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

CONTENTS

Annexes

SECTION A. General description of project activity

A.1 Title of the project activity:

São João Landfill Gas to Energy Project (SJ).
Version 2 B
Date of the document: December 21th, 2005.

The only changes made to this version of the PDD compared to the PDD of the Validation Report version Rev.1 dated 11/08/2005 (DD/MM/YYYY) referred to in the letter of approval of the DNA of Brazil are related to the recalculation of the build margin emission factor with the plant efficiencies recommended by the CDM Executive Board at its 22nd meeting.

A.2. Description of the project activity:

SJ is a project designed to explore the landfill gas produced in Aterro Sanitário "Sítio São João" – São João landfill, which is in fact one of the biggest landfills in Brazil. This landfill is located in the metropolitan region of São Paulo, Brazil's biggest city and financial center of the country. With an estimated population of around 10 million citizens in 2000, São Paulo generates nearly 15.000 tons of waste daily.

SJ's goal is to explore the gas produced in São João landfill, using it to generate electricity. The landfill has been designed according to modern practices and is currently graded 8,3 (from 0 to 10) in state of São Paulo's environmental agency (CETESB – Companhia de Tecnologia de Saneamento Ambiental) landfill evaluation. This attests that the landfill is operating in adequate conditions, according to CETESB.

However, the designed solution for the landfill gas at the time of the landfill's conception was to collect it through passive venting, occasionally flaring it at the head of the wells, which is not favourable in terms of methane destruction. This is due to the poorly constructive and operational characteristics of the wells, where there is no technique seeking efficiency in the mixture biogas/air and the flaring time.

Aiming to explore the energy potential of the landfill gas and also minimize environmental problems related to global warming, SJ was designed. The project is at this moment at late development stage, with implementation scheduled for April 2005. Not only will methane emissions be reduced, but also 20 MW renewable energy installed capacity will be explored.

SJ provides major contribution towards sustainable development:

- Renewable energy generation;
- Methane emission reductions through flaring and generating electricity, avoiding global warming and reducing explosion risks at the landfill site;
- Considering that there are very few biogas to energy projects under consideration in Brazil, with only one actually generating energy, SJ can greatly contribute to spread knowledge on the exploitation of the biogas potential in Brazil - replicability;

- There will be considerable temporary job positions' creation during implementation phase, with creation also of direct positions at the operation stage;

- Considering knowledge on this kind of project is still not well developed in Brazil, SJ will have a great impact through technology transfer.

- Emission reductions revenues are to be shared with São Paulo municipality, increasing cash flow towards investments such as rubbish damps recovery, waste management awareness, plus other environmental benefits.

It can be clearly seen SJ greatly contributes to sustainable development.

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)
Brazil (host)	• Public entity Prefeitura Municipal de São Paulo – the municipality of São Paulo • Private entity Biogás Energia Ambiental 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.		

Biogás is a company founded to exploit landfill gas potentials in Brazil. The company has been active since year 2000, and has now won two bids for exploiting landfill gas in the municipality of São Paulo. One of them is the landfill gas in Sítio São João landfill – where SJ takes place – and the other one is for the gas in Bandeirantes landfill, which, along São João, receives most of the waste generated in the city of São Paulo. Among Biogás shareholders are Arcadis Logos Engenharia S.A, a company part of the Arcadis group – Dutch firm specialized on engineering, project management and consultancy; Heleno & Fonseca Construtécnica S.A, Brazilian construction firm; and Van der Wiel, another Dutch enterprise acting in the fields of transport, infrastructure and environmental technique.

The municipality of São Paulo has under its administration the responsibility of caring for the biggest city in Brazil. São Paulo has nowadays around 10 million inhabitants, with around 10 million more leaving in its surroundings, forming one of the world's biggest urban areas – the metropolitan region of São Paulo. Counting on good infrastructure in telecom and transport, with a downtown airport connecting major cities in Brazil, São Paulo is the heart of the industrial and financial activities in Brazil, though industries have been leaving the city since the early and mid 1990's.

São Paulo is also the richest city – in absolute terms – in Brazil. Nevertheless, the city is heavily indebted, and such liability today is around R$ 27,6 billion, or US$ 9,2 billion. Being in such a situation, the administrations have been seeking partnerships and new ways to boost investment and improve life quality in the area. One of such initiatives is being a participant in SJ. The municipality will receive revenues to be earned through emissions reductions commercialization, an income to be used for new investments in landfill installations and rubbish dumps recovery.

A.4. Technical description of the project activity:

A.4.1. Location of the project activity:

SJ is located in São Paulo metropolitan region, the biggest urban area in Brazil. São Paulo is the capital of a state with the same name, situated in the southeast part of Brazil.

A.4.1.1. Host Party(ies):

Brazil

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

São Paulo

A.4.1.3. City/Town/Community etc:

São Paulo

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

São João landfill is located in the east part of São Paulo municipality, at km 33 of "Estrada de Sapopemba" – Sapopemba road – close to the border with Mauá municipality.

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

SJ is a waste – solid waste disposal on land CDM project activity.

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

The SJ includes high density polyethylene pipes connected to the landfill wells; blowers to extract the gas from the landfill; facilities for gas treatment, such as heat exchangers, chillers; and the flares, which will destroy the methane not used to generate electricity. For the energy generation purposes, Biogás aims at installing a powerhouse with 20 MW capacity. The technology for electricity energy generation is likely based on Caterpillar engines, model 3516 A. or any similar engine available. Naturally, considering biogas fuelled engines are usually adapted from models using other fuels, mainly natural gas, the above mentioned model may change.

The degassing installations will be responsible for extracting the landfill gas from the landfill and transport it to the gas engines in the power plant. During the transportation, the gas goes through a treatment to allow its use as fuel for energy generation. Other functions of the degassing installations are:

drying landfill gas by gas coolers; and measuring and analyzing the quantity and quality of the landfill gas for safety, process and operating purposes.

The landfill gas will be cooled down when transported from the landfill, resulting in a condensate. This will be drained to condensate shafts, to be placed nearby the gas pipes. Once in the degassing installations, the landfill gas will be cooled again to remove moisture. This is a very important step in the gas treatment process, since the condensate, which contains silicium components, could block the gas pipes and also damage the gas engines, due to the silicium. After this step, the gas will be heated again through a second heat exchanger, or economizer, to a temperature of around 25 ^{o}C, far enough from the dew point of 4 ^{o}C to avoid further condensation.

Considering demoisturing is fundamental for the energy generation, as per the reasons mentioned in the previous paragraph, a demister will be installed for extra-safety reasons. The demister is a stainless steel high density filter which separates liquid particles (small amounts of condensate) from the landfill gas. This liquid is to be drained off to a condensate shaft as well.

The blowers will be used for transportation of the landfill gas from the landfill to the gas engines, under correct suction and pre-pressure. Capacity and pressure will be adjusted through frequency controlled electromotors. Moreover, the blowers will be equipped with all the necessary safety equipment, including a noise reducing housing.

On the pressure side of the degassing installation, all kinds of gas analyzing and gas measuring instruments will be present. These instruments are very important for safety, process and operating purposes.

After the described treatment, analyzing and measurement, the landfill gas will be transported as a fuel to the gas engines. These will drive electrical generators in order to generate electrical power. An ocasional surplus of the landfill gas can be burned off by the flares.

The whole process will be controlled by an electrical control system. This control system will be provided with a PLC (Programmable Logical Controller). All the measured process signals will be processed by the PLC to output signals for the gas-coolers, blowers, flares and gas-engines. Also the system will count on a SCADA system (visualization of the process on a personal computer). With this system it will be possible to control and monitor the installation at a distance, including through the internet.

SJ is anticipated to be one of the biggest biogas power plants in the world, which therefore may foster the replication of this project activity in several others landfill gas throughout this country. The replication renders the project to assist climate change mitigation even if it is not counted as direct benefit to the project activity itself. Moreover, considering the electricity generation culture in Brazil is, overall, biased towards hydropower, SJ plays an important role in spreading the development of renewable energy sources other than hydro.

Therefore, this project would not happen without technology transfer. As mentioned, among Biogás shareholders are Van der Wiel – worldwide known Dutch firm acting in the transport, infrastructure and environmental technique – and Arcadis, engineering, project management and consultancy Netherlands-based firm with a branch in Brazil (ArcadisLogos Engenharia), responsible for landfill gas capture engineering design. In the case of SJ, the former will be responsible for project implementation and operation, while the latter will take care of gas extraction design. Most of the equipment will be imported

– engines for energy generation, flow meters, gas analyzer and flares. Both project's implementation and operation will happen under strict environmental regulations, and therefore environmentally safe technology transfer will be, in fact, at the core of SJ.

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

Brazil has never adopted laws or any kind of legislation to enforce landfill gas flaring. It is important to note that a considerable effort will have to take place regarding the waste disposal practices in Brazil before any legislation on gas flaring at well-managed landfills is enforced. According to the latest official statistics on urban solid waste in Brazil – *Pesquisa Nacional de Saneamento Básico 2000* (PNSB 2000) – the country produces 228.413 tons of waste per day, which corresponds to 1,35 kg/inhabitant/day. And though there is a worldwide trend towards reducing, reusing and recycling, therefore reducing the amount of urban solid waste to be disposed in landfills, the situation in Brazil is peculiar. Most of the waste produced in the country is sent towards uncontrolled areas – *lixões* – which are, in most of the cases, open dumps without any sort of proper infrastructure to avoid environmental hazards. Figure 1 shows the the final destination of the waste per municipality, according to PNSB 2000.

São João landfill was designed according to the best practices at the time of its conception, applying modern engineering and environmental sound technology in order to avoid environmental hazards, such as underground water contamination. Regarding landfill gas emissions, the project contemplated only passive venting, intending to solely let the gas escape. Eventually, the gas is flared at the top of wells' heads, in a very inefficient combustion mechanism. It is estimated that only around 20% of the gas is flared through such system.

With the implementation of SJ, the above situation will no longer happen. Sealing properly the wells' heads, the project will avoid that methane previously released to the atmosphere is extracted either to the flares or to the powerhouse, where the gas will be ultimately used to generate energy. SJ's implementation will therefore reduce greenhouse gas emissions.

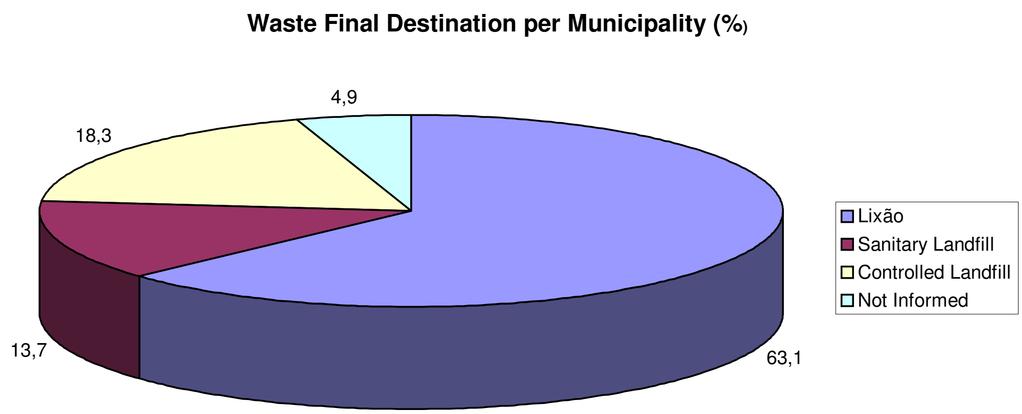

Figure 1. Waste Final Destination per Municipality in Brazil

Source: PNSB, 2000[1].

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

YEARS	ANNUAL ESTIMATION OF EMISSION REDUCTIONS IN TONNES OF CO_2E
2006	1.175.529
2007	1.062.469
2008	960.678
2009	869.033
2010	786.523
2011	712.237
2012	645.356
TOTAL ESTIMATED REDUCTIONS (TONNES OF CO_2E)	6.211.825
TOTAL NUMBER OF CREDITING YEARS	7
ANNUAL AVERAGE OVER THE CREDITING PERIOD OF ESTIMATED REDUCTIONS (TONNES OF CO_2E)	887.404

Emission reductions from SJ are therefore expected to reach 6,21 million tCO_2e in the first crediting period (2006 to 2012).

A.4.5. Public funding of the project activity:

There is no public funding involved in SJ project activity.

SECTION B. Application of a baseline methodology

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

The baseline methodology applied to this project is ACM0001, called "Consolidated baseline methodology for landfill gas project activities".

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

ACM0001 was developed as a way to "unify" approved baseline methodologies applicable to different situations where landfill gas destruction projects are being proposed. One of these situations is where "the captured gas is used to produce energy (e.g. electricity/thermal energy), and emission reductions are claimed for displacing or avoiding energy generation from other sources". This is precisely SJ situation, and therefore the reason for the choice of ACM0001.

[1] IBGE - Instituto Brasileiro de Geografia e Estatística. *Pesquisa Nacional de Saneamento Básico*, 2000.

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

The chosen methodology is drawn upon option (b) of paragraph 48 of the CDM M&P. Significant investments have been made at the site in order to improve landfill gas collection and flare and by that reduce the global warming effect. Therefore an economic analysis on whether such investments would be made in the baseline scenario is necessary.

According to ACM0001, the baseline scenario is the atmospheric release of the methane generated, with some gas being destroyed to comply with regulations or contractual requirements. In fact, at São João landfill at this moment, a little gas is being burned inefficiently at some well's heads. This amount is around 20% of the gas captured by the passive venting system in place.

Therefore, the baseline scenario can be described as the landfill gas produced by the landfill minus 20% that would be destroyed anyway.

Table 1. Baseline data

Year	Waste Deposition (tonnes)	Year	Waste Deposition (tonnes)
1992	5.500	2000	2.034.546
1993	768.591	2001	2.157.783
1994	862.211	2002	2.292.821
1995	1.516.727	2003	2.120.943
1996	1.841.783	2004	2.008.528
1997	1.971.480	2005	2.200.000
1998	2.046.081	2006	2.200.000
1999	2.126.986	2007-on	0
First Order Decay Model Factors			
Lo (tCH_4/t refuse)	0,065	k	0,105

B.3. Description of how the anthropogenic emissions of GHG by sources are reduced below those that would have occurred in the absence of the registered CDM project activity:

ACM0001 requires the use of the "Tool for demonstration and assessment of additionality" to show the project is not the baseline scenario. This tool is applied as follows.

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

a) SJ project activity has so far being a study only. A preliminary environmental assessment for project implementation has been carried out, and an environmental license has been granted. Project is expected to be operational on the 1st of January 2006.

b) This PDD is documented evidence that project developers have seriously considered CDM in the decision to proceed with the project activity.

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

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

Alternatives to SJ include only the current situation at the landfill, which is landfill gas release to the atmosphere. The initiative not carried out as a CDM project is not viable since the investments to extract methane and generate energy are not worth considering in the current and future economic scenarios for the highly volatile Brazilian context, as will be better explained in Step 2.

Sub-step 1b. Enforcement of applicable laws and regulations:
As shown in A.4.4, Brazil has never enforced any law to mitigate landfill gas emissions. In state of São Paulo, CETESB, the environmental agency, has been acting towards closing rubbish dumps and forcing municipalities to give proper destination to the waste generated. That may be done through concessions to private entities either to build and operate sanitary landfills or to be responsible for the whole municipality's waste management. In all cases, however, active collection and flaring of the landfill gas has never been a demand. Passive venting at São João landfill, as already considered, is the only credible and realistic alternative to SJ.

Therefore, the situation prior to the project's implementation – the alternative to SJ – is in compliance with all regulations.

Step 2. Investment analysis

Sub-step 2a. Determine appropriate analysis method
Option III – benchmark analysis – is chosen.

Sub-step 2b – Option III. Apply benchmark analysis
Brazilian businesses are usually analyzed through the internal rate of return to the equity invested in project initiatives. In the case of SJ, this is the financial indicator picked. This indicator is to be compared with government bond rates, since such bonds are considered risk-free investments, and moreover are considered the opportunity cost of capital in Brazil.

Sub-step 2c. Calculation and comparison of financial indicators
Brazilian entrepreneurs usually evaluate investment opportunities through the Internal Rate of Return projects are able to deliver. This is common sense considering the Brazilian economy is highly volatile, and therefore the opportunity cost of capital – government bonds interest rate – tend to vary quite often. Initially, it is important to clarify that the project is basically structured in two distinct sub-units: the gas collection and treatment plant; and the powerplant. Therefore the investment analysis is calculated independently for each sub-unit.

For the methane capture investment, Biogás calculated the IRR and compared to the interest government bond rates were paying by the time the project was developed, during the year 2003 (average government bonds interest rate = 23,29%). As will be shown ahead, these government bonds pay much higher interest than the 13,73% determined for the project activity without CER's revenues. For the IRR calculation in Biogás the input numbers used are the biogas price, fixed cost, variable cost, VAT (ICMS = 12%, COFINS + PIS = 4,65%), insurance (2%), depreciation, income tax and the cost of capital. All the numbers were presented to the DOE. The cash-flow result is provided following:

Table 2. Cash flow for SJ's landfill gas project

Year	Gross Revenues	Sales Taxes: VAT (COFINS + PIS)	Sales Taxes: ICMS	Net Revenues	Fixed Costs	Variable Costs	Insurance	Total Costs
2003	R$0	R$0	R$0	R$0	R$0	R$0	R$0	R$0
2004	R$8.848.476	R$411.454	R$1.061.817	R$7.375.205	R$1.200.000	R$1.000.000	R$176.970	R$2.376.970
2005	R$8.848.476	R$411.454	R$1.061.817	R$7.375.205	R$1.200.000	R$1.320.000	R$176.970	R$2.696.970
2006	R$8.848.476	R$411.454	R$1.061.817	R$7.375.205	R$1.200.000	R$1.440.000	R$176.970	R$2.816.970
2007	R$8.848.476	R$411.454	R$1.061.817	R$7.375.205	R$1.200.000	R$1.440.000	R$176.970	R$2.816.970
2008	R$8.848.476	R$411.454	R$1.061.817	R$7.375.205	R$1.200.000	R$1.440.000	R$176.970	R$2.816.970
2009	R$8.848.476	R$411.454	R$1.061.817	R$7.375.205	R$1.200.000	R$1.440.000	R$176.970	R$2.816.970
2010	R$8.848.476	R$411.454	R$1.061.817	R$7.375.205	R$1.200.000	R$1.440.000	R$176.970	R$2.816.970
2011	R$8.848.476	R$411.454	R$1.061.817	R$7.375.205	R$1.200.000	R$1.440.000	R$176.970	R$2.816.970
2012	R$8.848.476	R$411.454	R$1.061.817	R$7.375.205	R$1.200.000	R$1.440.000	R$176.970	R$2.816.970
2013	R$8.848.476	R$411.454	R$1.061.817	R$7.375.205	R$1.200.000	R$1.440.000	R$176.970	R$2.816.970
2014	R$8.848.476	R$411.454	R$1.061.817	R$7.375.205	R$1.200.000	R$1.440.000	R$176.970	R$2.816.970
2015	R$8.848.476	R$411.454	R$1.061.817	R$7.375.205	R$1.200.000	R$1.440.000	R$176.970	R$2.816.970

Year	Depreciation	Interest	EBTA	Income Tax	Net Income	Investment	Cash Generation	Equity Required
2003	R$0	(R$111.222)	R$0	R$0	R$0	(R$13.500.000)	(R$4.611.222)	R$5.000.000
2004	R$1.112.500	(R$1.718.440)	R$2.167.295	R$605.151	R$1.562.144	(R$5.500.000)	(R$2.825.356)	R$2.825.356
2005	R$1.550.000	(R$1.269.716)	R$1.858.519	R$531.045	R$1.327.474	(R$4.000.000)	(R$3.372.526)	R$3.372.526
2006	R$1.800.000	(R$919.450)	R$1.838.786	R$526.309	R$1.312.477	R$0	R$862.477	R$0
2007	R$1.800.000	(R$569.183)	R$2.189.052	R$610.373	R$1.578.680	R$0	R$1.128.680	R$0
2008	R$1.800.000	(R$218.917)	R$2.539.319	R$694.436	R$1.844.882	R$0	R$1.394.882	R$0
2009	R$1.800.000	R$0	R$2.758.235	R$746.976	R$2.011.259	R$0	R$3.811.259	R$0
2010	R$1.800.000	R$0	R$2.758.235	R$746.976	R$2.011.259	R$0	R$3.811.259	R$0
2011	R$1.800.000	R$0	R$2.758.235	R$746.976	R$2.011.259	R$0	R$3.811.259	(R$927.277)
2012	R$1.800.000	R$0	R$2.758.235	R$746.976	R$2.011.259	R$0	R$3.811.259	(R$1.800.000)
2013	R$1.800.000	R$0	R$2.758.235	R$746.976	R$2.011.259	R$0	R$3.811.259	(R$1.800.000)
2014	R$1.800.000	R$0	R$2.758.235	R$746.976	R$2.011.259	R$0	R$3.811.259	(R$1.800.000)
2015	R$1.800.000	R$0	R$2.758.235	R$746.976	R$2.011.259	R$0	R$3.811.259	(R$1.800.000)

Year	Debt	Amortization	Dividends	Available Cash	Shareholders Cashflow	Carbon Revenue	Total Expected Return	IRR
2003	R$9.000.000	R$0	R$0	R$388.778	(R$5.000.000)	R$0	(R$5.000.000)	-
2004	R$0	R$0	R$0	R$388.778	(R$2.825.356)	R$0	(R$2.825.356)	-
2005	R$0	(R$2.250.000)	R$0	R$388.778	(R$3.372.526)	R$0	(R$3.372.526)	-
2006	R$0	(R$2.250.000)	R$0	R$1.251.255	R$0	R$0	R$0	-
2007	R$0	(R$2.250.000)	R$0	R$2.379.935	R$0	R$0	R$0	-
2008	R$0	(R$2.250.000)	R$2.401.140	R$1.373.677	R$2.401.140	R$0	R$2.401.140	-
2009	R$0	R$0	R$4.184.936	R$1.000.000	R$4.184.936	R$0	R$4.184.936	-10,57%
2010	R$0	R$0	R$3.683.982	R$1.127.277	R$3.683.982	R$0	R$3.683.982	-1,63%
2011	R$0	R$0	R$3.011.259	R$1.000.000	R$3.938.536	R$0	R$3.938.536	4,20%
2012	R$0	R$0	R$2.011.259	R$1.000.000	R$3.811.259	R$0	R$3.811.259	7,91%
2013	R$0	R$0	R$2.011.259	R$1.000.000	R$3.811.259	R$0	R$3.811.259	10,49%
2014	R$0	R$0	R$2.011.259	R$1.000.000	R$3.811.259	R$0	R$3.811.259	12,35%
2015	R$0	R$0	R$2.011.259	R$1.000.000	R$3.811.259	R$0	R$3.811.259	13,73%

Formulae:

Net revenue = Gross Revenues - Sales Taxes
Total costs = Fixed costs + Variable costs + Insurance
EBTA = Net revenue – Total costs – Depreciation – Interest
Net income = EBTA – Income tax
Shareholders' cash-flow = - Equity required + Dividends
Cash generation = Net income + Depreciation + Investment + Debt
Cash available = accrued Cash generation + Equity required

The net present value calculation can also be used to show the economic unattractiveness of SJ. Considering the Total Expected Return above, and the discount rate of 23,29% per year (the average government bond interest in 2003), the net present value calculated is –R$ 4.148.667,44.

For the energy generation sub-unit, the same analysis was carried out. For this sub-unit, the IRR calculated was 15,0%, far from Brazilian bonds interest rate paid averagely through the year 2003. The cash flow is shown in the following Table 3.

Table 3. Cash flow for SJ's energy generation sub-unit

	SJ "energia"												
	1	2	3	4	5	6	7	8	9	10	11	12	13
	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
EBIT		5,8	5,9	6,4	6,5	6,2	6,7	6,7	6,3	5,2	4,3	6,7	8,6
Non Operational													
Depreciation and Amortization	0,0	2,9	3,9	3,9	3,9	3,9	3,9	3,9	3,9	3,9	3,9	1,5	0,7
Working Capital variation	0,0	0,3	(0,0)	0,1	(0,0)	(0,0)	(0,2)	0,0	(0,0)	(0,0)	(0,0)	0,0	0,0
Operational Cash Flow	0,0	8,9	9,8	10,3	10,4	10,0	10,3	10,5	10,2	9,1	8,2	8,2	9,3
Interest	0,0	0,1	0,4	0,6	0,8	1,0	0,6	0,6	0,7	0,5	0,4	0,2	0,1
Equity	(36,8)	(11,1)	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Dividends	0,0	(2,9)	(2,7)	(2,8)	(3,0)	(3,1)	(3,1)	(3,4)	(3,4)	(2,8)	(2,2)	(4,7)	(6,7)
Cash Flow after Investments	(36,8)	(4,9)	7,5	8,1	8,2	8,0	7,8	7,8	7,5	6,9	6,3	3,7	2,7
Disbursement	26,0	11,2	6,6	6,3	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Amortizations (Amort FINIMP)	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	(2,7)	(2,7)	(2,7)	(2,7)	(2,7)
Interest paid (Amort FINIMP)	0,0	(0,0)	(0,5)	(1,2)	(1,6)	(1,6)	(1,6)	(1,6)	(1,5)	(1,2)	(0,9)	(0,7)	(0,4)
Amortizations (BNDES)	0,0	0,0	(1,5)	(1,7)	(1,8)	(1,9)	(2,0)	(2,1)	(0,2)	0,0	0,0	0,0	0,0
Interest paid (BNDES)	0,0	0,0	(0,3)	(0,3)	(0,3)	(0,2)	(0,2)	(0,1)	(0,0)	0,0	0,0	0,0	0,0
Amortizations (Importação)	0,0	(3,3)	(6,6)	(6,3)	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Interest paid (Importação)	0,0	(0,8)	(0,5)	(0,2)	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Amortizations (IGPM)	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	(1,3)	(1,3)	(1,3)	(1,3)	(1,3)
Interest paid (IGPM)	0,0	(0,6)	(0,8)	(0,8)	(0,8)	(0,8)	(0,8)	(0,8)	(0,7)	(0,6)	(0,5)	(0,3)	(0,2)
Cash Flow after Debt	(10,8)	1,5	3,8	3,9	3,7	3,5	3,2	3,2	0,9	1,0	0,9	(1,4)	(2,0)
Income Tax (IR)	0,0	(0,7)	(0,8)	(0,9)	(0,9)	(0,9)	(0,9)	(0,9)	(0,9)	(0,8)	(0,7)	(0,7)	(0,8)
Income Tax (CSLL)	0,0	(0,3)	(0,3)	(0,3)	(0,3)	(0,3)	(0,3)	(0,3)	(0,3)	(0,3)	(0,3)	(0,3)	(0,3)
Capital Increase	14,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Capital Decrease									(3,9)	(4,0)	(4,2)	(4,4)	(4,5)
Net Cash Flow	3,2	0,5	2,7	2,7	2,5	2,3	2,0	2,0	(4,1)	(4,1)	(4,3)	(6,7)	(7,6)

	R$ million												
	2005	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**
EBIT	0	6	6	6	6	6	7	7	6	5	4	7	9
Tax	0,0	(1,0)	(1,1)	(1,2)	(1,2)	(1,2)	(1,2)	(1,2)	(1,2)	(1,1)	(1,0)	(1,0)	(1,1)
Depreciation and Amortization	0	3	4	4	4	4	4	4	4	4	4	1	1
CAPEX	(37)	(11)	0	0	0	0	0	0	0	0	0	0	0
Carbon	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Total Project	(36,80)	(3,45)	8,65	9,03	9,15	8,88	9,30	9,30	8,97	8,04	7,20	7,20	8,21
IRR	15,0%												

In this case, the net present value can also be calculated to show the project would not move forward should the carbon revenue not be in place. In fact, at a discount rate of 23,29% per year, the NPV for SJ energy sub-unit is –R$ 11,94 million.

Sub-step 2d. Sensitivity analysis

Consider Biogás could be more efficient reducing fixed costs. In a very optimistic case, for instance reducing the costs by 30%, the internal rate of return would be increased to 16,15%, which barely approximates the government bonds rate at the end of the year 2003. On the other hand, costs could also go higher, and an increase by 30% would cause the IRR to decline at 11,46%.

For the energy sub-unit, sensitivity analysis was carried out considering earnings increase. In this case, if earnings were considerably increased, becoming 25% bigger, project's IRR would not even reach 20%, being 19,87%. This is not enough to surpass the benchmark threshold of 23,29%, as previously considered. Moreover, even though the government bonds interest rate has declined in the beginning of 2004, it ended the year 2004 upward, which reduces the incentive for equity investment even more. On the contrary, if by any means earnings declined by 25%, IRR would then be 11,1%, not attractive comparing with the benchmark. Therefore, even in a situation where cash generation is increased, the energy sub-unit is not expected to provide an attractive IRR if carbon revenues are not considered.

Step 4. Common practice analysis

Sub-step 4a. Analyze other activities similar to the proposed project activity:
There is no similar project to SJ being carried out in Brazil at the current moment. This will be, in fact, the second largest project of its kind in Brazil, and its counterpart, also developed by Biogás Energia Ambiental, is a CDM project, which does not need to be considered in this analysis. Landfill gas to energy projects are not known in Brazil for there is no local technology available and few experts in the field to apply knowledge in actual projects.

Sub-step 4b. Discuss any similar options that are occurring
Considering there are no similar activities widely observed and commonly carried out, it is not necessary to perform an analysis at this point.

Step 5. Impact of CDM registration
Once SJ is registered as a CDM project, it will be entitled to sell emission reductions from methane destruction to Annex-I countries. Such revenue will contribute to leverage its IRR to the point considered attractive by its investors in a way that the project will be able to operate. Naturally, SJ will have a major impact in bringing new investors to the Brazilian market, as replicability will surely occur in this sort of situation. Moreover, considering most of the equipments are imported, and that the Brazilian economy is highly volatile, it is important to guarantee that foreign-currency investments are well protected against political and economic turmoils. In that sense, revenues from certified emission reductions commercialization, which are widely nominated in euros, will provide a natural hedge to this investment, making the situation more comfortable for the entrepreneurs to move on with the idea.

B.4. Description of how the definition of the project boundary related to the baseline methodology selected is applied to the project activity:

SJ will take place in São João landfill, and the landfill area will be the project's boundary, which includes the gas extraction facilities and the power plant.

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

This baseline study was concluded on 21/12/2005 (DD/MM/ YYYY), by Econergy, which is not a participant in this project. Contact information:

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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:

01/01/2006 (DD/MM/ YYYY)

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

21y 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:

31/03/2006 (DD/MM/ YYYY)

C.2.1.2. Length of the first crediting period:

7y 0m

C.2.2. Fixed crediting period:

C.2.2.1. Starting date:

Left blank on purpose.

C.2.2.2. Length:

Left blank on purpose.

SECTION D. Application of a monitoring methodology and plan

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

The methodology applied to SJ is ACM0001, called "Consolidated baseline methodology for landfill gas project activities".

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

The applicability conditions for ACM0001 have already been considered under the baseline section of this PDD. In fact, SJ is a project activity undertaken with the purpose of capturing and flaring methane from landfill operations, and also using this methane as fuel for a power plant, generating electricity that will avoid fossil fuelled plants at the margin of the Brazilian electricity system, therefore causing a reduction in GHG emissions.

ACM0001 is therefore fully applicable to SJ.

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

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

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

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

>>

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

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

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

>>

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

D.2.2.1. Data to be collected in order to monitor emissions from the project activity, and how this data will be archived:

ID number *(Please use numbers to ease cross-referencing to D.3)*	Data variable	Source of data	Data unit	Measured (m), calculated (c) or estimated (e)	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic/ paper)	Comment
1 LFG_{Total}	Total landfill gas captured	Flow meter to flares and powerhouse	Nm^3	M	Continuous	100%	Electronic	Measured by a flow meter. Data will be aggregated monthly and yearly. Normal cubic meters represent the gas volume in cubic meters at STP. Data will be kept for two years after the end of the crediting period.
2 LFG_{Flare}	Amount of landfill gas to flares	Flow meter to flares	Nm^3	M	Continuous	100%	Electronic	Measured by a flow meter. Data will be aggregated monthly and yearly. Normal cubic meters represent the gas volume in cubic meters at STP. Data will be kept for two years after the end of the crediting period.
3 $LFG_{Electricity}$	Amount of landfill gas to powerhouse	Flow meter to powerhouse	Nm^3	C	Continuous	100%	Electronic	Amount of landfill gas to the powerhouse will be determined by the difference between (1) and (2), above. Data will be kept for two years after the end of the crediting period.
4 FE	Flare combustion efficiency. Determined by the operation hours (1) and the methane content in the exhaust gas (2)	Flare efficiency	%	M / C	(1) continuously, (2) quarterly, monthly if unstable	n/a	Electronic	(1) Continuous measurement of operation time of flare (e.g. with temperature). (2) Periodic measurement of methane content of flare exhaust gas. Data will be kept for two years after the end of the crediting period.
5 w_{CH4}	Methane fraction in the landfill gas	Continuous analyzes	m^3CH_4/m^3 LFG	M	Continuous	100%	Electronic	Measured by continuous gas quality analyzer.
6	Regulatory requirements relating to landfill gas	Environmental legislation	Test	n/a	-	100%	Electronic	

	projects							
7	Electricity fed into grid	Electricity meter	MWh	M	Continuous	100%	Electronic	Electricity fed into the grid will be measured as to determine emission reductions from renewable electricity generation and commercialization. Data will be kept for two years after the end of the crediting period.
8	CO_2 emission intensity of the electricity	Brazilian grid	tCO_2/MWh	C	Once at project start and then at each baseline renewal	100%	Electronic	CO_2 emission intensity of the electricity being generated by the grid will be determined through an approved baseline methodology, which is ACM0002. This data will be updated at the baseline renewal, in accordance with the considered methodology. Please refer to annex 3 – baseline determination, for how the emission factor will be determined. Data will be kept for two years after the end of the crediting period.

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

SJ will generate no emissions since it will use project-generated electricity to operate the landfill gas project, including the pumping equipment for the collection system and energy required to transport heat.

D.2.3. Treatment of leakage in the monitoring plan

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

ID number *(Please use numbers to ease cross-referencing to table D.3)*	Data variable	Source of data	Data unit	Measured (m), calculated (c) or estimated (e)	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic/ paper)	Comment
								No leakage under ACM0001.

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

No leakage under ACM0001.

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

Methane destruction: $ER = (MD_{project} - MD_{reg}) * GWP_{CH_4}$ $MD_{reg} = MD_{project} * AF$ $MD_{project} = MD_{flared} + MD_{electricity}$ $MD_{flared} = LFG_{flare} * w_{CH_4} * D_{CH_4} * FE$ $MD_{electricity} = LFG_{electricity} * w_{CH_4} * D_{CH_4}$	ER are the emission reductions; $MD_{project}$ is the amount of methane actually destroyed/combusted during the year; MD_{reg} is the methane that would have been destroyed/combusted during a year in the absence of the project activity; GWP_{CH4} is the approved global warming potential value for methane (considered 21 throughout SJ's lifetime for the purpose of estimating emission reductions); EG is net quantity of electricity displaced; and $CEF_{electricity}$ is the CO_2 emissions intensity of the electricity displaced. Considering there is no regulatory or contractual requirement determining MD_{reg}, an Effectiveness Adjustment Factor - EAF of 20% is used in SJ's case. MD_{flared} is the quantity of methane destroyed by flaring (tCH_4), LFG_{flare} is the quantity of landfill gas flared during a year measured in normal cubic meters (Nm^3), w_{CH4} is the average methane fraction of the landfill gas as measured during a year and expressed as a fraction CH_4 volume per LFG volume, FE is the flare efficiency (the fraction of the methane destroyed) and D_{CH4} is the methane density expressed in tonnes of methane per cubic meter of methane (tCH_4/m^3CH_4), measured at STP. This value is in fact 0.0007168 tCH_4/Nm^3CH_4. $MD_{electricity}$ is the quantity of methane destroyed by generation of electricity and $LFG_{electricity}$ is the quantity of landfill gas fed into electricity generator.

Electricity displacement: $ER_y = BE_{thermal,y} + BE_{electricity,y} - PE_y - L_y$ $BE_{thermal,y} = 0$ $PE_y = 0$ $L_y = 0$ $BE_{electricity,y} = EF_{electricy} * EG_y$	*ERy:* are the emissions reductions of the electricity displacement part during the year y in tons of CO_2. *BEelectricity,y:* Are the baseline emissions due to displacement of electricity during the year y in tons of CO_2. *BEthermal,y:* Are the baseline emissions due to displacement of thermal energy during the year y in tons of CO_2. *PEy:* Are the project emissions during the year y in tons of CO_2. *Ly:* Are the leakage emissions during the year y in tons of CO_2.

D.3. Quality control (QC) and quality assurance (QA) procedures are being undertaken for data monitored		
Data *(Indicate table and ID number e.g. 3.-1.; 3.2.)*	Uncertainty level of data (High/Medium/Low)	Explain QA/QC procedures planned for these data, or why such procedures are not necessary.
1-3 LFG	Low	Flow meters will be subject to a regular maintenance and testing regime to ensure accuracy.
4 FE	Medium	Regular maintenance will ensure optimal operation of flares. Flare efficiency should be checked quarterly, with monthly checks if the efficiency shows significant deviations from previous values.
5 w_{CH4}	Low	The gas analyzer will be subject to a regular maintenance and testing regime to ensure accuracy.
7	Low	Electricity meter will be calibrated periodically to ensure accuracy.

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

Both the gas plant and the energy plant will have specific operators in charge of checking the gas flared, gas sent to engines, and electricity generated. Such personnel is responsible for getting relevant information from both units monitoring systems. Monthly reports will consider the main factors as well as emission reductions calculated in accordance with this PDD.

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

Econergy is the entity determining the monitoring methodology. Econergy is not a participant in this project. Contact information:

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SECTION E. Estimation of GHG emissions by sources

E.1. Estimate of GHG emissions by sources:

SJ will generate no emissions since it will use project-generated electricity to operate the landfill gas project, including the pumping equipment for the collection system and energy required to transport heat.

E.2. Estimated leakage:

No leakages under ACM0001.

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

$E1 + E2 = 0$. Therefore, project emissions are zero.

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

Methane Destruction:

GHG emissions by sources in the baseline were estimated using IPCC's guidelines[2]. In the case of SJ, the first order decay approach was used:

$$Q = L_0 R(e^{-kc} - e^{-kt}) \quad \textbf{(1)}$$

Where:
Q = methane generated in current year (t/yr)
L_0 = methane generation potential (t/t of refuse)
R = average annual waste acceptance rate during active life (t/yr)
k = methane generation rate constant (1/yr)
c = time since solid waste disposal site (SWDS) closure (yr)
t = time since SWDS opened (yr)

However, considering waste disposal varies among years, IPCC recommends a slightly changed way to perform such estimations, in order to take into account such variances:

$$Q_{T,x} = kR_x L_0 e^{-k(T-x)} \quad \textbf{(2)}$$

Where:
$Q_{T,x}$ = the amount of methane generated in current year (T) by the waste R_x
X = the year of waste input
R_x = the amount of waste disposed in year x (t)
T = current year

[2] Revised 1996 IPCC Guidelines for National Greenhouse Gases Inventory.

With that in mind, one has to perform a sum in order to account for all the methane to be generated by each ton of waste, according to the deposition year. This fact can be expressed, according to the last equation presented, as:

$$Q_T = \sum Q_{T,x} \quad \textbf{(3)}$$

Where Q_T is the total amount of methane to be generated in the landfill during a certain timeframe.
To summarize, relevant factors for methane estimation are:

- Year the waste site opened
- Year the waste site closed
- Amount of waste disposed in the site in a given year
- Methane generation rate constant (k)
- Methane generation potential (L_0)

All the above information, but the disposal rate, is given in the table in section B.3. The waste disposed in each year since the site opened is shown in Table 4.

Table 4. Yearly waste disposal in São João landfill

Year	Waste Deposition (tonnes)	Year	Waste Deposition (tonnes)
1992	5.500	2000	2.034.546
1993	768.591	2001	2.157.783
1994	862.211	2002	2.292.821
1995	1.516.727	2003	2.120.943
1996	1.841.783	2004	2.008.528
1997	1.971.480	2005	2.200.000
1998	2.046.081	2006	2.200.000
1999	2.126.986	2007-on	0

Note: Waste disposing finishes in 2006.

Considering nowadays some landfill gas is inefficiently flared at the top of wells' heads after being passively collected as to address safety and odour concerns, an Effectiveness Adjustment Factor (EAF) has to be used to account for this situation in accordance with ACM0001. In this case, it is estimated that around 20% of the methane passively collected can be flared under such poor combustion conditions (the default EAF). Therefore:

$$Baseline_{methane+destruction} = \sum Q_{T,x} - 0{,}2 * \sum Q_{T,x} = 0{,}8 * \sum Q_{T,x}$$

Applying the above information, along with proper values for k and L_0, in equation (2), the following table with estimated emissions in the baseline, for the first crediting period, can be drawn:

Table 5. Methane Baseline emissions estimate for SJ

Year	Methane Emissions (tCO_2e)
2006	1.417.852
2007	1.276.527
2008	1.149.288
2009	1.034.732
2010	931.595
2011	838.738
2012	755.136

Therefore, for the first crediting period, baseline emissions should be near 7,4 million tCO_2e.

Electricity Displacement:

The baseline case regarding the electricity displacement part of the project is the GHG emission from electricity generation by the various Brazilian power plants, generating the same amount of electricity SJ is producing at the margin of the electricity system. At the grid's margin, the electricity generated is associated with a carbon emission factor, due to fossil fuelled generators operating.

ACM0002, the baseline methodology chosen for the emission factor calculation, considers the determination of the emissions factor for the grid to which the project activity is connected as the core data to be determined in the baseline scenario. In Brazil, there are two main grids, South-Southeast-Midwest and North-Northeast, therefore the South-Southeast-Midwest Grid is the relevant one for this project.

The method that will be chosen to calculate the Operating Margin (OM) for the electricity baseline emission factor is the option (b) *Simple Adjusted OM,* since the preferable choice (c) *Dispatch Data Analysis OM* would face the barrier of data availability in Brazil.

In order to calculate the Operating Margin, daily dispatch data from the Brazilian electricity system manager (ONS) needed to be gathered. ONS does not regularly provide such information, which implied in getting it through communicating directly with the entity.

The provided information comprised years 2002, 2003 and 2004, and is the most recent information available at this stage (At the end of 2005 ONS supplied raw dispatch data for the whole interconnected grid in the form of daily reports[3] from Jan. 1, 2002 to Dec. 31, 2004, the most recent information available at this stage).

Simple Adjusted Operating Margin Emission Factor Calculation

According to the methodology, the project is to determine the Simple Adjusted OM Emission Factor ($EF_{OM,\ simple\ adjusted,\ y}$). Therefore, the following equation is to be solved:

---

[3] *Acompanhamento Diário da Operação do Sistema Iterligado Nacional*. ONS-CNOS, Centro Nacional de Operação do Sistema. Daily reports on the whole interconnected electricity system from Jan. 1, 2001 to Dec. 31, 2003.

$$EF_{OM,simple\_adjusted,y} = (1-\lambda_y)\frac{\sum_{i,j} F_{i,j,y}.COEF_{i,j}}{\sum_j GEN_{j,y}} + \lambda_y \frac{\sum_{i,k} F_{i,k,y}.COEF_{i,k}}{\sum_k GEN_{k,y}} \ (tCO_2e/GWh)$$

It is assumed here that all the low-cost/must-run plants produce zero net emissions.

$$\frac{\sum_{i,k} F_{i,k,y}.COEF_{i,k}}{\sum_k GEN_{k,y}} = 0 \ (tCO_2e/GWh)$$

Please refer to the methodology text or the explanations on the variables mentioned above.

The ONS data as well as the spreadsheet data with the calculation of emission factors have been provided to the validator (DOE). In the spreadsheet, the dispatch data is treated as to allow calculation of the emission factor for the most three recent years with available information, which are 2002, 2003 and 2004.

The Lambda factors were calculated in accordance with methodology requests. More detailed information is provided in Annex 3. The table below presents such factors.

Year	Lambda
2002	0,5053
2003	0,5312
2004	0,5041

Electricity generation for each year needs also to be taken into account. This information is provided in the table below.

Year	Electricity Load (MWh)
2002	275.402.896
2003	288.493.929
2004	297.879.874

Using therefore appropriate information for $F_{i,j,y}$ and $COEF_{i,j}$, OM emission factors for each year can be determined, as follows.

$$EF_{OM,simple\_adjusted,2002} = (1-\lambda_{2002})\frac{\sum_{i,j} F_{i,j,2002}.COEF_{i,j}}{\sum_j GEN_{j,2002}} \therefore EF_{OM,simple\_adjusted,2002} = 0{,}4207 \ tCO_2/MWh$$

$$EF_{OM,simple\_adjusted,2003} = (1-\lambda_{2003})\frac{\sum_{i,j} F_{i,j,2003}.COEF_{i,j}}{\sum_j GEN_{j,2003}} \therefore EF_{OM,simple\_adjusted,2003} = 0{,}4397 \ tCO_2/MWh$$

$$EF_{OM,simple\_adjusted,2004} = (1-\lambda_{2004})\frac{\sum_{i,j} F_{i,j,2004}.COEF_{i,j}}{\sum_{j} GEN_{j,2004}} \therefore EF_{OM,simple\_adjusted,2004} = 0{,}4327 \text{ tCO}_2\text{/MWh}$$

Finally, to determine the baseline *ex-ante*, the mean average among the three years is calculated, finally determining the $EF_{OM,simple\_adjusted}$.

$$EF_{OM,simple\_adjusted\ 2002\_2004} = 0{,}4310 \text{ tCO}_2\text{/MWh}$$

According to the methodology used, a Build Margin emission factor also needs to be determined.

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

Electricity generation in this case means 20% of total generation in the most recent year (2004), as the 5 most recent plants built generate less than such 20%. Calculating such factor one reaches:

$$EF_{BM,2004} = 0{,}1045 \text{ tCO}_2\text{/MWh}$$

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. That gives:

$$EF_{electricity,2002-2004} = 0{,}5 * 0{,}4310 + 0{,}5 * 0{,}1045 = 0{,}2677 \text{ tCO}_2\text{/MWh}$$

It is important to note that adequate considerations on the above weights are currently under study by the Meth Panel, and there is a possibility that such weighing changes in the methodology applied here.

The baseline emissions would be then proportional to the electricity delivered to the grid throughout the project's lifetime. Baseline emissions due to displacement of electricity are calculated by multiplying the electricity baseline emissions factor ($EF_{electricity,2002\text{-}2004}$) with the electricity generation of the project activity.

$BE_{electricity,y} = EF_{electricity,2002\text{-}2004} \,.\, EG_y$

Therefore, for the first crediting period, the baseline emissions will be calculated as follows:

$BE_{electricity,y}$ = 0,2677 tCO_2/MWh . EG_y (in tCO_2e)

EG is the same amount of energy SJ will generate. Moreover, considering the operating conditions (8.560 hours/yr, 90% capacity factor and 20MW installed capacity) of the power station, baseline emissions could be forecasted as shows Table 6.

Table 6. Electricity displacement baseline emissions

Year	Baseline Emissions (tCO_2e)
2006	41.247
2007	41.247
2008	41.247
2009	41.247
2010	41.247
2011	41.247
2012	41.247

By that, in the first crediting period, baseline emissions for the electricity displacement part would total 288,7 thousand tCO_2e.

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

Methane Destruction:

The conservative approach to determine the emission reductions must also take into account the future efficiency of the gas extraction facility, as not all the estimated gas will flow into the gas treatment unit. It's estimated that roughly 80% of the total generated gas will be extracted using active collection systems such as the one to be installed in São João. Therefore, the emission reductions estimates from methane destruction are the avoided baseline emissions, considering the extraction efficiency:

$$ER_{methane\_destruction} = EAF * col\_efficiency * \sum Q_{T,x} = 0{,}64 * \sum Q_{T,x}$$

Naturally, considering the emission reductions will be measured, all the methane flared, discounted by the EAF, will be counted as emission reductions.

Considering all such hypothesis, emission reductions from methane destruction shall amount to around 5,8 million tCO_2e in the first crediting period.

Electricity Displacement:

Considering SJ generates no GHG emissions when generating electricity, as biogas is a renewable source, emission reductions are:

$ER_{electricity} = EG * CEF = EG * 0{,}2677$, where the emission intensity of the electricity being displaced, calculated in accordance with ACM0002, is 0,2677 tCO_2e/MWh for the first crediting period.

Considering the generation perspective as put in section E.4., emission reductions from electricity displacement should amount to 288.731 tCO_2e during the first crediting period.

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

Year	Estimation of project activity emission reductions (tonnes of CO_2e)	Estimation of the baseline emission reductions (tonnes of CO_2e)	Estimation of leakage (tonnes of CO_2e)	Estimation of emission reductions (tonnes of CO_2e)
2006	1.175.528	0	0	1.175.528
2007	1.062.468	0	0	1.062.468
2008	960.678	0	0	960.678
2009	869.033	0	0	869.033
2010	786.523	0	0	786.523
2011	712.237	0	0	712.237
2012	645.356	0	0	645.356
Total (tonnes of CO_2e)	6.211.825	0	0	6.211.825

Summing up the above estimates, SJ is predicted to reduce the emissions of 6,21 million tCO_2e in the first crediting period.

SECTION F. Environmental impacts

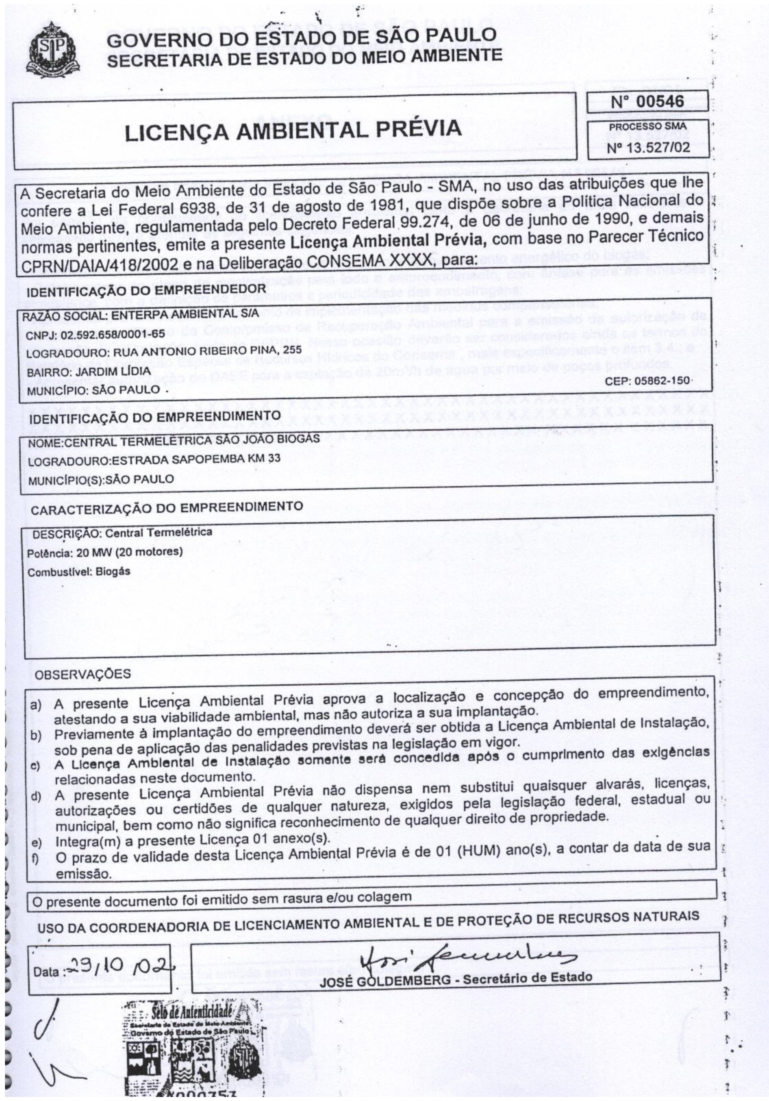
F.1. Documentation on the analysis of the environmental impacts, including transboundary impacts:

Environmental impacts from project initiatives are to be analyzed by the State Secretary of Environment (*SMA – Secretaria de Estado do Meio Ambiente*) through its department for environmental impact assessment (DAIA) and state of São Paulo environmental agency (CETESB).

For SJ, a preliminary environmental report (RAP) was prepared, in accordance with state of São Paulo environmental legislation. This has been submitted to SMA for appraisal and questionings. After being analyzed by DAIA, a statement was forwarded to the developer, allowing it to proceed with the project and apply for the installation license. This will be issued by CETESB, after it makes further considerations on the project through the RAP.

SJ has been granted a preliminary environmental license. It attests the project has been assessed by the environmental authorities, with no major impacts predicted. Nevertheless, as seen in figure 2, the license requests the project developers to design more detailed documentation, especially regarding monitoring of gaseous emissions, in order to have the installation license issued. The license is shown in figures 2 and 3.

There will be no transboundary impacts resulting from SJ. All the relevant impacts occur within Brazilian borders and will be mitigated to comply with the environmental requirements for project's implementation.



GOVERNO DO ESTADO DE SÃO PAULO
SECRETARIA DE ESTADO DO MEIO AMBIENTE

LICENÇA AMBIENTAL PRÉVIA

N° 00546

PROCESSO SMA
Nº 13.527/02

A Secretaria do Meio Ambiente do Estado de São Paulo - SMA, no uso das atribuições que lhe confere a Lei Federal 6938, de 31 de agosto de 1981, que dispõe sobre a Política Nacional do Meio Ambiente, regulamentada pelo Decreto Federal 99.274, de 06 de junho de 1990, e demais normas pertinentes, emite a presente **Licença Ambiental Prévia,** com base no Parecer Técnico CPRN/DAIA/418/2002 e na Deliberação CONSEMA XXXX, para:

IDENTIFICAÇÃO DO EMPREENDEDOR

RAZÃO SOCIAL: ENTERPA AMBIENTAL S/A
CNPJ: 02.592.658/0001-65
LOGRADOURO: RUA ANTONIO RIBEIRO PINA, 255
BAIRRO: JARDIM LÍDIA
MUNICÍPIO: SÃO PAULO
CEP: 05862-150

IDENTIFICAÇÃO DO EMPREENDIMENTO

NOME:CENTRAL TERMELÉTRICA SÃO JOÃO BIOGÁS
LOGRADOURO:ESTRADA SAPOPEMBA KM 33
MUNICÍPIO(S):SÃO PAULO

CARACTERIZAÇÃO DO EMPREENDIMENTO

DESCRIÇÃO: Central Termelétrica
Potência: 20 MW (20 motores)
Combustível: Biogás

OBSERVAÇÕES

a) A presente Licença Ambiental Prévia aprova a localização e concepção do empreendimento, atestando a sua viabilidade ambiental, mas não autoriza a sua implantação.
b) Previamente à implantação do empreendimento deverá ser obtida a Licença Ambiental de Instalação, sob pena de aplicação das penalidades previstas na legislação em vigor.
c) A Licença Ambiental de Instalação somente será concedida após o cumprimento das exigências relacionadas neste documento.
d) A presente Licença Ambiental Prévia não dispensa nem substitui quaisquer alvarás, licenças, autorizações ou certidões de qualquer natureza, exigidos pela legislação federal, estadual ou municipal, bem como não significa reconhecimento de qualquer direito de propriedade.
e) Integra(m) a presente Licença 01 anexo(s).
f) O prazo de validade desta Licença Ambiental Prévia é de 01 (HUM) ano(s), a contar da data de sua emissão.

O presente documento foi emitido sem rasura e/ou colagem

USO DA COORDENADORIA DE LICENCIAMENTO AMBIENTAL E DE PROTEÇÃO DE RECURSOS NATURAIS

Data : 23/10/02

JOSÉ GOLDEMBERG - Secretário de Estado

Selo de Autenticidade
Secretaria de Estado do Meio Ambiente
Governo do Estado de São Paulo

Figure 2. Preliminary environmental license for SJ (page 1 of 2)

GOVERNO DO ESTADO DE SÃO PAULO
SECRETARIA DE ESTADO DO MEIO AMBIENTE

ANEXO

Fls 01/01

PROCESSO SMA
Nº 13.527/02

O presente anexo é parte integrante da LICENÇA AMBIENTAL PRÉVIA N º 00546

Por ocasião da continuidade do licenciamento ambiental junto a Secretaria do Meio Ambiente o interessado deverá atender as seguintes exigências:

- Detalhamento do projeto básico da unidade de captação e aproveitamento energético do biogás;
- Detalhamento do plano de monitorização para todo o empreendimento, com ênfase para as emissões atmosférica, com a definição de parâmetros e periodicidade das amostragens;
- Apresentar plano de acompanhamento da implementação das medidas compensatórias;
- Assinatura do Termo de Compromisso de Recuperação Ambiental para a emissão da autorização de supressão de vegetação, junto ao DEPRN. Nessa ocasião deverão ser considerados ainda os termos do Relatório da Comissão Especial de Recursos Hídricos do Consema , mais especificamente o item 3.4.; e
- Apresentar autorização do DAEE para a captação de 20m³/h de água por meio de poços profundos.

XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX XXXXXX XXXXXX
X

O presente documento foi emitido sem rasura e/ou colagem

Selo de Autenticidade
Secretaria de Estado do Meio Ambiente
Governo do Estado de São Paulo

Figure 3. Preliminary environmental license for SJ (page 2 of 2)

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

As already mentioned, Aterro Sanitário Sítio São João, the landfill where SJ will take place, has been designed with modern engineering practices that put it as a well-managed landfill under state of São Paulo environmental agency (CETESB) assessment.

Nevertheless, operation of a degasifying unit, with intention to flare the gas, either in flare equipment or in engines for energy generation, may cause gaseous emissions such as volatile organic compounds and dioxins that have to be analyzed. This is not expected to happen considering the landfill gas goes through a treatment prior to be flared, and similar conditions have already been successfully applied by the project developer at its other landfill gas to energy project in Brazil.

It's important to consider, after all, that the project will only be operating with its working license in place, after the necessary studies, as required by the environmental agency, have taken place. In any case, measures will be taken also after the project implementation and operation if that's required by the agency.

SECTION G. Stakeholders' comments

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

Invitation for comments by local stakeholders is required by the Brazilian Designated National Authority as part of the procedures for analyzing CDM projects and issuing letters of approval. This procedure is the one that will be followed by Biogás to take its GHG mitigation initiative to the public.

In its first resolution, the DNA required project participants to communicate with the public through letters, to be sent inviting for comments to:

- The Brazilian national NGO's forum;
- The local attorneys' and prosecutors' agency;
- The municipality's chamber (mayor and assemblymen);
- State's and municipal's environmental authorities;
- Local communities' associations.

The project developers have submitted such letters.

G.2. Summary of the comments received:

From the above stakeholders, only one provided comments on SJ. This was the state of São Paulo environmental agency, CETESB – Companhia de Tecnologia de Saneamento Ambiental. The letter was signed by Mr. JoãoWagner Alves, manager of CETESB's global issues division.

In the letter, Mr. João Wagner makes a brief introduction to climate change and to the potential methane has in enhancing the warming effect in the atmosphere, while also referring to the Brazilian national GHG inventory. Mr. Wagner also provides a definition for biogas, and the methane content in it under different circumstances.

In the letter, Mr. Wagner also points out that the better way to avoid methane emissions is to avoid waste generation, recommending reuse and recyling, pointing also that, if correctly managed, landfill waste

deposition is feasible. In the end, he remembers that CETESB has already assessed São João landfill and has qualified it with a 8,3 grade in 2004, meaning the landfill is adequately managed.
To finalize, Mr. Wagner makes two suggestions:

- To evaluate plausible alternatives to the energetic use of the biogas that make use of national available technology;
- To evaluate fomenting initiatives such as reuse, recycling and other waste management practices, such as composting, to mitigate global warming.

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

Project participants provided a feedback on the letter through an e-mail message. In such message, the participants clarified that equipment selection would be made taking into account the socio-environmental and economic performance of the project, remembering that so far not all the necessary technology for degassying landfills is available through national suppliers. And if this is bad on one hand, on the other hand the so-called technology transfer will necessarily be in place for project implementation and operation, achieving one of the CDM goals.

Regarding waste reuse, recycling and other measures to avoid GHG emissions, project participants stated that such measures must definitely be in place. Participants highlighted that emission reductions revenues from SJ will be shared equally by the project developers and São Paulo municipality, meaning the environmental authorities will have available resources from the CDM initiative to invest in such "GHG-free" ideas. Finally, project participants also mentioned that, due to the fact that the waste is already disposed in São João landfill, the gas is already being produced, and therefore any measures by the municipality towards reuse, recycling and composting will have no effect on the GHG generation at the site.

Later, Mr. Wagner called Econergy to thank for the feedback.

Annex 1

CONTACT INFORMATION ON PARTICIPANTS IN THE PROJECT ACTIVITY

Organization:	Biogás Energia Ambiental S/A
Street/P.O.Box:	Rua Guararapes, 1909 – 4o. andar – cj 41 Brooklin
Building:	
City:	São Paulo
State/Region:	SP
Postfix/ZIP:	04561-004
Country:	Brazil
Telephone:	+55 (11) 5505 5533
FAX:	+55 (11) 5505 4090
E-Mail:	energia@biogas-ambiental.com.br
URL:	www.logoseng.com.br/biogas
Represented by:	
Title:	Director
Salutation:	Mr
Last Name:	Avelino da Silva
Middle Name:	Antônio
First Name:	Manuel
Department:	Administration
Mobile:	+55 (11) 9913 7759
Direct FAX:	+55 (11) 3117 3179
Direct tel:	+55 (11) 3117 3171 ext. 121
Personal E-Mail:	maaas@logoseng.com.br

Organization:	Municipality of São Paulo
Street/P.O.Box:	Rua do Paraíso, 387 3rd floor - Paraíso
Building:	
City:	São Paulo
State/Region:	SP
Postfix/ZIP:	04103-000
Country:	Brazil
Telephone:	+55 (11) 3372 2205
FAX:	+55 (11) 3372 2200
E-Mail:	
URL:	www.prefeitura.sp.gov.br
Represented by:	
Title:	Secretary of Green and Environment
Salutation:	Mr
Last Name:	Alves Sobrinho
Middle Name:	Martins
First Name:	Eduardo Jorge
Department:	Green and Environment Secretary
Mobile:	

Direct FAX:	
Direct tel:	
Personal E-Mail:	eduardojorge@prefeitura.sp.gov.br

Annex 2

INFORMATION REGARDING PUBLIC FUNDING

There is no public funding involved in SJ.

Annex 3

BASELINE INFORMATION

Year	Waste Deposition (tonnes)	Year	Waste Deposition (tonnes)
1992	5.500	2000	2.034.546
1993	768.591	2001	2.157.783
1994	862.211	2002	2.292.821
1995	1.516.727	2003	2.120.943
1996	1.841.783	2004	2.008.528
1997	1.971.480	2005	2.200.000
1998	2.046.081	2006	2.200.000
1999	2.126.986	2007-on	0
First Order Decay Model Factors			
Lo (tCH_4/t refuse)	0,065	k	0,105

The above factors were determined from Van der Wiel analysis of the landfill gas potential in São João landfill. The Dutch firm has great experience in the field and has designed its own model for estimation. However, as ACM0001 requires the application of a publicly known model, Van der Wiel's analyses were adapted to IPCC's first order decay model, using the above factors under a conservative approach, i.e., which leads to a smaller emission reduction estimate

Methane Destruction Emission Reductions

Year	Emission Reductions (tCO_2e)
2006	1.134.281
2007	1.021.221
2008	919.431
2009	827.786
2010	745.276
2011	670.990
2012	604.109

Electricity Displacement Emission Reductions

Year	Emission Reductions (tCO_2e)
2006	41.247
2007	41.247
2008	41.247
2009	41.247
2010	41.247
2011	41.247
2012	41.247

Total Emission Reductions

Year	Emission Reductions (tCO_2e)
2006	1.175.529
2007	1.062.469
2008	960.678
2009	869.033
2010	786.523
2011	712.237
2012	645.356

The Brazilian electricity system has been historically divided into two subsystems: the North-Northeast (N-NE) and the South-Southeast-Midwest (S-SE-CO). 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)[4]:

"… where the Brazilian Electricity System is divided into three separate subsystems:
(i) The South/Southeast/Midwest Interconnected System;

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[4] Bosi, M. *An Initial View on Methodologies for Emission Baselines: Electricity Generation Case Study*. International Energy Agency. Paris, 2000.

(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'".

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 methodology ACM0002 asks project proponents to account for "all generating sources serving the system". In that way, when applying one of these methodologies, 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 "Road-Testing Baselines For Greenhouse Gas Mitigation Projects in the Electric Power Sector", published in October 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, as the table below shows the build margin in both cases.

IEA/ONS Merged Data Build Margin (tCO_2/MWh)	**ONS Data Build Margin (tCO_2/MWh)**
0,205	0,1045

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 fossil fueled plants efficiencies were also taken from the IEA paper. This was done considering the lack of more detailed information on such efficiencies from public, reliable and credible sources.

From the mentioned reference:

> *The fossil fuel conversion efficiency (%) for the thermal power plants was calculated based on the installed capacity of each plant and the electricity actually produced. For most of the fossil fuel power plants under construction, a constant value of 30% was used as an estimate for their fossil fuel conversion efficiencies. This assumption was based on data available in the literature and based on the observation of the actual situation of those kinds of plants currently in operation in Brazil. The only 2 natural gas plants in combined cycle (totaling 648 MW) were assumed to have a higher efficiency rate, i.e. 45%.*

Therefore only data for plants under construction in 2002 (with operation start in 2002, 2003 and 2004) was estimated. All others efficiencies were calculated. To the best of our knowledge there was no retrofit/modernization of the older fossil-fuelled power plants in the analyzed period (2002 to 2004). For that reason project participants find the application of such numbers to be not only reasonable but the best available option.

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.

On the following pages, a summary of the analysis is provided. First, the table with the 130 plants dispatched by the ONS are provided. Then, a table with the summarized conclusions of the analysis, with the emission factor calculation displayed. Finally, the load duration curves for the S-SE-MW system are presented.

ONS Plants

	Subsystem*	Fuel source**	Power plant	Operation start [2, 4, 5]	Installed capacity (MW) [1]	Fossil 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
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).

Summary Table

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

Baseline (including imports)	EF_{OM} [tCO2/MWh]	Load [MWh]	LCMR [GWh]	Imports [MWh]
2002	0,8504	275.402.896	258.720	1.607.395
2003	0,9378	288.493.929	274.649	459.586
2004	0,8726	297.879.874	284.748	1.468.275
	Total (2001-2003) =	**861.776.699**	**818.118**	**3.535.256**
	$EF_{OM, simple-adjusted}$ [tCO2/MWh]	**$EF_{BM,2004}$**	**Lambda**	
	0,4310	0,1045	λ_{2002}	
	Alternative weights	**Default weights**	0,5053	
	w_{OM} = 0,75	w_{OM} = 0,5	λ_{2003}	
	w_{BM} = 0,25	w_{BM} = 0,5	0,5312	
	EF_{CM} [tCO2/MWh]	**Default EF_{OM} [tCO2/MWh]**	λ_{2004}	
	0,3494	0,2677	0,5041	

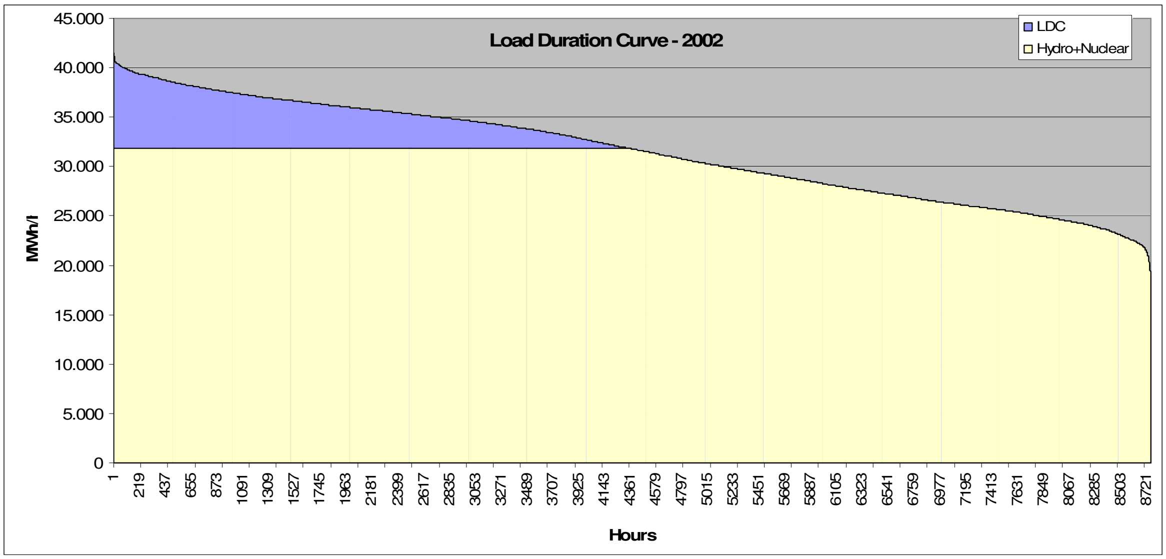

Figure 3. Load duration curve for the S-SE-MW system, 2002

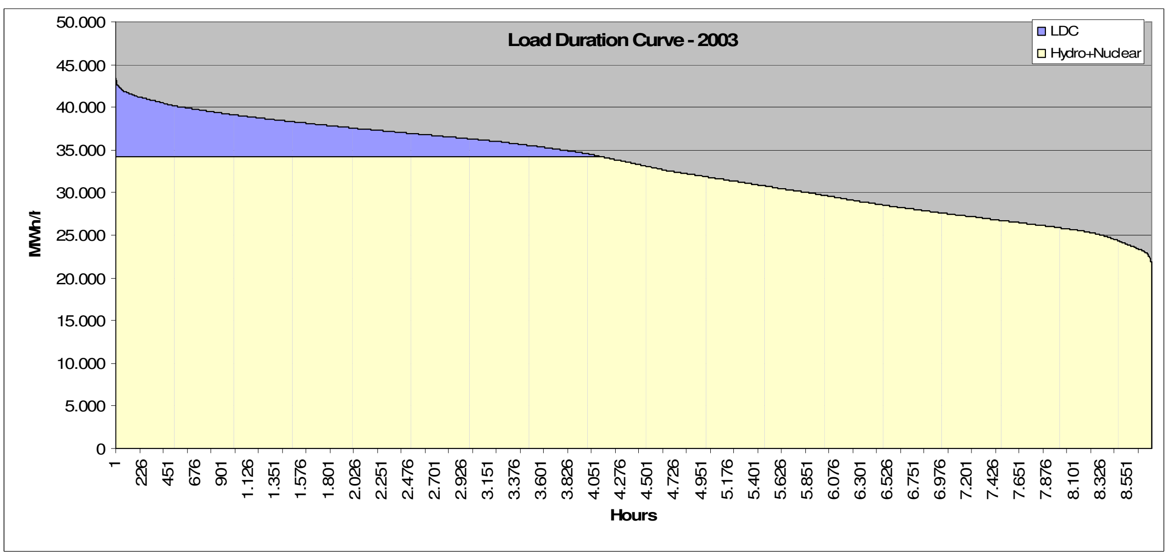

Figure 4. Load duration curve for the S-SE-MW system, 2003

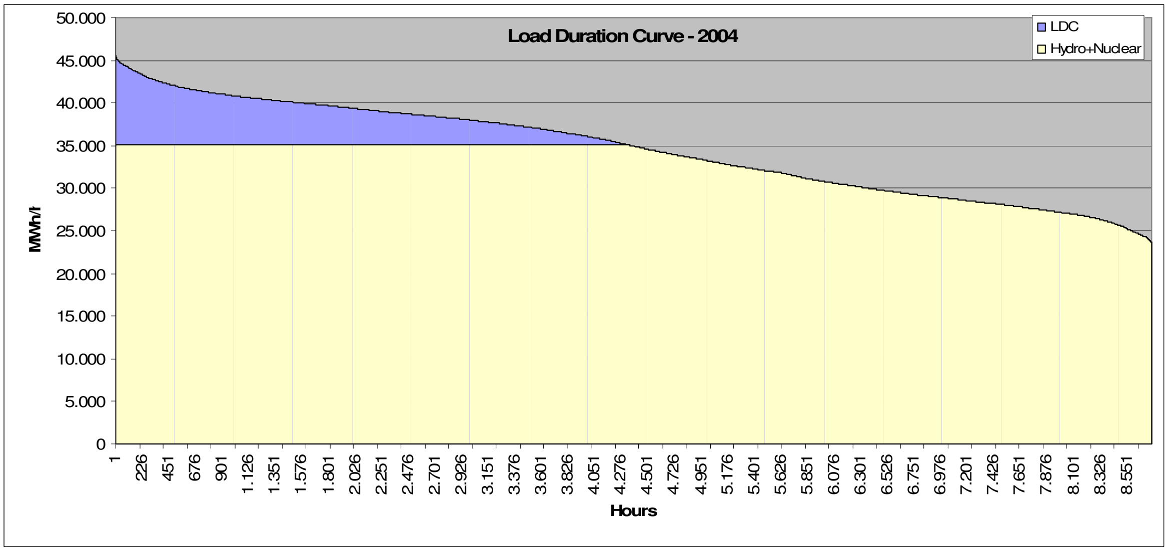

Figure 5. Load duration curve for the S-SE-MW system, 2004

Annex 4

MONITORING PLAN

From the monitoring methodology, it could be seen that there are five main variables to be measured:

- Methane flow from the landfill
- Methane flow into flares
- Methane flow into powerhouse
- Methane content in the landfill gas
- Flares' efficiencies
- Electricity sent to the grid

The degasifying unit of SJ will be installed with most up-to-date equipment to perform measures continually and allow for remote access to equipment and data. The system equipments will be connected through a Programmable Logic Control tool that will let operators quickly check the unit's main variables through a user-friendly interface. Through the PLC, users will have also access to continuously measured data, such as methane content in the landfill gas and the methane flows.

Methane flows:

There will be two flow meters installed for SJ operation: one in the main line straight after the blowers; and one in the line to the flares. Methane destroyed in the powerhouse will therefore be measured by the difference between the two above. Both will be the same model, likely the same used at Biogás other landfill gas to energy project: Instromet B.V SM-RI-X-K, which will be calibrated before entering in operation. The flow meters will be connected to the gas facilities PLC, and data will be recorded continuously. Moreover, the meters will be sealed, which prevent data manipulation.

Attached to each of the flow meters will be an electronic volume conversion device, which converts the volume measured by the flow meter to volume at 0^oC and 1,01325 bar, i.e., the STP. These devices will also be calibrated.

Methane content in LFG:

Methane content in the LFG is critical in SJ, since it will be the fuel to the powerhouse and therefore its concentration will lately determine the amount of electricity that can be generated. For measuring this information, SJ will count on a continuous analyzer (at its other project, Biogás has used a BINOS 100, manufactured by NUK, a German supplier). The analyzer will also be connected to the data system through the PLC, with information easily accessible through a desktop computer.

Flares' efficiencies:

SJ will be designed to ensure complete methane destruction at the installed flares. Nevertheless, complying with the monitoring methodology applied in this case, project owners will hire specialists to carry out exhaust gases analyses in order to determine if any methane is not being flared and, if so, how much of the gas is being released to the atmosphere.

Electricity sent to the grid:
Electricity generated at the powerhouse will be monitored both internally, by the meter installed at the output of the facility, and externally, at the electricity distributor sub-station. In both cases, the meters will be calibrated and will comply with regulatory standards for energy commercialization in Brazil.

Biogás will generate monthly reports covering all such information, but the flares efficiencies, which will be determined on a less often basis. Such reports will be delivered to the verifier for means of writing the verification report. Some of the included information will be:

- Total energy generation
- Exported energy
- Internally consumed energy
- Total extracted biogas
- Total biogas destroyed in flares
- Total biogas destroyed in engines
- Monthly average methane content in biogas
- Monthly average hourly extracted volumes of biogas
- Emission reductions from destroyed methane

The way these variables are displayed in the report can undergo minor changes in order to incorporate verification suggestions and/or needs.