{i,j,y}$ is given in [kg], $COEF_{i,j}$ in [tCO_2e/kg] and $F_{i,k,y} \cdot COEF_{i,k}$ in [tCO_2e]
- $GEN_{i,k,y}$ is the electricity generation for plant k, with fuel i, in year y, obtained from the ONS database, in MWh
- $EF_{CO2,i}$ is the emission factor for fuel i, obtained from the Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories, in tC/TJ.
- $OXID_i$ is the oxidization factor for fuel i, obtained from the Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories, in %.
- 44/12 is the carbon conversion factor, from tC to tCO_2.
- 3.6×10^{-6} is the energy conversion factor, from MWh to TJ.
- $\eta_{i,k,y}$ is the thermal efficiency of plant k, operating with fuel i, in year y, obtained from PCF (2003).
- NCV_i is the net calorific value of fuel i [TJ/kg].

$\sum_{k,y} GEN_{k,y}$ is obtained from the UT database, as the summation of non-low-cost/must-run resources electricity generation, in MWh.

Table 9 - Share of hours in year *y* (in %) for which low-cost/must-run sources are on the margin in the S-SE-MW system for the period 2003-2005 (ONS-ADO, 2005).

Year	$\frac{\sum_{i,k} F_{i,k,y} \cdot COEF_{i,k}}{\sum_{k} GEN_{k,y}}$ [tCO$_2$/MWh]	λ_y [%]
2003	0.9823	0.5312
2004	0.9163	0.5055
2005	0.8086	0.5130

With the numbers from ONS, the first step was to calculate the lambda and the emission factors for the simple operating margin. The λ_y factors are calculated as indicated in methodology ACM0002, with data obtained from the ONS database. Figure 6, Figure 7 and Figure 8 (see above, in Annex 3) present the load duration curves and λ_y determination for years 2003, 2004 and 2005, respectively. The results for years 2003, 2004 and 2005 are presented in Table 9.

Finally, applying the obtained numbers to calculate $EF_{OM,simple\text{-}adjusted,2002\text{-}2004}$ as the weighted average *of* $EF_{OM,simple\text{-}adjusted\ 2003}$, $EF_{OM\ simple\text{-}\ adjusted,2004}$ *and* $EF_{OM,simple\text{-}adjusted,2005}$ and λ_y to Equation 7:

- $EF_{OM,simple\text{-}adjusted,2003\text{-}2005}$ = 0.4349 tCO_{2e}/MWh

- **STEP 2** – Calculate the build margin mission factor ($EF_{BM,y}$) as the generation weighted average emission factor (tCO$_{2e}$/MWh) of a sample of power plants *m*, as follows:

$$EF_{BM,y} = \frac{\sum_{i,m} F_{i,m,y} \cdot COEF_{i,m}}{\sum_{m} GEN_{m,y}} \qquad \textbf{Equation 11}$$

Where $F_{i,m,y}$, $COEF_{i,m}$ and $GEN_{m,y}$ are analogous to the variables described for the simple OM method (ACM-0002) 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.

Applying the data from the Brazilian national dispatch center to the equation above:

$EF_{BM,2005} = 0.0872\ tCO_{2e}/MWh$

- **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 ($EF_{BM,y}$):

$$EF_y = w_{OM} \cdot EF_{OM,y} + w_{BM} \cdot EF_{BM,y}$$ **Equation 12**

Finally, the electricity baseline emission factor is calculated through a weighted-average formula, considering both the OM and the BM, being the weights 50% and 50% by default:

$$EF_y = 0.5 \times 0.4349 + 0.5 \times 0.0872$$ **Equation 13**

$EF_y = 0.2611\ tCO_2/MWh$

Reference Plant energy efficiency ($\varepsilon_{el,\ reference\ plant}$)

Data of bagasse and generated electricity by bagasse power plants were acquired from Copersucar (Cooperativa Produtores de Cana-de-açúcar, Açúcar e Álcool do Estado de São Paulo) a sugarcane, sugar and alcohol producers cooperatives. Founded in 1959, today it has 87 associates, which among them 29 sugar and alcohol producers located in São Paulo, Minas Gerais and Paraná states. The sugar and alcohol producers are made public by the Copersucar website at: http://www.copersucar.com.br/

Figure 9 below shows the electrical energy efficiency in kWh generated electricity per tonne of processed sugarcane in 2006. The 34.12 line is to limit the power plants that have more than 50% excess electricity of the generated amount. These plants are showed separately in Figure 10. All of them are registered or in process of CDM registration.

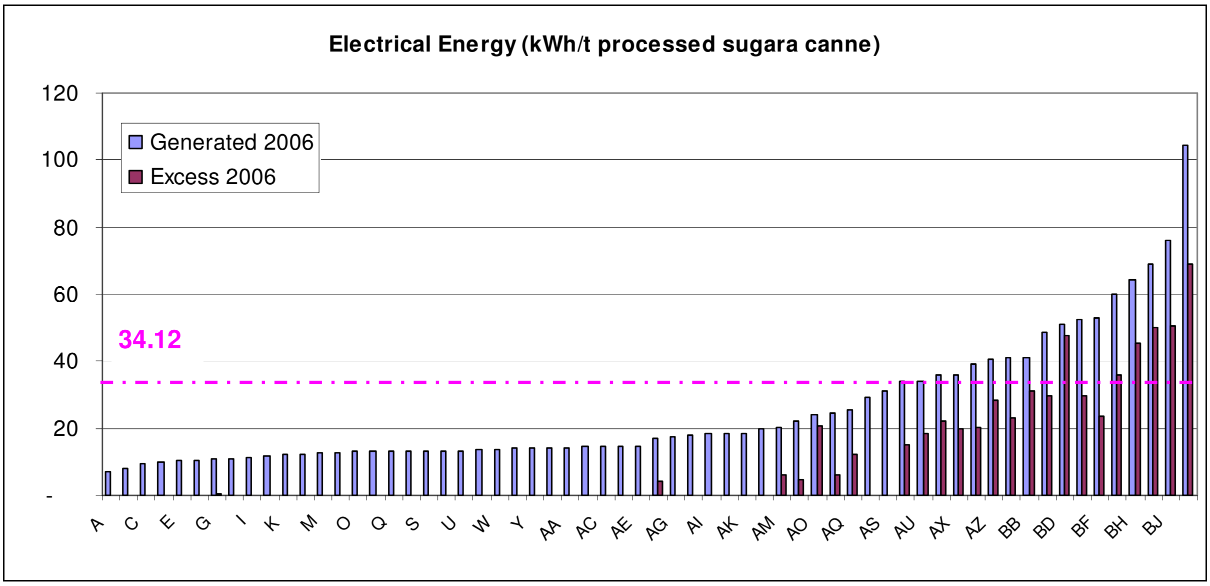

Figure 9 - All Copersucar Bagasse Power Plant in 2006

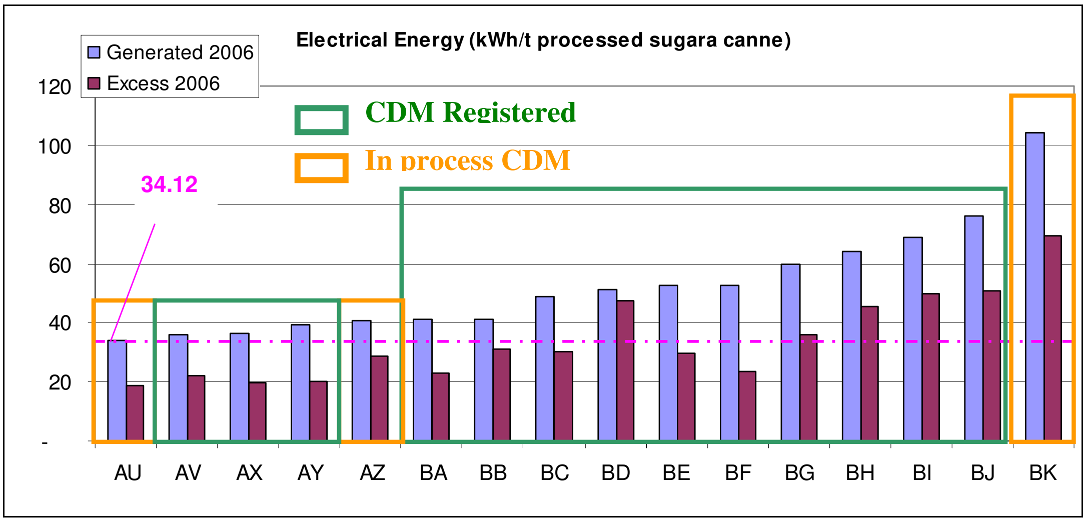

Figure 10 - Sugarcane Bagasse Power Plants (with codified names) with Excess Energy - greater than 50% in 2006. This excess energy is exported to the grid. Important: data from these plants are not used to define efficiency values for reference plants, which operate with low efficiency.

The business-as-usual energy generation efficiency was calculated excluding all CDM registered or in process for, power plants, because these can not be reference plants, since they have a higher efficiency. Figure11 shows the efficiency distribution of these high efficiency power plants in years 2005 and 2006, which **are not** considered in our estimation.

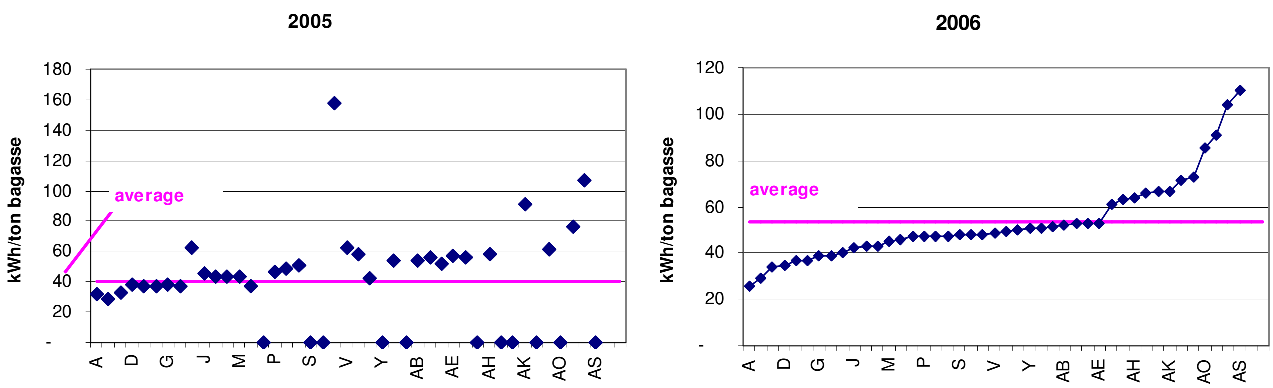

Figure 11 – Efficiency of Bagasse Cogeneration Power Plants in years 2005 and 2006

Since there are no regional data on the sugarcane production in Goiás, it will be used data supplied by Copersucar (see annexed spreadsheet "Copersucar Reference plants Brazil.xls")

Considering the rate bagasse production/sugarcane production to be 0.3, according to Infoener – Energy Information – University of São Paulo (http://infoener.iee.usp.br/scripts/biomassa/br_cana.asp), the average generated energy per bagasse for reference power plants (excluding CDM registered or under implementation) was 49.98 kWh/ton Bagasse in 2006 (see page “Energy per Bagasse quantity”).

Taking the Bagasse NCV value from a statistical net calorific value (wet base) of 2,130 Kcal/Kg[9] (2.47 MWh/ton), it will lead to an estimated net energy efficiency for reference plants of 0.021 $MWh_{el}/MWh_{biomass}$.

Annex 4

MONITORING INFORMATION

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

[9] Ministério de Minas e Energia. Empresa de Pesquisa Energética Balanço Energético Nacional 2006: Ano base 2005. Rio de Janeiro: EPE, 2006.