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

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#### SECTION A. General description of project activity

#### A.1 Title of the project activity:

Projeto de Gás de Aterro TECIPAR – PROGAT Version 02.2 Date: 02/03/2009

#### A.2. Description of the project activity:

The Projeto de Gás de Aterro TECIPAR – PROGAT aims to capture the landfillgas generated at Ventura landfill and use it to generate electricity.

Applying the state of the art on landfill gas capture technology, BIOPAR Soluções Ambientais Ltda. will install a complete gas collection system in whole Ventura landfill, in order to avoid the emission of methane to the atmosphere. Part of the gas captured will be used to generate electricity and the remaining will be flared. The actual practice of Ventura landfill is to emit all gas produced to the atmosphere, without any control or partial destruction, in a passive way through the existing concrete and/or plastic gas wells. The electricity supplied to the grid will displace the same amount of energy produced by fossil fuels.

The project will have a positive impact over sustainable development:

#### a) Environmental Benefits

An environmental benefit with the implementation of the Projeto de Gás de Aterro TECIPAR – PROGAT is the destruction of methane that otherwise would be emitted to the atmosphere, increasing the impact on global warming. The project will also have another environmental benefit once it will be used to generate electricity, avoiding the generation of the same amount of energy by fossil fuels to the grid.

#### b) Social / Income Generation Benefits / Labour Capacitating

As landfill gas electricity generation projects is a wide new venture in Brazil (only a few projects are already generating electricity from the landfill gas), new capacitated job positions will be created. A team of engineers and operators will be hired and trained in order to run the project and to make continuous monitoring and maintenance of the collecting system, gas station and power house. These job positions will receive a salary higher than the one actually payed by the market, as the project needs a more skilled labour.

#### 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)	• BIOPAR Soluções Ambientais Ltda. (Brazilian Private Entity)	No





**Executive Board** 

(\*) 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.

BIOPAR Soluções Ambientais Ltda. is a joint-venture between ESTRE Ambiental S/A, Multiambiente Brasil and TECIPAR.

#### A.4. Technical description of the project activity:

#### A.4.1. Location of the project activity:

Projeto de Gás de Aterro TECIPAR - PROGAT is located at Av. Ouro Branco, 474, Santana de Parnaíba – SP, Brazil

Brazil

Host Party(ies):

**Region/State/Province etc.:** 

São Paulo

A.4.1.3.

A.4.1.1.

A.4.1.2.

City/Town/Community etc:

Santana de Parnaíba

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

Ventura landfill is located at the following Geographic coordinates

23°24'50" S 46°57'28" W

The picture below presents the detailed location of the landfill







#### Figure 1. Ventura landfill location

Source: Wikipedia (http://pt.wikipedia.org) and Google Earth

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

The Projeto de Gás de Aterro TECIPAR – PROGAT is categorized in the following Sectoral Scopes:

- Sectoral Scope 13 Waste Handling and Disposal: used to calculate emission reductions due to the production of methane from the decomposition of municipal solid waste to the atmosphere; and
- Sectoral Scope 1 Energy industries (renewable / non-renewable sources): applied to calculate the grid-emission factor of CO<sub>2</sub>e and the emission reductions from the sale of renewable electricity to the grid.

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

The technology to be employed will be the improvement of landfill gas collection and flaring, through the installation of an active recovery system composed by:

• a collection pipeline;





- a transportation pipeline network;
- a blowering system and flaring system (located in the Gas Station); and
- an electricity generation facility.

Figure 2 presents a lay-out of such kind of installation.



#### 1. Collection System

Figure 2. Schematic situation of a landfill with active gas recovery

#### 1. Collection System

Considering the dimensions of Ventura landfill, having in mind the LFG capture, the infra-structure was defined based on vertical wells. These elements will be connected to a collection pipeline, which will transport the gas to the Regulation Stations – the Regulation Stations will be used to control the pressure drop from the wells. Some horizontal wells can be drilled if necessary.

BIOPAR Soluções Ambientais Ltda. intends to install initially around 46 new wells directly in the landfill (achieving a total of 68 by the time of the landfill's closure). A cover layer will be installed around the wells in order to avoid gas leakage. Technical analysis might conclude the necessity to install horizontal wells and a final cover layer with HDPE.

The top of the wells will be equipped with a wellhead. This element is important to make the connection between the well and the collection pipeline. Wellheads will be made of HDPE ø 200 mm and 1 m length. In the body of the wellhead, an HDPE ø 90 mm derivation will be constructed and





united to a butterfly valve, which will be connected to a HDPE  $\phi$  90 mm flexible hose, which will be connected to the collection pipeline.

The collection pipeline will be constructed using HDPE. The dimensioning of the pipeline was made considering the maximum gas production per well. Welding activities will be intense to connect each ramification to the Regulation Station. The cover of the pipeline will be made with any kind of material which does not represent any kind of possible damage to the material.

Some condensate knock-out will be installed in order to drain any quantity of leachate collected with the gas. They will be installed in the lowest points of the collection pipeline and right before the connection to the Regulation Stations. The condensates will be returned to the landfill, via pumps installed in the bottom of the knock-outs.

All wells will be connected to Regulation Stations around the landfill, through the collection pipelines. BIOPAR Soluções Ambientais Ltda. will install 5 Regulation Stations by the time of the landfill's closure around all landfill, each station capable of receiving connections from 12 wells. The basic functions of the stations will be to control and monitor systematically the characteristics of the landfill gas extracted. In each Regulation Station additional condensate separators, regulation valves and flow-valves will be installed.

#### **2.** Transmission Pipeline

From the Regulation Stations, the gas is sent to the Gas Station through individual HDPE pipeline. Initially, BIOPAR Soluções Ambientais Ltda. will install 1,183 m of collection pipeline, with the possibility to increase by the time of the landfill's closure.

#### 3. Gas Station

The gas collection will be made through the application of appropriate pressure in each well. The system will be composed by a group of centrifugal multi-stage blowers, connected in apparel with the main collector. The pressuring of the system will depend on the pressure needed by the flares and generators.

The dimensioning of the components is straight connected to the gas production from Ventura landfill; for the project 2 blower of 2,500 Nm<sup>3</sup>/h will be installed (one of them as stand-by) and might reach a number of 3 by the time of the landfill's closure, according with the landfill's gas production capacity. Moreover, the Gas Station will have the following elements:

- ON/OFF Security Valve;
- Condensate Separator;
- Gas Analyzer;
- Pressure measurement;
- Temperature measurement;

The gas station will also count with a gas destruction/flaring system. This system will composed by 1 enclosed flares of 2,500 Nm<sup>3</sup>/h by the time of the landfill's closure and might reach a number of 2, according with the landfill's gas production capacity. The flare is constructed by a vertical cylindrical combustion chamber, where the biogas is burned in a constant temperature ( $\geq 1,000^{\circ}$ C), controlled by the air admission flow, with a residence time  $\geq 0.3$  sec. The flares will have the following characteristics:

Dimensions	Height:	8.5 m





	External Diameter: 2,200 mm		
	Biogas		
Fuel	Inlet Pressure: 50 mbar		
	Minimum $CH_4$ concentration: 30%		
Inflaming	Blowed from the base of the flare, through multiple air inlet windows		
	Maximum: 2,500 Nm <sup>3</sup> /h		
Load	Minimum: 500 Nm <sup>3</sup> /h		
	Air ratio: 5:1		
Burner	Automatic		
Flame Stabilizer:	Continuous control, through UV-sond flame detection		
<b>Combustion Chamber</b>	Refractory, 150 mm thick		
<b>Combustion Temperature</b>	$> 850^{\circ}$ C, for more than $> 0.3$ sec;		
Crictical Temperature	1,330°C;		
Combustion	Min. 99% (CO <sub>2</sub> /CO+CO <sub>2</sub> );		
<b>Temperature Controller</b>	Continuous, through a Pt–Rh–Pt thermocouple		

#### **5.** Power House

A Power House will be installed, using appropriate Internal Combustion Engines, to generate electricity. The number of engines will depend on the amount of LFG collected, but it's foreseen that no more than 7 will be in place, by the time of the landfill's closure, achieving a total installed capacity of 6.5 MW. The electricity dispatched to the Brazilian grid will be the total generated minus the internal consumption. While the power house is not installed, the project will consume electricity to the grid. Additionally, an emergency diesel generator will be installed to supply electricity to the project, in cases when grid-supply is interrupted.





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Years	Annual estimation of emission reductions in tonnes of CO <sub>2</sub> e	
2009	66.583	
2010	76.962	
2011	85.053	
2012	89.789	
2013	94.226	
2014	96.485	
2015	99.240	
<b>Total estimated reductions</b> (tonnes of CO <sub>2</sub> e)	608.337	
Total Number of crediting years	7	
Annual average over the crediting period of estimated reductions (tonnes of CO <sub>2</sub> e)	86.905	

#### A.4.4 Estimated amount of emission reductions over the chosen <u>crediting period</u>:

#### A.4.5. Public funding of the project activity:

There is no public funding involved in Projeto de Gás de Aterro TECIPAR – PROGAT.



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#### SECTION B. Application of a baseline and monitoring methodology

# **B.1.** Title and reference of the <u>approved baseline and monitoring methodology</u> applied to the <u>project activity</u>:

Projeto de Gás de Aterro TECIPAR – PROGAT applies the following methodology and tools:

- Version 09.1 of ACM0001 Consolidated methodology for landfill gas project activities;
- Version 05.2 of the *Tool for the demonstration and assessment of additionality;*
- Version 01 of the *Tool to determine project emissions from flaring gases containing methane.*
- Version 01 of the Tool to calculate baseline, project and/or leakage emissions from electricity consumption.
- Version 01.1 of the *Tool for calculation of emission factor for electricity systems*.
- Version 02 of the Tool to calculate project or leakage CO2 emissions from fossil fuel combustion.
- Version 04 of the *Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site.*

## **B.2** Justification of the choice of the methodology and why it is applicable to the <u>project</u> <u>activity:</u>

#### a) ACM0001

Applicability conditions:

This methodology is applicable to landfill gas capture project activities, where the baseline scenario is the partial or total atmospheric release of the gas and the project activities include situations such as:

a) The captured gas is flared; and/or

*b) The captured gas is used to produce energy (e.g. electricity/thermal energy);* 

c) The captured gas is used to supply consumers through natural gas distribution network. If emissions reduction are claimed for displacing natural gas, project activities may use approved methodology AM0053.

ACM0001 is applicable to the Projeto de Gás de Aterro TECIPAR – PROGAT because the baseline scenario is the partial or total atmospheric release of the gas (usual practice of the Ventura landfill management) and the project activity includes the flaring and electricity generation of the captured gas.

The boundary of the project are Ventura landfill and the all the power generation sources connected to the Brazilian electric grid.

<b>B.3.</b> Description of the sources and gases included in the <u>project boundary</u>				
	Source	Gas	Included?	Justification / Explanation





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	Emissions from electricity consumption	CO <sub>2</sub>	Yes	According with the methodology ACM0001, "Electricity may be consumed from the grid or generated onsite/offsite in the baseline scenario". In the baseline scenario, electricity is consumed to operate the landfill and is assumed to be very small, compared with the project's consumption. For simplification, this source will be excluded from baseline emissions.
		CH <sub>4</sub>	No	Excluded for simplification. This is conservative.
Baseline		N <sub>2</sub> O	No	Excluded for simplification. This is conservative.
	Emissions from	CO <sub>2</sub>	No	This emission source was neglected because the project activity won't consume/generate thermal energy
	thermal energy generation	CH <sub>4</sub>	No	Excluded for simplification. This is conservative.
		N <sub>2</sub> O	No	Excluded for simplification. This is conservative.
	Emissions from decomposition of waste at the landfill site	CO <sub>2</sub>	No	$CO_2$ emissions from the decomposition of organic waste are not accounted.
		CH <sub>4</sub>	Yes	The major source of emissions in the baseline.
		N <sub>2</sub> O	No	$N_2O$ emissions are small compared to $CH_4$ emissions from landfills. Exclusion of this gas is conservative.
On-site fossil fuel consumption due to the project activity other than for electricity generationProject ActivityEmissions from on-site	CO <sub>2</sub>	No	This source of project emissions will be neglected as no fossil fuel will be used on- site.	
	due to the project activity	CH <sub>4</sub>	No	Excluded for simplification. This emission source is assumed to be very small.
	other than for electricity generation	N <sub>2</sub> O	No	Excluded for simplification. This emission source is assumed to be very small.
	Emissions from on-site electricity use	<i>CO</i> <sub>2</sub>	Yes	Before the construction of the Power house, electricity used on-site will be consumed from the grid. Additionally, an emergency disesl-generator will be installed to supply electricity to the project in cases of grid- supply interruption.
		CH <sub>4</sub>	No	Excluded for simplification. This emission source is assumed to be very small.
		N <sub>2</sub> O	No	Excluded for simplification. This emission source is assumed to be very small.

The following diagram presents the boundaries of the project:









# **B.4**. Description of how the <u>baseline scenario</u> is identified and description of the identified baseline scenario:

#### a) ACM0001

According with ACM0001, the procedure to select the most plausible baseline scenario is:

#### Step 1: Identification of alternative scenarios.

The following realistic and credible alternatives are identified to the project, according with the *Tool* for the demonstration and assessment of additionality – version 05:

- a) Project Activity undertaken without being registered as a CDM Project Activity
- b) Continuation of the landfill operation (Business as Usual BAU scenario);
- c) Implementation of the CDM project activity considering only the LFG destruction in flares;
- d) Implementation of the CDM project activity considering LFG use in boilers to generate heat;

In Brazil, there are no policies regarding mandatory landfill gas capture or destruction requirements due to safety issues or local environmental regulations nor policies which promote the productive use of landfill gas such as those for the production of renewable energy, or those that promote the processing of organic waste.

Since 2000, the *Política Nacional de Resíduos Sólidos* (National Solid Waste Policy) has been under discussion, but no further conclusion was taken. The scope of the policy is to obligate the use of engineering technologies to transform open dumps on sanitary landfill, applying NBR 81419 (Brazilian Standard on the presentation of landfill design projects). However, the Policy does not foreseen neither obligation on landfill gas destruction and the promotion of the landfill gas use such as those for the production of renewable energy, or those that promote the processing of organic waste.

In 2002, the *PROINFA – Programa de Incentivo a Fontes Alternativas* was created, in order to incentive the generation of 3,300 MW of renewable sources to generate electricity, divided in three groups: wind-energy (1,100 MW), small-hydro power plants (1,100 MW) and biomass (1,100 MW, including bagasse, wood, solid waste, rice husk, etc.). Despite of achieving the goals, no landfill-gasto-energy project was implemented due to the low price paid for the MWh produced.

The following table presents an analysis of the compliance of the alternatives listed previously with the local/national regulation.

Alternative	Compliance with Local / National Policies	Observations
Project Activity undertaken without being registered as a CDM Project Activity	~	
BAU scenario	✓	<ul> <li>Ventura landfill has an authorization to operate, emitted from the environmental authority;</li> </ul>
LFG destruction in flares	$\checkmark$	<ul> <li>There is no law which obligates the landfill do destroy the gas produced nor due to local environmental regulations,</li> </ul>





		nor due to GHG reductions;
		There is no law which obligates the
		landfill do destroy the gas produced nor
LEC use to generate electricity		due to local environmental regulations,
LI'O use to generate electricity	v	nor due to GHG reductions;
		There are no policies to promote the use
		of LFG to produce electricity;
		There is no law which obligates the
		landfill do destroy the gas produced nor
LFG use in boilers to generate	./	due to local environmental regulations,
heat	× ·	nor due to GHG reductions;
		There are no policies to promote the use
		of LFG to produce heat in boilers;

As will be explained ahead, Ventura landfill does not have any legal/contractual obligation on destroying the methane generated; however, there exists a gas exhaust system made of PDR wells used to alleviate the landfill's internal pressure and some of the gas is destroyed in the top of the system – it's estimated that 5% of the methane generated is destroyed; thus AF = 0.05.

In order to identify the most plausible baseline scenario, it's necessary to demonstrate:

- what would happen with the LFG;
- what would happen with the power generation; and
- what would happen with the heat generation in the absence of the project activity.

The table below presents the alternatives to the LFG and the conclusions for each alternative:

SCENARIO	OBSERVATIONS
LFG1 The project activity (i.e. capture of	This alternative is not applicable as the CERs
landfill gas and its flaring and/or its use)	are the only source of revenues which amortizes
undertaken without being registered as a CDM	the investments in the LFG collection system
project activity.	and electricity generation.
LFG2 Atmospheric release of the landfill gas or	This alternative is <i>applicable</i> because without
partial capture of landfill gas and destruction to	the project activity the LFG generated would
comply with regulations or contractual	continue to be emitted to the atmosphere in an
requirements, or to address safety and odour	uncontrolled manner as there are no
concerns.	legal/contractual obligations to destroy the gas.

Concerning the power generation, the table below presents the realistic and credible alternative(s) and the observations:

SCENARIO	OBSERVATIONS
P1 Power generated from landfill gas	This alternative is not applicable as the CERs
undertaken without being registered as CDM	are the only source of revenues which amortizes
project activity.	the investments in the LFG collection system
	and electricity generation.
P2 Existing or construction of a new on-site or	This alternative is <b>not applicable</b> because using
off-site fossil fuel fired cogeneration plant.	fossil fuel is not the best alternative, once LFG
	is available and in abundance in the landfill.
	Moreover, BIOPAR Soluções Ambientais Ltda.
	core business is energetic use of the landfill gas.
P3 Existing or construction of a new on-site or	This alternative is not applicable because LFG
off-site renewable based cogeneration plant.	can be fired directly to generate electricity and





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	there is no need for heat in Ventura landfill.
	Moreover, BIOPAR Soluções Ambientais Ltda.
	core business is energetic use of the landfill gas.
P4 Existing or construction of a new on-site or	This alternative is not applicable because LFG
off-site fossil fuel fired captive power plant.	can be fired directly to generate electricity and
	there is no need for heat in Ventura landfill.
	Moreover, BIOPAR Soluções Ambientais Ltda.
	core business is energetic use of the landfill gas.
<b>P5</b> Existing or construction of a new on-site or	This alternative is not applicable because
off-site renewable based captive power plant.	Ventura landfill has enough gas to generate
	more electricity than is consumed internally.
P6 Existing and/or new grid-connected power	This alternative is <i>applicable</i> to the project
plants.	activity. Electricity could be consumed from the
	arid if no nower generation occurred

No heat scenarios will be analyzed as the project does not foreseen the heat generation/consumption.

## STEP 2: Identify the fuel for the baseline choice of energy source taking into account the national and/or sectoral policies as applicable.

This step is not applicable as no fossil fuel is consumed in the baseline by the Projeto de Gás de Aterro TECIPAR – PROGAT.

STEP 3: Step 2 and/or step 3 of the latest approved version of the "Tool for demonstration and assessment of additionality" shall be used to assess which of these alternatives should be excluded from further consideration (e.g. alternatives facing prohibitive barriers or those clearly economically unattractive).

Please, refer to B.5.

STEP 4: Where more than one credible and plausible alternative remains, project participants shall, as a conservative assumption, use the alternative baseline scenario that results in the lowest baseline emissions as the most likely baseline scenario. The least emission alternative will be identified for each component of the baseline scenario. In assessing these scenarios, any regulatory or contractual requirements should be taken into consideration.

According with *Step 2* and *Step 3* of the *Tool for the demonstration and assessment of additionality*, the only alternative remaining, among those presented in *STEP1*, is the BAU scenario (please, refer to B.5).

As per methodology ACM0001, Projeto de Gás de Aterro TECIPAR – PROGAT corresponds to Scenario 1.

Saanamia	Baseline		Description of the situation	
Scenario	Landfill gas	Electricity	Heat	Description of the situation
1	LFG2	P6	N/A	The atmospheric release of landfill gas or landfill gas is partially captured and subsequently flared. The electricity is obtained from the grid.

**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):



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#### Application of the Tool for the demonstration and assessment of additionality.

BIOPAR Soluções Ambientais was created in 17/01/2008, with the clear objective to exploit the LFG produced in the Ventura Landfill under the Kyoto Protocol, as stated in the Article 3<sup>rd</sup> of the Company's Social Contract.

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

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

All alternatives to the project activity were presented in the Item B.4.

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

All alternatives are in accordance with mandatory laws and regulations, as presented in the Item B.4.

#### **STEP 2: Investment analysis**

#### Sub-step 2a: Determine appropriate analysis method

The analysis method chosen was Option III - Benchmark Analysis.

#### Sub-step 2b: Option III. Apply benchmark analysis

Investment analysis will be made through the IRR of the three alternatives (continuation of the BAU practice; flaring of LFG; electricity generation) without the CERs revenues. The economic analysis will be made through a 21-years period.

## Sub-step 2c: Calculation and comparison of financial indicators (only applicable to Options II and III):

#### Alternative 1: Continuation of the BAU practice

Under this scenario, methane is emitted in a passive way to the atmosphere and no investment is made in a landfill gas destruction system. Thus, no capital compromise is foreseen.

#### Alternative 2: Flaring of landfill gas

Under this scenario, the investments needed on the gas collection system and Gas Station are:

INVESTMENT COSTS								
Description	Num		€	R\$	(1 € = 2.7 R\$)			
Flares	1	€	610,000.00	R\$	1,647,000.00			
Pipeline, containers and transformers	1	€	200,000.00	R\$	540,000.00			
Civil Works	1	€	15,000.00	R\$	40,500.00			
Transport and imports(60% of the flares)	50%	€	305,000.00	R\$	823,500.00			
Executive Project	1	R\$	120,000.00	R\$	120,000.00			
Blower	1	R\$	150,000.00	R\$	150,000.00			
Installation Costs	1	R\$	80,000.00	R\$	80,000.00			
Rate €/R\$	2.7							
			TOTAL	R\$	3,401,000.00			
O&M				R\$	438,880/year			





As there are no sources of income from the destruction of methane, the capital invested will never return and there is no IRR.

#### Alternative 3: Electricity Generation

Under this scenario, the sale of electricity is a source of income to the project. In order to analyze if this receipt is financially attractive, a benchmark comparison was undertaken, based on the project's IRR.

BIOPAR Soluções Ambientais Ltda. will install the electricity generators in different steps, according with the gas production capacity of the landfill (please, refer to Annex 3)

The prices of each component are presented below:

ITEM	EQUIPMENTS	€	<b>R</b> \$ (1 € = 2.7 <b>R</b> \$)
	A = Supervision, control and anti-fire system	-	R\$ 280,800.00
UEC cleaning	B = LFG cleaning	-	R\$ 1,358,100.00
LFG cleaning	C = Connection to the gas lines and instrumentation	-	R\$ 189,000.00
systems	D = Transport and importation (60% of B and C)	-	R\$ 928,260.00
Б. I. I.	E = 1 individual modular engine (container)	€ 503,000.00	R\$ 1,358,100.00
Engines and	F = 01 Auxiliary installations and assembly	€ 126,666.67	R\$ 342,000.00
auxillary	G = 01 Electric sections and connections	€ 60,500.00	R\$ 163,350.00
equipments	H = Transport and imports ( $60\%$ of E, F and G)	-	R\$ 1,118,070.00
	Personnel (4 operators)		R\$ 120,000.00
O&M Costs	"Full service" maintenance		71.54 R\$/MWh
(R\$/year)	Lubrificants (included in "full-service")		-
	Electric devices maintenance		R\$ 150,000.00

For the financial analysis, the following assumptions were adopted:

- Initial price of the electricity exported = 169 R/MWh, based on the PROINFA tariff<sup>1</sup>;
- Initial operational cost = 74.1 R/MWh
- Inflation rate = +4% per year;

The costs of the collection and flaring systems are the same presented above.

The following cash-flow is presented:

<sup>&</sup>lt;sup>1</sup>http://www.nae.gov.br/cadernos\_nae/04caderno\_mudancasclimaticasquioto.pdf. The PROINFA tariff was adopted, concerning the low price of the MWh paied in the last auction of electricity in Brazil (R\$ 150.00/MWh)





	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Gross Incomes (R\$)	R\$ 0.00	R\$ 3,140,640.18	R\$ 3,502,502.13	R\$ 4,856,802.95	R\$ 5,051,075.07	R\$ 6,566,397.59	R\$ 6,829,053.50	R\$ 8,522,658.76	R\$ 8,863,565.12	R\$ 10,486,368.79	R\$ 11,184,637.37
(+) Incomes from Electricity Sale CONSTANT	R\$ 0.00	R\$ 3,019,846.33	R\$ 3,238,260.11	R\$ 4,317,680.14	R\$ 4,317,680.14	R\$ 5,397,100.18	R\$ 5,397,100.18	R\$ 6,476,520.21	R\$ 6,476,520.21	R\$ 7,367,583.61	R\$ 7,555,940.25
(+) Incomes from Electricity Sale NOM	R\$ 0.00	R\$ 3,140,640.18	R\$ 3,502,502.13	R\$ 4,856,802.95	R\$ 5,051,075.07	R\$ 6,566,397.59	R\$ 6,829,053.50	R\$ 8,522,658.76	R\$ 8,863,565.12	R\$ 10,486,368.79	R\$ 11,184,637.37
(-) VAT (R\$)	R\$ 0.00	R\$ 0.00	R\$ 0.00	R\$ 0.00	R\$ 0.00	R\$ 0.00	R\$ 0.00	R\$ 0.00	R\$ 0.00	R\$ 0.00	R\$ 0.00
VAT 01 (COFINS = 3%)	R\$ 0.00	R\$ 0.00	R\$ 0.00	R\$ 0.00	R\$ 0.00	R\$ 0.00	R\$ 0.00	R\$ 0.00	R\$ 0.00	R\$ 0.00	R\$ 0.00
VAT 02 (PIS = 0.7%)	R\$ 0.00	R\$ 0.00	R\$ 0.00	R\$ 0.00	R\$ 0.00	R\$ 0.00	R\$ 0.00	R\$ 0.00	R\$ 0.00	R\$ 0.00	R\$ 0.00
(=) Net incomes from electricity sale (R\$)	R\$ 0.00	R\$ 3,140,640.18	R\$ 3,502,502.13	R\$ 4,856,802.95	R\$ 5,051,075.07	R\$ 6,566,397.59	R\$ 6,829,053.50	R\$ 8,522,658.76	R\$ 8,863,565.12	R\$ 10,486,368.79	R\$ 11,184,637.37
(-) Operational Costs and Expenditures (R\$)	-R\$ 438,880.25	-R\$ 2,049,155.98	-R\$ 2,213,569.07	-R\$ 2,798,544.32	-R\$ 2,892,930.88	-R\$ 3,547,022.00	-R\$ 3,671,347.67	-R\$ 4,401,939.28	-R\$ 4,560,461.64	-R\$ 5,262,197.06	-R\$ 5,573,155.42
O&M 1 - Gas - NOM	-R\$ 438,880.25	-R\$ 438,880.25	-R\$ 438,880.25	-R\$ 438,880.25	-R\$ 438,880.25	-R\$ 438,880.25	-R\$ 438,880.25	-R\$ 438,880.25	-R\$ 438,880.25	-R\$ 438,880.25	-R\$ 438,880.25
O&M 2 - Electricity Generation – NOM	R\$ 0.00	-R\$ 1,610,275.73	-R\$ 1,774,688.82	-R\$ 2,359,664.07	-R\$ 2,454,050.63	-R\$ 3,108,141.75	-R\$ 3,232,467.42	-R\$ 3,963,059.02	-R\$ 4,121,581.39	-R\$ 4,823,316.81	-R\$ 5,134,275.17
(-) CAPEX (R\$)	-R\$ 15,211,890.62		-R\$ 3,224,033.28		-R\$ 3,487,114.40		-R\$ 3,771,662.93			-R\$ 4,242,607.85	
CAPEX 1 (Gas Collection System) NOM	-R\$ 3,513,330.62										
CAPEX 2 (Acquisition of 3 engines 2008) NOM	-R\$ 11,698,560.00										
CAPEX 3 (Acquisition of +1 engine 2010) NOM			-R\$ 3,224,033.28								
CAPEX 4 (Acquisition of +1 engine 2012) NOM					-R\$ 3,487,114.40						
CAPEX 5 (Acquisition of +1 engine 2014) NOM							-R\$ 3,771,662.93				
CAPEX 6 (Acquisition of +1 engine 2017) NOM										-R\$ 4,242,607.85	
(=) EBIT (R\$)	-R\$ 15,650,770.87	R\$ 1,091,484.20	-R\$ 1,935,100.22	R\$ 2,058,258.63	-R\$ 1,328,970.21	R\$ 3,019,375.59	-R\$ 613,957.10	R\$ 4,120,719.49	R\$ 4,303,103.48	R\$ 981,563.88	R\$ 5,611,481.94
(-) Income Taxes (IR & CSLL = 11%) (R\$)	R\$ 0.00	-R\$ 345,470.42	-R\$ 385,275.23	-R\$ 534,248.32	-R\$ 555,618.26	-R\$ 722,303.74	-R\$ 751,195.88	-R\$ 937,492.46	-R\$ 974,992.16	-R\$ 1,153,500.57	-R\$ 1,230,310.11
Free Cash-Flow (R\$) - NOM	-R\$ 15,650,770.87	R\$ 746,013.78	-R\$ 2,320,375.45	R\$ 1,524,010.31	-R\$ 1,884,588.46	R\$ 2,297,071.86	-R\$ 1,365,152.99	R\$ 3,183,227.03	R\$ 3,328,111.32	-R\$ 171,936.69	R\$ 4,381,171.83
Inflation to discount the Cash-Flow	1.0000	1.0400	1.0816	1.1249	1.1699	1.2167	1.2653	1.3159	1.3686	1.4233	1.4802
Free Cash-Flow (R\$) - CONSTANT	-R\$ 15,650,770.87	R\$ 717,320.94	-R\$ 2,145,317.54	R\$ 1,354,839.62	-R\$ 1,610,954.12	R\$ 1,888,025.63	-R\$ 1,078,900.24	R\$ 2,418,990.92	R\$ 2,431,818.34	-R\$ 120,800.44	R\$ 2,959,762.71





#### **CDM – Executive Board**

	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
Gross Incomes (R\$)	R\$ 11,632,022.86	R\$ 10,091,319.47	R\$ 8,760,050.46	R\$ 7,476,825.01	R\$ 5,831,923.51	R\$ 5,922,489.52	R\$ 4,205,205.64	R\$ 4,373,413.87	R\$ 4,219,835.88	R\$ 2,365,142.22	R\$ 2,459,747.91
(+) Incomes from Electricity Sale CONSTANT	R\$ 7,555,940.25	R\$ 6,303,008.37	R\$ 5,261,059.30	R\$ 4,317,680.14	R\$ 3,238,260.11	R\$ 3,162,065.57	R\$ 2,158,840.07	R\$ 2,158,840.07	R\$ 2,002,913.13	R\$ 1,079,420.04	R\$ 1,079,420.04
(+) Incomes from Electricity Sale NOM	R\$ 11,632,022.86	R\$ 10,091,319.47	R\$ 8,760,050.46	R\$ 7,476,825.01	R\$ 5,831,923.51	R\$ 5,922,489.52	R\$ 4,205,205.64	R\$ 4,373,413.87	R\$ 4,219,835.88	R\$ 2,365,142.22	R\$ 2,459,747.91
	•										
(-) VAT (R\$)	R\$ 0.00										
VAT 01 (COFINS = 3%)	R\$ 0.00										
VAT 02 (PIS = 0.7%)	R\$ 0.00										
(=) Net incomes from electricity sale (R\$)	R\$ 11,632,022.86	R\$ 10,091,319.47	R\$ 8,760,050.46	R\$ 7,476,825.01	R\$ 5,831,923.51	R\$ 5,922,489.52	R\$ 4,205,205.64	R\$ 4,373,413.87	R\$ 4,219,835.88	R\$ 2,365,142.22	R\$ 2,459,747.91
(-) Operational Costs and Expenditures (R\$)	-R\$ 5,778,526.43	-R\$ 5,142,951.82	-R\$ 4,596,698.68	-R\$ 4,071,474.67	-R\$ 3,393,867.59	-R\$ 3,451,655.60	-R\$ 2,744,934.16	-R\$ 2,837,176.32	-R\$ 2,794,043.49	-R\$ 2,031,680.39	-R\$ 2,095,392.40
O&M 1 - Gas - NOM	-R\$ 438,880.25										
O&M 2 - Electricity Generation – NOM	-R\$ 5,339,646.18	-R\$ 4,704,071.57	-R\$ 4,157,818.43	-R\$ 3,632,594.42	-R\$ 2,954,987.34	-R\$ 3,012,775.35	-R\$ 2,306,053.91	-R\$ 2,398,296.07	-R\$ 2,355,163.23	-R\$ 1,592,800.14	-R\$ 1,656,512.14
(-) CAPEX (R\$)											
CAPEX 1 (Gas Collection System) NOM											
CAPEX 2 (Acquisition of 3 engines 2008) NOM											
CAPEX 3 (Acquisition of +1 engine 2010) NOM											
CAPEX 4 (Acquisition of +1 engine 2012) NOM											
CAPEX 5 (Acquisition of +1 engine 2014) NOM											
CAPEX 6 (Acquisition of +1 engine 2017) NOM											
(=) EBIT (R\$)	R\$ 5,853,496.43	R\$ 4,948,367.65	R\$ 4,163,351.78	R\$ 3,405,350.33	R\$ 2,438,055.92	R\$ 2,470,833.92	R\$ 1,460,271.48	R\$ 1,536,237.55	R\$ 1,425,792.39	R\$ 333,461.83	R\$ 364,355.51
(-) Income Taxes (IR & CSLL = 11%) (R\$)	-R\$ 1,279,522.51	-R\$ 1,110,045.14	-R\$ 963,605.55	-R\$ 822,450.75	-R\$ 641,511.59	-R\$ 651,473.85	-R\$ 462,572.62	-R\$ 481,075.53	-R\$ 464,181.95	-R\$ 260,165.64	-R\$ 270,572.27
Free Cash-Flow (R\$) - NOM	R\$ 4,573,973.92	R\$ 3,838,322.51	R\$ 3,199,746.23	R\$ 2,582,899.58	R\$ 1,796,544.33	R\$ 1,819,360.07	R\$ 997,698.86	R\$ 1,055,162.02	R\$ 961,610.45	R\$ 73,296.19	R\$ 93,783.24
Inflation to discount the Cash-Flow	1.5395	1.6010	1.6651	1.7317	1.8009	1.8730	1.9479	2.0258	2.1068	2.1911	2.2788
	r										
Free Cash-Flow (R\$) - CONSTANT	R\$ 2,971,166.24	R\$ 2,397,404.91	R\$ 1,921,684.67	R\$ 1,491,560.15	R\$ 997,557.30	R\$ 971,371.22	R\$ 512,191.90	R\$ 520,857.65	R\$ 456,421.11	R\$ 33,451.42	R\$ 41,155.24







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The electricity tariff is readjusted every year, according with an estimated inflation rate of +4% per year – the reference tariff was adopted from the value payed by PROINFA to landfill-gas-to-energy projects (R\$ 169/MWh<sub>exported</sub>) and the reference operational cost was R\$ 74.4/MWh<sub>exported</sub>.

The official benchmark used to compare the attractiveness of the project ws the treasury bonds, a low-risk long-term investment indicator from the National Treasury. For the Projeto de Gás de Aterro TECIPAR – PROGAT, NTNF 010117 was used for comparison.

NTNF 010117 is a Treasury Government's Bond, with pre-fixed remuneration and not indexed to any financial indicator (inflation, interest rate – SELIC rate, foreign currency, etc), thus it's risk-free. As presented in the graphic below, this bond has a regular variation and hasn't dropped below 12% in 2008:



As the decision to proceed with the project was taken in 01/01/2007 (please, refer to C.1), the average of the index from January/2008 to 30/06/2008 ( $13.35\%^2$ ) was calculated and used to determine the rate reference for the financial analysis comparison. This average NTNF 010117 pays much higher interest than the 1.70% determined for the project activity without CER's revenues.

#### Sub-step 2d: Sensitivity analysis (only applicable to Options II and III):

The main variables affecting the IRR can be considered the price of the MWh exported and O&M costs. An analysis was made, considering the variation of from +5% to +15% in the price of the electricity sold and from -5% to -15% in the CAPEX of the Gas Collection system (CAPEX<sub>Gas</sub>),

<sup>&</sup>lt;sup>2</sup> Tesouro Nacional - Preços e taxas dos títulos públicos disponíveis para compra; available at

http://www.tesouro.fazenda.gov.br/tesouro\_direto/download/historico/2008/historicoNTNF\_2008.xls





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from -5% to -15% in the CAPEX of the Electricity Generation (CAPEX<sub>Electricity</sub>) and from -5% to -15% in the Operational Costs of the Gas Collection ( $OM_{Gas}$ ) and Electricity Generation ( $OM_{Electricity}$ ). The table below presents the final result of the variation:

Variable	Variation	IRR
	-5%	1.804%
CAPEX Gas	-10%	1.992%
	-15%	2.254%
	-5%	1.863%
OPEX Gas	-10%	2.159%
	-15%	2.554%
CADEN	-5%	2.265%
Electricity	-10%	3.395%
Licentry	-15%	5.086%
ODEV	-5%	2.600%
OPEX	-10%	4.201%
Licentry	-15%	6.205%
D.:	+ 5%	3.543%
Flectricity	+ 10%	6.984%
Licentry	+ 15%	11.896%

The results of the sensitivity analysis resulted that even if the main costs vary more than 10%, the project IRR will still be way below the NTNF 010117.

The box below presents the outcome of **Step 2**:

Alternative	Financial Conclusion								
<b>BAU</b> situation (landfill's operation)	N/A, as this situation does not involve any kind of								
BAO situation (fandini s operation)	investment.								
Only floring of londfill goe	Investment in a gas collection and flaring system will never								
Only naming of fandrin gas	return, as the only source of income is the sale of CERs.								
Conception of algotricity	Despite of having positive financial indicators, the IRR is								
Generation of electricity	below government bond-rates.								

#### **STEP 3. Barrier analysis**

The Barrier Analysis will not be applied, as the project proponents decided to demonstrate the financial viability of the project.

#### **STEP 4. Common practice analysis**

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



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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 open dumps which are, in most of the cases, areas without any sort of proper infrastructure to avoid environmental hazards. Table 1 shows the final destination of the waste per municipality, according to PNSB 2000.

 Table 1. Districts with waste collection services, by final waste destination unit, according with the Geographical Regions and Federation Units - 2000

		Districts with waste collection services									
Geographical				Units	of collected	waste final d	estination				
<b>Regions and</b> Federation Units	Total	Open Dump	Open dumps in Flooded Areas	Controlled Landfill	Sanitary Landfill	Special Waste Landfill	Composting	Recycling	Incineration		
Brazil	8,381	5,993	63	1,868	1,452	810	260	596	325		
North	512	488	8	44	32	10	1	0	4		
Rondônia	54	50		7	3						
Acre	22	17		2	4	1					
Amazonas	71	60	2	11	4	1			3		
Roraima	15	15									
Pará	183	191	5	11	17	5	1		0		
Amapá	23	23	1						1		
Tocantins	144	132		13	4	3					
Northeast	2,714	2,538	7	169	134	69	19	28	7		
Maranhão	204	199	1	11	2	18	2	1	4		
Piauí	217	212	3	11	3	2					
Ceará	551	512	1	16	62	1					
Rio Grande do Norte	171	158	2	17	5	2	1	2			
Paraíba	268	264		2	5	7	8	4	1		
Pernambuco	359	329		43	15	8	5	12	1		
Alagoas	113	107		9	1	6	1	2			
Sergipe	80	65		21	2	4					
Bahia	751	692		39	39	21	2	7	1		
Southeast	2,846	1,713	36	785	683	483	117	198	210		
Minas Gerais	1,396	1,153	17	293	97	108	56	52	50		
Espírito Santo	236	133		66	66	31	1	8	10		
Rio de Janeiro	273	199	7	92	61	61	22	42	6		
São Paulo	941	228	12	334	459	283	38	96	144		
South	1,746	848	11	738	478	219	117	351	101		
Paraná	619	402	4	210	134	142	12	43	4		
Curitiba	1				1	1			1		
Santa Catarina	376	199	2	130	107	26	19	52	29		
Rio Grande do Sul	751	247	5	398	237	51	86	256	68		
Mid-West	563	406	1	132	125	29	6	19	3		
Mato Grosso do Sul	118	91	1	39	18	1		10			
Mato Grosso	158	124		35	13	7	5	4	1		
Goiás	286	191		57	94	20		4	1		
Distrito Federal	1			1		1	1	1	1		

Source: IBGE, Diretoria de Pesquisas, Departamento de População e Indicadores Sociais, Pesquisa Nacional de Saneamento Básico 2000. Note: one same district might have more than one final destination of waste collected.

Note: This table was adapted from the original table from PNSB

Only few of the existing Brazilian landfills have installed a collecting and flaring methane system. The majority of landfills operate with natural emission of methane to the atmosphere, through concrete wells.



The most recent statistic on MSW Final Disposal is from *ABRELPE – Associação Brasileira de Empresas de Limpeza Pública e Resíduos Especiais*. Despite of being the most recent data, *ABRELPE* applies a different methodology and presents a different scenario. According with their annual, a methodology approach used a baseline of 100,000 inhabitants per city which resulted in a universe of 127 cities. A check-list was sent to each of those 127 cities with the following result:

Table 2. Statistics from	n ABKELF
<b>Final Destination</b>	%
Open Dump	6.30
Other	4.72
Sanitary Landfill	62.20
Controlled Landfill	21.26
No Answer	472

## Table 2. Statistics from ABRELPE

Source: ABRELPE – Associação Brasileira de Empresas de Limpeza Pública e Resíduos Especiais; **Panorama dos Resíduos Sólidos no Brasil 2006.** 

In terms of population, the use of landfills are a common practice as those 127 cities represent around 30% of the total population from Brazil; however, considering all the cities in Brazil the result expected might be close to the one analyzed by PNSB mainly due to the lack of investments in sanitation of cities from the Northeast and Minas Gerais State.

However, the few existing landfills operate with passive emission of methane to the atmosphere, as controlled landfill gas collection and destruction is not mandated by laws/regulations nor due to local environmental regulations, nor due to GHG emission reduction (the DNA has informed that there are no national law which obligates the destruction of methane in landfills), thus, investments in a collection/flaring system are voluntary. Being voluntary means that some kind of income are expected to overcome the capital invested, what does not happen in such cases, as the Government, NGOs and private entities has no obligation/interest in acquiring the LFG destroyed in flares, except for the Kyoto Protocol.

Therefore, it's possible to conclude that the installation of such systems in a landfill is not a common practice, once there are no legal obligation to do it and once the capital invested will never overcome. Hence, the interes of the landfill's owners will be to proceed with the landfill's operation (BAU practice) what means the natural emission of methane do the atmosphere.

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

Some landfills operate with a forced methane extraction and destruction using blowers, collection systems and flaring systems and were developed only under the CDM:

Project Title	Period for Comments	Situation	Municipalities Attended	Type of Project
Salvador da Bahia Landfill Gas Management Project	12 Dec 03 - 12 Jan 04	Registered (registration number 0052)	1 (Salvador)	<ul> <li>LFG Flare</li> </ul>
NovaGerar Landfill Gas to Energy Project	05 Apr 04 - 06 May 04	Registered (registration number 0008)	1 (Nova Iguaçu)	<ul><li>LFG Flare</li><li>Electricity Generation</li></ul>

#### Table 3. LFG CDM Projects developed or under development in Brazil



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Project Title	Period for Comments	Situation	Municipalities Attended	Type of Project
Landfill gas to energy project at Lara landfill, Maua, Brazil	21 May 04 - 21 Jun 04	Registered (registration number 0091)	8 <sup>3</sup> (Diadema Mauá Praia Grande Ribeirão Pires Rio Grande da Serra São Bernardo do Campo São Caetano do Sul São Vicente)	<ul> <li>LFG Flare</li> <li>Electricity Generation</li> </ul>
Brazil MARCA Landfill Gas to Energy Project	24 May 04 - 24 Jun 04	Registered (registration number 0137)	9 <sup>4</sup> (Cariacica Domingos Martins Marechal Floriano Santa Leopoldina Santa Teresa Serra Venda Nova do Imigrante Viana Vitória)	<ul> <li>LFG Flare</li> <li>Electricity Generation</li> </ul>
Onyx gas recovery project – Tremembé, Brazil	25 Oct 04 - 25 Nov 04	Registered (registration number 0027)	7 <sup>3</sup> (Caçapava Ilhabela Monteiro Lobato Santo Antônio do Pinhal São José do Barreiro São Bento do Sapucaí São Sebastião)	<ul> <li>LFG Flare</li> </ul>
Caieiras landfill gas emission reduction	04 Dec 04 - 04 Jan 05	Registered (registration number 0171)	7 <sup>3</sup> (Caieiras Cajamar Campo Limpo Paulista Franco da Rocha São Paulo Taboão da Serra Várzea Paulista)	<ul> <li>LFG Flare</li> </ul>
ESTRE's Paulínia Landfill Gas Project (EPLGP)	24 Dec 04 - 24 Jan 05	Registered (registration number 0165)	19 <sup>3</sup> (Americana Artur Nogueira Capivari Cesário Lange Hortolândia Jaguariúna Louveira Mogi-Mirim Nazaré Paulista Nova Odessa Paulínia Pereiras Piracicaba Porangaba Santo Antônio de Posse	• LFG Flare

<sup>3</sup>Source: CETESB – Inventário Estadual de Resíduos Sólidos Domiciliares; Relatório 2007 <sup>4</sup> <u>http://www.marcaambiental.com.br/clipublicos.asp</u>



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Project Title	Period for Comments	Situation	Municipalities Attended	Type of Project
			Sumaré Tietê Valinhos Vinhedo)	
		<b>D</b>	. 3	
Bandeirantes Landfill Gas to Energy Project (BLFGE)	28 Jan 05 - 28 Feb 05	Registered (registration number 0164)	l <sup>3</sup> (São Paulo) OBS: Landfill closed	<ul> <li>LFG Flare</li> <li>Electricity Generation</li> </ul>
São João Landfill Gas to Energy Project (SJ)	17 Feb 05 - 20 Mar 05	Registered (registration number 0373)	1 <sup>3</sup> (São Paulo)	<ul><li>LFG Flare</li><li>Electricity Generation</li></ul>
Project Anaconda	30 Apr 05 - 31 May 05	Registered (registration number 0226)	5 <sup>3</sup> (Bom Jesus dos Perdões Campos do Jordão Caraguatatuba Jandira Nazaré Paulista Santa Isabel)	<ul> <li>LFG Flare</li> </ul>
Canabrava Landfill Gas Project	18 Aug 05 - 17 Sep 05	Registered (registration number 0893)	1 (Salvador) OBS: Landfill closed	<ul> <li>LFG Flare</li> </ul>
Aurá Landfill Gas Project	02 Dec 05 - 01 Jan 06	Registered (registration number 0888)	1 (Belém)	<ul> <li>LFG Flare</li> </ul>
Manaus Landfill Gas Project	07 Dec 05 - 06 Jan 06	Validation	1 (Manaus)	<ul> <li>LFG Flare</li> </ul>
Central de Resíduos do Recreio Landfill Gas Project	09 Mar 06 - 08 Apr 06	Registered (registration number 0648)	105	<ul> <li>LFG Flare</li> </ul>
Alto-Tiete landfill gas capture project	13 Mar 06 – 12 Apr 06	Registered (registration number 1636)	9 <sup>3</sup> (Arujá Carapicuíba Cunha Ferraz de Vasconcelos Itaquaquecetuba Mairiporã Mogi das Cruzes Poá Suzano)	<ul> <li>LFG Flare</li> </ul>
ESTRE Itapevi Landfill Gas Project (EILGP)	22 Mar 06 - 21 Apr 06	Registered (registration number 0911)	5 <sup>3</sup> (Cotia Itapevi Jandira São Roque Vargem Grande Paulista)	<ul> <li>LFG Flare</li> </ul>
Quitauna Landfill Gas Project	05 May 06 - 04 Jun 06	Registered (registration	ا ک (Guarulhos)	<ul> <li>LFG Flare</li> </ul>



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Project Title	Period for Comments	Situation	Municipalities Attended	Type of Project
		number 0912)		
Natal Landfill Gas Recovery Project	26 Jul 06 - 24 Aug 06	Validation	1 (Natal)	<ul> <li>LFG Flare</li> </ul>
SANTECH – Saneamento & Tecnologia Ambiental Ltda. – SANTEC Resíduos landfill gas emission reduction Project Activity	15 Aug 06 - 13 Sep 06	Validation	19	<ul> <li>LFG Flare</li> </ul>
CTRVV Landfill emission reduction project	30 Sep 06 - 29 Oct 06	Registered (registration number 1491)	1 (Vila Velha)	<ul> <li>LFG Flare</li> </ul>
Probiogas – JP – João Pessoa Landfill Gas Project	05 Dec 06 - 03 Jan 07	Registered (registration number 1165)	5 (Bayeux Cabedelo Conde João Pessoa Santa Rita)	<ul> <li>LFG Flare</li> </ul>
Proactiva Tijuquinhas Landfill Gas Capture and Flaring project	20 Feb 07 - 21 Mar 07	Requesting Registration	6 (Biguaçu Bombinhas Florianópolis Gov. Celso Ramos Porto Belo Tijuquinhas)	<ul> <li>LFG Flare</li> </ul>
ESTRE Pedreira Landfill Gás Project (EPLGP)	03 Mar 07 - 01 Apr 07	Registered (registration number 1134)	2 <sup>3</sup> (Atibaia São Paulo)	LFG Flare
Terrestre Ambiental Landfill Gás Project	03 Mar 07 - 01 Apr 07	Registered (registration number 1133)	4 <sup>3</sup> (Bertioga Cubatão Guarujá Santos)	<ul> <li>LFG Flare</li> </ul>
Embralixo/Araúna - Bragança Landfill Gas Project (EABLGP)	10 Mar 07 - 08 Apr 07	Registered (registration number 1179)	1 <sup>3</sup> (Bragança Paulista)	LFG Flare
URBAM/ARAUNA - Landfill Gas Project (UALGP)	10 Mar 07 - 08 Apr 07	Registered (registration number 1247)	2 <sup>3</sup> (Paraibuna São José dos Campos)	<ul> <li>LFG Flare</li> </ul>

Source: CDM-EB

From the total of 1,452 districts attended by sanitary landfills, only 221 (as presented in the table above) dispose the waste in landfills with an active system of recovery and destruction of biogas. It's considered that all landfills with active landfill gas recovery are developed as CDM Project Activities because there is no legal obligation to destroy the methane and because such projects would not be implemented without the CDM as the CERs revenues are their only source of income.

From those projects presented above, 21 are of LFG Flaring, while 6 are of Electricity Generation (an important reminder: only two of the electricity generation projects are operating generating electricity). Thus, this kind of project activity is not widely spread in Brazil and the landfills that operate this type of project represent only a small portion of the total existing landfills.

Thus, it can be concluded that the proposed project activity is additional because:





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- 1. there are no laws or regulations obligating the destruction of biogas generated in landfills or the use of the gas to generate electricity;
- 2. the project is one of the fewest to use the landfill gas to generate electricity, and other LFG capturing projects were developed only under the CDM;
- 3. the project is not the most economic attractive alternative, and only the CDM incentives can make the project economically attractive.

#### **B.6.** Emission reductions:

## B.6.1. Explanation of methodological choices:

#### <u>ACM0001</u>

#### a) Baseline Emissions

The Methodology ACM0001 states that greenhouse gas baseline emissions during a given year "y"  $(BE_y)$  are estimated according with the below equation:

$$BE_{y} = (MD_{project, y} - MD_{BL, y}) \times GWP_{CH4} + EL_{LFG, y} \times CEF_{elect, BL, y} + ET_{LFG, y} \times CEF_{ther, BL, y}$$
(1)

Where:

$BE_y$	Baseline emissions in year y (tCO <sub>2</sub> e);
MD <sub>project, y</sub>	The amount of methane that would have been destroyed/combusted during the year
	y (tCH <sub>4</sub> ) in project scenario
$MD_{BL, y}$	The amount of methane that would have been destroyed/combusted during the year
	in the absence of the project due to regulatory and/or contractual requirement, in
	tonnes of methane $(tCH_4)$
$GWP_{CH4}$	Global Warming Potential of Methane (tCO <sub>2</sub> e/tCH <sub>4</sub> )
$EL_{LFG, y}$	Net quantity of electricity produced using LFG, which in the absence of the project
	activity would have been produced by power plants connected to the grid or by an
	on-site/off-site fossil fuel based captive power generation, during year y, in
	megawatt hours (MWh).
CEF <sub>elec, BL, y</sub>	CO <sub>2</sub> emissions intensity of the baseline source of electricity displaced
	(tCO <sub>2</sub> e/MWh), estimated using the "Tool for calculation of emission factor for
	electricity systems" – version 01.
$ET_{LFG, y}$	The quantity of thermal energy produced utilizing the landfill gas, which in the
	absence of the project activity would have been produced from onsite/offsite fossil
	fuel fired boiler, during the year y in TJ.
$CEF_{ther, BL, y}$	CO <sub>2</sub> emissions intensity of the fuel used by boiler to generate thermal energy which
	is displaced by LFG based thermal energy generation (tCO <sub>2</sub> e/TJ)

As the Projeto de Gás de Aterro TECIPAR – PROGAT will not replace the heat generation by fossil fuel:

 $ET_{LFG, y} = 0$ 

The equation is updated to:



$$BE_{y} = (MD_{project, y} - MD_{BL, y}) \times GWP_{CH4} + EL_{LFG, y} \times CEF_{elect, BL, y}$$
(2)

As presented in B.4, the Projeto de Gás de Aterro TECIPAR – PROGAT does not have any contractual obligations to burn methane and there is no national/sectoral regulation obligating the landfill gas destruction. However, as per ACM0001 – version 08.1, in cases where regulatory or contractual requirements do not specify  $MD_{BL,y}$  or no historic data exists for LFG captured and destroyed an "Adjustment Factor" (AF) shall be used and justified, taking into account the project context.

$$MD_{BL, y} = MD_{project, y} \times AF$$
(3)

Where AF is the baseline adjustment factor and is estimated as follows:

#### 1. Percentage of methane exhausted through passive systems

The Ventura landfill counts with a passive venting system, which is way less efficient the active systems because of the pressure (in the passive system, landfill gas is emitted to the atmosphere due to variation of the barometric pressure). As per measurements made in 11 Dutch landfills, an average collection efficiency of passive system was equal to  $37\%^5$ .

#### 2. Percentage of methane destroyed in the passive systems

The PDR wells installed operates just like an open flare, where there is no control of the combustion temperature and of the air flow. As per the *Tool to determine project emissions from flaring gases containing methane*, a maximum efficiency to be adopted in open flares is equal to 50%; thus an efficiency of 50% is adopted in the AF estimative.

#### 3. Percentage of methane actually being destroyed in the passive systems

According with BIOPAR Soluções Ambientais Ltda., the Ventura landfill has 15 PDR wells nowadays, which only an average of 3 are burning the methane (a plant locating the wells installed and the wells which are burning LFG is presented in Annex 3).

Considering the above presented, the calculation of AF is as follows:

$$AF = \eta_{\text{closed landfills}} \times \eta_{\text{open flares}} \times \frac{N_{\text{wells bunring gas}}}{N_{\text{wells total}}}$$
(4)

AF	Adjustment factor
$\eta_{ ext{closed landfills}}$	Collection efficiency of passive systems in closed landfills (37%)
$\eta_{\scriptscriptstyle openflares}$	Efficiency of methane destruction in open flares (50%)
$N_{wells\ burning\ gas}$	Number of PDR wells actually burning the landfill gas collected in the passive
	system (3 wells)
$N_{wells \ total}$	Total number of PDR actually installed in the Ventura landfill (15 wells)

<sup>&</sup>lt;sup>5</sup> <u>http://www.mnp.nl/ipcc/Archive/AR4FOD/ExpRevFOD/FODrev/FOD\_AChapter10.doc</u>



$$AF = 37\% \times 50\% \times \frac{3}{15} = 3.70\%$$

Thus, a conservative AF of 5% was adopted and equation (2) is updated to:

$$BE_{y} = 0.95 \times MD_{\text{project, y}} \times GWP_{CH4} + EL_{LFG, y} \times CEF_{elect, BL, y}$$
(5)

The sum of the quantities fed to the flare(s), to the power plant(s), to the boiler(s), to the electricity generator(s) and to the natural gas distribution network, estimated using equation (5) will be compared annually with the total quantity of methane generated. The lowest value of the two will be adopted as MD<sub>project,y</sub>.

$$MD_{\text{project, y}} = MD_{\text{flare, y}} + MD_{\text{electricity, y}} + MD_{\text{thermal, y}} + MD_{\text{PL, y}}$$
(6)

Where:

<b>MD</b> <sub>flared,y</sub>	Quantity of methane destroyed by flaring (tCH <sub>4</sub> )
$MD_{electricity,y}$	Quantity of methane destroyed by generation of electricity (tCH <sub>4</sub> )
$MD_{thermal,y}$	Quantity of methane destroyed for the generation of thermal energy (tCH <sub>4</sub> )
$MD_{PL,v}$	Quantity of methane sent to the gas distribution grid $(tCH_4)$

Right Hand Side of the equation (6) is sum over all the points of captured methane use in case the methane is flared in more than one flare, and/or used in more than one electricity generation source, and/or more than one thermal energy generator. As the project will not inject purified methane in the gas distribution grid nor heat,

 $MD_{PL, y} = 0$  $MD_{thermal, y} = 0$ 

And the equation (6) is updated to:

$$MD_{project,y} = MD_{flare, y} + MD_{electricity, y}$$
(7)

The supply to each point of methane destruction, through flaring or use for energy generation, shall be measured separately.

$$MD_{flare, y} = \left(LFG_{flare, y} \times W_{CH4, y} \times D_{CH4}\right) - \left(\frac{PE_{flare, y}}{GWP_{CH4}}\right)$$
(8)

And

$$MD_{electricity,y} = LFG_{electricity,y} \times W_{CH4,y} \times D_{CH4}$$
(9)
Where:





LFG <sub>flare, y</sub>	Quantity of landfill gas fed to the flare(s) during the year measured in cubic meters (m <sup>3</sup> )
LFG <sub>electricity, y</sub>	Quantity of landfill gas sent to the power house (m <sup>3</sup> )
W <sub>CH4,y</sub>	Average methane fraction of the landfill gas as measured during the year and expressed
	as a fraction (in $m^{3}CH_{4}/m^{3}_{LFG}$ )
$D_{CH4}$	Methane density expressed in tonnes of methane per cubic meter of methane
	$(tCH_{4/}m^{3}CH_{4})$
$PE_{flare,y}$	Project emissions from flaring of the residual gas stream in year $y$ (tCO <sub>2</sub> e) determined
	following the procedure described in the "Tool to determine project emissions from
	flaring gases containing methane". If methane is flared through more than one flare,
	the $PE_{\text{flare y}}$ shall be determined for each flare using the tool.

a.1) Methane emissions calculation

The *ex-ante* estimatives of the amount of methane that would have been destroyed/combusted during year y is calculated using thee *"Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site"*:

$$MD_{\text{project}, y} = \frac{\phi \times (1 - f) \times GWP_{CH_4} \times (1 - OX) \times \frac{16}{12} \times F \times DOC_f \times MCF \times \sum_{x=1}^{y} \sum_{j} W_{x, j} \times DOC_j \times e^{-k_j(y-x)} \times (1 - e^{-k_j})}{GWP_{CH_4}}$$
(10)

MD <sub>project, y</sub>	Methane emissions avoided during the year y from preventing waste disposal at the
	solid waste disposal site (SWDS) during the period from the start of the project activity
	to the end of the year y $(tCO_2e)$
$\phi$	Model correction factor to account for model uncertainties (0,9)
f	Fraction of methane captured at the SWDS and flared, combusted or used in another
	manner
$GWP_{CH4}$	Global Warming Potential (GWP) of methane, valid for the relevant commitment
	period
OX	Oxidation factor (reflecting the amount of methane from SWDS that is oxidised in the
	soil or other material covering the waste)
F	Fraction of methane in the SWDS gas (volume fraction) (0.5)
$DOC_f$	Fraction of degradable organic carbon (DOC) that can decompose
MCF	Methane correction factor
$W_{i,x}$	Amount of organic waste type j prevented from disposal in the SWDS in the year x
	(tons)
$DOC_j$	Fraction of degradable organic carbon (by weight) in the waste type <i>j</i>
k <sub>i</sub>	Decay rate for the waste type <i>j</i>
j	Waste type category (index)
x	Year during the crediting period: x runs from the first year of the first crediting period
	(x = 1) to the year y for which avoided emissions are calculated $(x = y)$
у	Year for which methane emissions are calculated





According with USEPA<sup>6</sup>, collection efficiency for energy recovery between 75% and 85% sounds reasonable "because each cubic foot of gas will have a monetary value to the owner/operator". A conservative value of 60% was adopted, thus equation (10) is updated to:

$$MD_{\text{project, y}} = 60\% \times \frac{\phi \times (1-f) \times GWP_{CH_4} \times (1-OX) \times \frac{16}{12} \times F \times DOC_f \times MCF \times \sum_{x=1}^{y} \sum_{j} W_{x, j} \times DOC_j \times e^{-k_j(y-x)} \times (1-e^{-k_j})}{GWP_{CH_4}}$$
(10)

#### a.2) Grid-emission factor calculation

 $CEF_{elec, BL, y}$  will be calculated according with the *Tool for calculation of emission factor for electricity systems* ( $EF_{CM, y}$  in the tool). The tool 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.

The Emission Factor is calculated as the *Combined Margin (CM)*, comprised by two components: the *Built Margin (BM)* and the *Operation Margin (OM)*. The BM evaluates the contribution of the power plants which would have been built if the project plant would not have been implemented. The OM evaluates the contribution of the power plants which would have been dispatched in the absence of the project activity.

The CM calculation must be based in data from an official source, preferable the dispatch authority. The capacity additions and the values generated from the power plants registered as CDM project activities must be excluded from the calculation.

As per the steps of the tool:

#### STEP 1. Identify the relevant electric power system.

According with the Tool, "If the DNA of the host country has published a delineation of the project electricity system and connected electricity systems, these delineations should be used". The Brazilian DNA published Resolução n° 8, which makes official the use of a single Electric Grid for CDM project activities applying the tool.

STEP 2. Select an operating margin (OM) method

The Brazilian DNA has calculated the Grid Emission Factor applying option c) Dispatch data analysis OM.

STEP 3. Calculate the operating margin emission factor according to the selected method The dispatch data analysis OM emission factor  $(EF_{grid,OM-DD,y})$  is determined based on the power units that are actually dispatched at the margin during each hour *h* where the project is displacing electricity.

The Brazilian DNA will calculate and publish regularly the emission factor for each year in their web-site.

STEP 4. Identify the cohort of power units to be included in the build margin The power units will be identified by the Brazilian DNA

<sup>&</sup>lt;sup>6</sup> USEPA; Turning a Liability into an Asset: A Landfill Gas-to-Energy Project Development Handbook; September 1996



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<u>STEP 5. Calculate the build margin emission factor</u> The Build Margin will be calculated by the Brazilian DNA.

<u>STEP 6. Calculate the combined margin emissions factor</u> The combined margin emissions factor is calculated as follows:

$$EF_{Grid, CM, y} = EF_{Grid, OM, y} \times W_{OM} + EF_{Grid, BM, y} \times W_{BM}$$
(11)

Where:

EF <sub>Grid, CM, y</sub>	Emission factor for the Brazilian electric grid in year y (tCO <sub>2</sub> /MWh)
EF <sub>Grid, OM, y</sub>	Operating margin $CO_2$ emission factor in year y (t $CO_2$ /MWh)
EF <sub>Grid, BM, y</sub>	Build margin $CO_2$ emission factor in year y (t $CO_2/MWh$ )
WOM	Weighting of operating margin emissions factor (%)
W <sub>BM</sub>	Weighting of build margin emissions factor (%)

According with the Tool, values adopted for  $w_{OM}$  and  $w_{BM}$  were equal to 0.5 for each one during the 1<sup>st</sup> crediting period and 0.25 and 0.75, respectively, for the 2<sup>nd</sup> and 3<sup>rd</sup> crediting periods.

#### b) Project Emissions

Project emissions are related to the amount of methane not destroyed in the flares and due to any amount of electricity consumed from the grid or from the emergency captive diesel generator installed inside the landfill, which will operate only when grid-supply is interrupted.

#### b.1) Project emissions due to the amount of methane not destroyed in the flares

The amount of methane not destroyed will be calculated as per the "*Tool to determine project emissions from flaring gases containing methane*". The project will install enclosed flares and Projeto de Gás de Aterro TECIPAR – PROGAT will make continuous monitoring of methane concentration. The calculation of flare efficiency will be made by the following steps:

#### STEP 1: Determination of the mass flow rate of the residual gas that is flared

$$FM_{RG,h} = \frac{P_n}{\frac{R_n}{\sum (fv_{i,h} \times MM_i)} \times T_n} \times FV_{RG,h}$$
(12)

FM <sub>RG, h</sub>	Mass flow rate of the residual gas in hour $h$ (kg/h);
P <sub>n</sub>	Atmospheric pressure at normal conditions (101,325 Pa)
R <sub>n</sub>	Universal ideal gas constant (8,314 Pa.m <sup>3</sup> /kmol.K)
T <sub>n</sub>	Temperature at normal conditions (273.15 K)
fv <sub>i, h</sub>	Volumetric fraction of component i in the residual gas in the hour $h$
MM <sub>i</sub>	Molecular mass of residual gas component <i>i</i> (kg/kmol)
FV <sub>RG, h</sub>	Volumetric flow rate of the residual gas in dry basis at normal conditions in the hour h
	$(m^3/h)$



i

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The components  $CH_4$ , CO,  $CO_2$ ,  $O_2$ ,  $H_2$ ,  $N_2$ 

As a simplified approach, Projeto de Gás de Aterro TECIPAR – PROGAT will only measure the volumetric fraction of methane and consider the difference to 100% as being nitrogen (N<sub>2</sub>).

Step 2: Determination of the mass fraction of carbon, hydrogen, oxygen and nitrogen in the residual gas

$$fm_{j,h} = \frac{\sum fv_{i,h} \times AM_{j} \times NA_{j,i}}{\sum (fv_{i,h} \times MM_{i})}$$
(13)

Where:

fm <sub>j, h</sub>	Mass fraction of element j in the residual gas in hour h
fv <sub>i, h</sub>	Volumetric fraction of component i in the residual gas in the hour $h$
AM <sub>i</sub>	Atomic mass of element <i>j</i> (kg/kmol)
NA <sub>j, i</sub>	Number of atoms of element <i>j</i> in component <i>i</i>
j	The elements carbon, hydrogen, oxygen and nitrogen
P <sub>n</sub>	Atmospheric pressure at normal conditions (101 325 Pa)
R <sub>n</sub>	Universal ideal gas constant (8 314 Pa.m <sup>3</sup> /kmol.K)
T <sub>n</sub>	Temperature at normal conditions (273.15 K)
fv <sub>i, h</sub>	Volumetric fraction of component i in the residual gas in the hour $h$
MM <sub>i</sub>	Molecular mass of residual gas component <i>i</i> (kg/kmol)
FV <sub>RG, h</sub>	Volumetric flow rate of the residual gas in dry basis at normal conditions in the hour h
	$(m^3/h)$
i	The components $CH_4$ , $CO$ , $CO_2$ , $O_2$ , $H_2$ , $N_2$

STEP 3: Determination of the volumetric flow rate of the exhaust gas on a dry basis

Determine the average volumetric flow rate of the exhaust gas in each hour h based on a stoichiometric calculation of the combustion process, which depends on the chemical composition of the residual gas, the amount of air supplied to combust it and the composition of the exhaust gas, as follows:

$$TV_{n,FG,h} = V_{n,FG,h} \times FM_{RG,h}$$
<sup>(14)</sup>

Where:

TV <sub>n, FG, h</sub>	Volumetric flow rate of the exhaust gas in dry basis at normal conditions in hour $h$
	$(m^3/h)$
V <sub>n, FG, h</sub>	Volume of the exhaust gas of the flare in dry basis at normal conditions per kg of
	residual gas in hour $h (m^3/kg_{residual gas})$
FM <sub>RG, h</sub>	Mass flow rate of the residual gas in the hour h

$$V_{n, FG, h} = V_{n, CO_2, h} + V_{n, O_2, h} + V_{n, N_2, h}$$
(15)





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V <sub>n, FG, h</sub>	Volumetric flow rate of the exhaust gas in dry basis at normal conditions in hour $h$
	$(m^3/h)$
V <sub>n, CO2, h</sub>	Quantity of CO <sub>2</sub> volume free in the exhaust gas of the flare at normal conditions per kg
	of residual gas in the hour $h (m^3/kg_{residual gas})$
V <sub>n, O2, h</sub>	Quantity of $O_2$ volume free in the exhaust gas of the flare at normal conditions per kg of
	residual gas in the hour $h (m^3/kg_{residual gas})$
V <sub>n, N2, h</sub>	Quantity of N <sub>2</sub> volume free in the exhaust gas of the flare at normal conditions per kg of
	residual gas in the hour $h (m^3/kg_{residual gas})$

$$\mathbf{V}_{\mathbf{n},\mathbf{O}_2,\mathbf{h}} = \mathbf{n}_{\mathbf{O}_2,\mathbf{h}} \times \mathbf{M} \mathbf{V}_{\mathbf{n}}$$

(16)

Where:

V <sub>n, O2, h</sub>	Quantity of O <sub>2</sub> volume free in the exhaust gas of the flare at normal conditions per kg of
	residual gas in the hour $h (m^3/kg_{residual gas})$
n <sub>O2, h</sub>	Quantity of moles $O_2$ in the exhaust gas of the flare per kg residual gas flared in hour h
	(kmol/kg <sub>residual gas</sub> )
MV <sub>n</sub>	Volume of one mole of any ideal gas at normal temperature and pressure (22.4 L/mol)

$$V_{n,N_{2},h} = MV_{n} \times \left\{ \frac{fm_{N,h}}{200 \text{ AM}_{N}} + \left( \frac{1 - MF_{O_{2}}}{MF_{O_{2}}} \right) \times \left[ F_{h} + n_{O_{2},h} \right] \right\}$$
(17)

Where:

$V_{n, N2, h}$	Quantity of $N_2$ volume free in the exhaust gas of the flare at normal conditions per kg of
	residual gas in the hour $h$ (m <sup>2</sup> /kg <sub>residual gas</sub> )
$MV_n$	Volume of one mole of any ideal gas at normal temperature and pressure (22.4 L/mol)
n <sub>O2, h</sub>	Quantity of moles $O_2$ in the exhaust gas of the flare per kg residual gas flared in hour h
	(kmol/kg <sub>residual gas</sub> )
fm <sub>N, h</sub>	Volumetric fraction of Nitrogen in the residual gas in the hour h
$AM_N$	Atomic mass of element Nitrogen (kg/kmol)
MF <sub>02</sub>	O <sub>2</sub> volumetric fraction of air
F <sub>h</sub>	Stochiometric quantity of moles of O <sub>2</sub> required for a complete oxidation of one kg
	residual gas in hour h (kmol/kg <sub>residual gas</sub> )

$$V_{n, CO_2, h} = \frac{fm_{C, h}}{AM_C} \times MV_n$$

(18)

V <sub>n, CO2, h</sub>	Quantity of CO <sub>2</sub> volume free in the exhaust gas of the flare at normal conditions per kg
	of residual gas in the hour $h (m^3/kg_{residual gas})$
fm <sub>C, h</sub>	Volumetric fraction of Carbon in the residual gas in the hour h





MV <sub>n</sub>	Volume of one mole of any ideal gas at normal temperature and pressure (22.4 L/mol)
AM <sub>C</sub>	Atomic mass of element Carbon (kg/kmol)

$$n_{O_{2},h} = \frac{t_{O_{2},h}}{\left(1 - \frac{t_{O_{2},h}}{MF_{O_{2}}}\right)} \times \left[\frac{fm_{C,h}}{AM_{C}} + \frac{fm_{N,h}}{2AM_{N}} + \left(\frac{1 - MF_{O_{2}}}{MF_{O_{2}}}\right) \times F_{h}\right]$$
(19)

Where:

n <sub>O2, h</sub>	Quantity of moles $O_2$ in the exhaust gas of the flare per kg residual gas flared in hour h
	(kmol/kg <sub>residual gas</sub> )
t <sub>O2, h</sub>	Volumetric fraction of $O_2$ in the exhaust gas in the hour <i>h</i>
MF <sub>02</sub>	Volumetric fraction of $O_2$ in the air (0.21)
F <sub>h</sub>	Stochiometric quantity of moles of O <sub>2</sub> required for a complete oxidation of one kg
	residual gas in hour $h$ (kmol/kg <sub>residual gas</sub> )
fm <sub>j, h</sub>	Mass fraction of element j in the residual gas in hour h
j	The elements carbon (C) and nitrogen (N)
AMj	Atomic mass of element <i>j</i> (kg/kmol)

$$F_{\rm h} = \frac{fm_{\rm C,h}}{AM_{\rm C}} + \frac{fm_{\rm H,h}}{4 \times AMH} - \frac{fm_{\rm O,h}}{2 \times AMO}$$
(20)

Where:

F <sub>h</sub>	Stochiometric quantity of moles of O <sub>2</sub> required for a complete oxidation of one kg
	residual gas in hour $h$ (kmol/kg <sub>residual gas</sub> )
fm <sub>j, h</sub>	Mass fraction of element j in the residual gas in hour h
j	The elements carbon (C), hydrogen (H) and oxigen (O)
AM <sub>j</sub>	Atomic mass of element <i>j</i> (kg/kmol)

STEP 4: Determination of methane mass flow rate in the exhaust gas on a dry basis

$$TM_{FG,h} = \frac{TV_{n,FG,h} \times fv_{CH_4,FG,h}}{1,000,000}$$
(21)

TM <sub>FG, h</sub>	Mass flow rate of methane in the exhaust gas of the flare in dry basis at normal conditions in the hour $h$ (kg/h)
TV <sub>n, FG, h</sub>	Volumetric flow rate of the exhaust gas in dry basis at normal conditions in hour h $(m^3/h_{exhaust gas})$
fv <sub>CH4, FG, h</sub>	Concentration of methane in the exhaust gas of the flare in dry basis at normal conditions in hour $h (mg/m^3)$



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$$TM_{RG, h} = FV_{RG, h} \times fv_{CH_4, FG, h} \times \rho_{CH_4, n}$$

Where:

TM <sub>FG, h</sub>	Mass flow rate of methane in the exhaust gas of the flare in dry basis at normal
	conditions in the hour $h$ (kg/h)
FV <sub>n, RG, h</sub>	Volumetric flow rate of the residual gas in dry basis at normal conditions in hour $h$
	$(m^{3}/h))$
fv <sub>CH4, FG, h</sub>	Concentration of methane in the exhaust gas of the flare in dry basis at normal
	conditions in hour $h (mg/m^3)$
р <sub>СН4, п</sub>	Density of methane at normal conditions $(0.716 \text{ kg/m}^3)$

STEP 6: Determination of the hourly flare efficiency

As the Projeto de Gás de Aterro TECIPAR – PROGAT will install enclosed flares and the monitoring of methane concentration will be made continuously, the flare efficiency in the hour h ( $\eta_{\text{flare, h}}$ ) is

- 0% if the temperature of the exhaust gas of the flare ( $T_{flare}$ ) is below 500 °C during more than 20 minutes during the hour *h*.
- determined as follows in cases where the temperature of the exhaust gas of the flare ( $T_{flare}$ ) is above 500 °C for more than 40 minutes during the hour h :

$$\eta_{\text{flare, h}} = 1 - \frac{\text{TM}_{\text{FG, h}}}{\text{TM}_{\text{RG, h}}}$$
(23)

Where:

$\eta_{\text{flare, h}}$	Flare efficiency in the hour <i>h</i>
TM <sub>FG, h</sub>	Methane mass flow rate in exhaust gas averaged in hour $h$ (kg/h)
TM <sub>RG, h</sub>	Mass flow rate of methane in the residual gas in the hour $h$ (kg/h)

#### STEP 7. Calculation of annual project emissions from flaring

Project emissions from flaring are calculated as the sum of emissions from each hour *h*, based on the methane flow rate in the residual gas  $(TM_{RG,h})$  and the flare efficiency during each hour *h*  $(\eta_{flare,h})$ , as follows:

$$PE_{flare, y} = \sum_{h=1}^{8,760} TM_{RG, h} \times (1 - \eta_{Flare, h}) \times \frac{GWP_{CH_4}}{1,000}$$
(24)

Where.	
PE <sub>flare, y</sub>	Project emissions from flaring of the residual gas stream in year y (tCO <sub>2</sub> e)
TM <sub>RG, h</sub>	Mass flow rate of methane in the residual gas in the hour $h$ (kg/h)
$\eta_{\text{flare, h}}$	Flare efficiency in the hour <i>h</i>
GWP <sub>CH4</sub>	Global Warming Potential (tCO <sub>2</sub> e/tCH <sub>4</sub> ) valid for the commitment period

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b.2) Project Emissions due to the consumption of electricity from the grid

Project emissions from grid electricity consumption are calculated according with the *Tool to* calculate baseline, project and/or leakage emissions from electricity consumption. The project will consume electricity both from the grid and from a captive diesel generator, which will operate only when grid electricity supply is interrupted.

According with the tool, Projeto de Gás de Aterro TECIPAR – PROGAT will corresponds to to Scenarios:

- <u>Scenario A (for grid-consumption electricity)</u>: *Electricity consumption from the grid. The electricity is purchased from the grid only. Either no captive power plant is installed at the site of electricity consumption or, if any onsite captive power plant exits, it is not operating or it can physically not provide electricity to the source of electricity consumption*; and
- <u>Scenarion B (operation of the emergency captive diesel generator)</u>: One or more fossil fuel fired captive power plants are installed at the site of the electricity consumption source and supply the source with electricity. The captive power plant(s) is/are not connected to the electricity grid.

Despite of consuming electricity from the grid and from a captive power plant, **Scenario** C is not applied because the diesel generator (captive power plant) is *not* connected to the grid.

#### b.2.1) Project Emissions Calculation in Scenario A

For the calculation of project emissions in Scenario A, the following equation will be used:

$$PE_{EC, Scenario A, y} = \sum_{j} EC_{PJ, j, y} \times EF_{EL, j, y} \times (1 + TDL_{j, y})$$
(25)

Where:

,, nere.	
PE <sub>EC, Scenario A, y</sub>	Project emissions from electricity consumption in Scenario A, in year y (tCO <sub>2</sub> /yr)
$EC_{PJ, j, y}$	Quantity of electricity consumed by the project electricity consumption source <i>j</i> in year
	y (MWh/yr)
EF <sub>EJ, j, y</sub>	Emission factor for electricity generation for source <i>j</i> in year <i>y</i> (tCO <sub>2</sub> /MWh)
TDL <sub>j, y</sub>	Average technical transmission and distribution losses for providing electricity to
	source <i>j</i> in year <i>y</i>
j	Sources of electricity consumption in the project

The project will apply option A1 to calculate the emission factor, with the following assumptions:

- Index *j* corresponds to the Electric Grid (EG); and
- $EF_{EL, j, y} = EF_{EL, EG, y}$  is calculated according with the *Tool for calculation of emission factor for electricity systems*, previously presented.

Thus, the above equation is updated to:



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$$PE_{EC, Scenario A, y} = EC_{PJ, EG, y} \times EF_{EL, EG, y} \times (1 + TDL_{EG, y})$$
(26)
Where:

where.	
PE <sub>EC, y</sub>	Project emissions from electricity consumption in year y (tCO <sub>2</sub> /yr)
EC <sub>PJ, EG, y</sub>	Quantity of electricity consumed by the Electric Grid in year y (MWh/yr)
EF <sub>EJ, j, y</sub>	Emission factor for electricity generation for the Electric Grid in year y (tCO <sub>2</sub> /MWh)
TDL <sub>i, y</sub>	Average technical transmission and distribution losses for providing electricity to the
5.5	Electric Grid in year y

#### b.2.2) Project Emissions Calculation in Scenario B

For the calculation of project emissions in Scenario B, the following equation will be used:

$$PE_{EC, Scenario B, y} = \sum_{j} EC_{PJ, j, y} \times EF_{EL, j, y} \times (1 + TDL_{j, y})$$
(27)

Where:

PE <sub>EC, Scenario B, y</sub>	Project emissions from electricity consumption in Scenario B, in year y (tCO <sub>2</sub> /yr)
EC <sub>PJ, j, y</sub>	Quantity of electricity consumed by the project electricity consumption source <i>j</i> in year
	y (MWh/yr)
EF <sub>EJ, j, y</sub>	Emission factor for electricity generation for source $j$ in year $y$ (tCO <sub>2</sub> /MWh)
TDL <sub>j, y</sub>	Average technical transmission and distribution losses for providing electricity to
	source <i>j</i> in year <i>y</i>

The project will apply option B1 to calculate the emission factor, with the following assumptions:

- $TDL_{j,y} = 0$ , as there are no looses in the electricity transmission once the diesel generator is located inside Ventura landfill;
- Index *j* corresponds to the Emergency Captive Diesel Generator (ECDG); and
- $EF_{EL, j, y} = EF_{EL, DG, y}$  is calculated according as follows:

$$EF_{EL, ECDG, y} = \frac{\sum_{j} \sum_{j} FC_{n, i, t} \times NCV_{i, t} \times EF_{CO2, i, t}}{\sum_{n} EG_{n, t}}$$
(28)

EF <sub>EL, ECDG, y</sub>	Emission factor for the Emergency Captive Diesel Generator (ECDG) in year y
	(tCO <sub>2</sub> /MWh)
$FC_{n, i, t}$	Quantity of fossil fuel type <i>i</i> fired in the captive power plant <i>n</i> in the time period <i>t</i> (mass or
	volume unit)
NCV <sub>i, t</sub>	Average net calorific value of fossil fuel type $i$ used in the period $t$ (GJ/mass or volume
	unit)
EF <sub>CO2, i, t</sub>	Average CO <sub>2</sub> emission factor of fossil fuel type <i>i</i> used in the period <i>t</i> (tCO <sub>2</sub> /GJ)
EG <sub>n, t</sub>	Quantity of electricity generated in captive power plant $n$ in the time period $t$ (MWh)
j	Sources of electricity consumption in the project (ECDG = Emergency Captive Diesel



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	Generator)
n	Fossil fuel fired captive power plants installed at the site of the electricity consumption
	source <i>j</i> . For Projeto de Gás de Aterro TECIPAR – PROGAT, <i>n</i> corresponds to Diesel (D);
t	Time period for which the emission factor for electricity generation is determined. For
	Projeto de Gás de Aterro TECIPAR – PROGAT, t corresponds to the monitoring period
	(e.g. the year y)

Thus, the two above equations are updated to:

$$PE_{EC, Scenario B, y} = EC_{PJ, ECDG, y} \times \frac{FC_{ECDG, D, y} \times NCV_{D, y} \times EF_{CO2, D, y}}{EG_{ECDG, y}}$$
(29)

Where:

PE <sub>EC, Scenario B, y</sub>	Project emissions from electricity consumption in year y (tCO <sub>2</sub> /yr)
EC <sub>PJ, ECDG, y</sub>	Quantity of electricity consumed from the Emergency Captive Diesel Generator
	(ECDG) in year y (MWh/yr)
FC <sub>ECDG, D, y</sub>	Quantity of Diesel fired in the Emergency Captive Diesel Generator (ECDG) in the
	time period t (mass or volume unit)
NCV <sub>D, y</sub>	Average net calorific value of the Diesel used in the period <i>t</i> (GJ/mass or volume unit)
EF <sub>EJ, j, y</sub>	Emission factor for the Diesel in year $y$ (tCO <sub>2</sub> /MWh)
EG <sub>ECDG, y</sub>	Electricity Generated by the Emergency Captive Diesel Generator (ECDG) in the time
	period t (MWh)

As the all electricity produced by the Emergency Captive Diesel Generator will used only to supply the project,

 $EC_{PJ, ECDG, y} = EG_{ECDG, y}$ 

And the equation is updated to:

$$PE_{EC, Scenario B, y} = FC_{ECDG, D, y} \times NCV_{D, y} \times EF_{CO2, D, y}$$
(30)

Project emissions from electricity consumption is equal to the sum of

$$PE_{EC, y} = PE_{EC, Scenario A, y} + PE_{EC, Scenario B, y}$$
(31)

Project emissions from the inefficiency of flaring methane and from electricity consumption is equal to:

$$PE_{y} = PE_{EC, y} + PE_{Flare, y}$$
(32)

<u>c) Leakage</u> According with version 09.1 of ACM0001, no leakage needs to be accounted.



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#### d) Emission Reductions

Emission Reductions will be calculated according with the equation below:

$$ER_y = BE_y - PE_y$$

(33)

W	here:
••	nore.

where.	
ERy	Emission Reductions in year $y$ (tCO <sub>2</sub> e)
$BE_y$	Baseline Emissions due to the natural emissions of methane to the atmosphere and due
-	to the displacement of grid-fossil fuel electricity generation in year $y$ (tCO <sub>2</sub> e)
$PE_y$	Project Emissions from flare efficiency and electricity consumption from the grid and
-	from the captive diesel generator in year $y$ (tCO <sub>2</sub> e)

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

#### ACM0001 – Consolidated methodology for landfill gas project activities

Data / Parameter:	Regulatory requirements relating to landfill gas projects
Data unit:	% or m <sup>3</sup>
Description:	Regulatory requirements relating to landfill gas projects
Source of data used:	Publicly available information of the host country's regulatory
	requirements relating to landfill gas.
Value applied:	5%
Justification of the	Explained above.
choice of data or	
description of	
measurement methods	
and procedures actually	
applied :	
Any comment:	The information though recorded annually, is used for changes to the
	adjustment factor (AF) or directly MD <sub>reg,y</sub> at renewal of the credit period
	- variable updated at renewal of each credit period. The DNA was
	contacted and provided information that there are no federal
	laws/regulations which obligates the destruction of methane in landfills.

Data / Parameter:	GWP <sub>CH4</sub>
Data unit:	tCO <sub>2</sub> e/tCH <sub>4</sub>
Description:	Global Warming Potential of Methane
Source of data used:	IPCC
Value applied:	21
Justification of the	21 for the first commitment period. Shall be updated according to any
choice of data or	future COP/MOP decisions.
description of	
measurement methods	
and procedures actually	
applied :	
Any comment:	-

Data / Parameter:	D <sub>CH4</sub>
Data unit:	$t_{CH4}/m_{CH4}^3$
Description:	Methane Density





Source of data used:	-
Value applied:	0.0007168
Justification of the	At standard temperature and pressure (0°C and 1.013 bar)
choice of data or	
description of	
measurement methods	
and procedures actually	
applied :	
Any comment:	-

Data / Parameter:	BE <sub>CH4,SWDS,y</sub>
Data unit:	tCO <sub>2</sub> e
Description:	Methane generation from the landfill in the absence of the project activity
	at year y
Source of data used:	Calculated as per the "Tool to determine methane emissions avoided from
	disposal of waste at a solid waste disposal site"
Value applied:	
Justification of the	As per the "Tool to determine methane emissions avoided from disposal
choice of data or	of waste at a solid waste disposal site"
description of	
measurement methods	
and procedures actually	
applied :	
Any comment:	Used for ex-ante estimation of the amount of methane that would have
	been destroyed/combusted during the year

Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site

Data / Parameter:	φ
Data unit:	-
Description:	Model correction factor to account for model uncertainties
Source of data used:	2006 IPCC Guidelines for National Greenhouse Gas Inventories
Value applied:	0.9
Justification of the	As per the "Tool to determine methane emissions avoided from disposal
choice of data or	of waste at a solid waste disposal site"
description of	
measurement methods	
and procedures actually	
applied :	
Any comment:	Oonk et el. (1994) have validated several landfill gas models based on 17
	realized landfill gas projects. The mean relative error of multi-phase
	models was assessed to be 18%. Given the uncertainties associated with
	the model and in order to estimate emission reductions in a conservative
	manner, a discount of 10% is applied to the model results.

Data / Parameter:	OX
Data unit:	-
Description:	Oxidation factor (reflecting the amount of methane from SWDS that is
	oxidized in the soil or other material covering the waste)
Source of data used:	2006 IPCC Guidelines for National Greenhouse Gas Inventories
Value applied:	0





Justification of the	The Ventura landfill operates with a clay layer which is compacted when
choice of data or	the cell is being closed. As this kind of cover is not considered an
description of	oxidising material, OX used for calculations is equal to 0.
measurement methods	
and procedures actually	
applied :	
Any comment:	

Data / Parameter:	F
Data unit:	-
Description:	Fraction of methane in the SWDS gas (volume fraction)
Source of data used:	2006 IPCC Guidelines for National Greenhouse Gas Inventories
Value applied:	0.5
Justification of the	This factor reflects the fact that some degradable organic carbon does not
choice of data or	degrade, or degrades very slowly, under anaerobic conditions in the
description of	SWDS. A default value of 0,5 is recommended by IPCC.
measurement methods	
and procedures actually	
applied :	
Any comment:	

Data / Parameter:	DOC <sub>f</sub>
Data unit:	-
Description:	Fraction of degradable organic carbon (DOC) that can decompose
Source of data used:	2006 IPCC Guidelines for National Greenhouse Gas Inventories
Value applied:	0.5
Justification of the	Standard value applied by IPCC
choice of data or	
description of	
measurement methods	
and procedures actually	
applied :	
Any comment:	

Data / Parameter:	MCF
Data unit:	-
Description:	Methane correction factor
Source of data used:	2006 IPCC Guidelines for National Greenhouse Gas Inventories
Value applied:	1.0
Justification of the	According with the 2006 IPCC Guidelines, the Ventura landfill does
choice of data or	meet the criteria of managed SWDS and have depths of greater than or
description of	equal to 5 meters (50 meters) and/or high water table at near ground
measurement methods	level.
and procedures actually	
applied :	
Any comment:	The methane correction factor (MCF) accounts for the fact that
	unmanaged SWDS produce less methane from a given amount of waste
	than managed SWDS, because a larger fraction of waste decomposes
	aerobically in the top layers of unmanaged SWDS.



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Data / Parameter:	DOC <sub>i</sub>				
Data unit:	-				
Description:	Fraction of degrad	lable organic carbon (by weight) in the waste type j			
Source of data used:	2006 IPCC Guide	lines for National Greenhouse Gas Inventories			
Value applied:					
	DOC <sub>i</sub>	Waste tune :			
	(% wet waste)	waste type j			
	43	Wood and wood products			
	40	Pulp, paper and cardboard			
	15 Food, food waste, beverages and tobacco				
	24	Textiles			
	20	Garden, yard and park waste			
	0	Glass, plastic, metal, other inert waste			
Justification of the	According with th	e version of the Tool to determine methane emissions			
choice of data or	avoided from disposal of waste at a solid waste disposal site applied for				
description of	the project.				
measurement methods					
and procedures actually					
applied :					
Any comment:					

Data / Parameter:	Wj			
Data unit:	Tons			
Description:	Total amount of	organic waste preven	ted from disposal in year x (tons)	
Source of data used:	BIOPAR Soluçõe	es Ambientais Ltda.		
Value applied:				
	Year	Waste Disposed		
	2003	3,511		
	2004	5,776		
	2005	45,551		
	2006	85,549		
	2007	127,475		
	2008	144,000		
	2009	180,000		
	2010	180,000		
	2011	180,000		
	2012	180,000		
	2013	180,000		
	2014	180,000		
	2015	180,000		
	2016	180,000		
	2017	180,000		
	OBS: data from 2	2008 on are estimativ	es	
Justification of the				
choice of data or				
description of				





measurement methods	
and procedures actually	
applied :	
Any comment:	

Data / Parameter:	<b>P</b> <sub>n, j, x</sub>			
Data unit:	-			
Description:	Weight fraction of the waste type <i>j</i> in the san	nple <i>n</i> collected d	luring the	
	year x			
Source of data used:	BIOPAR Soluções Ambientais Ltda.			
Value applied:				
	Type of Weste	%		
	Type of waste	(wet basis)		
	Wood and wood products	0.13%		
	Pulp, paper and cardboard	0.25%		
	Food, food waste, beverages and tobacco 93.00%			
	Textiles	0.13%		
	Garden, yard and park waste	5.00%		
	Glass, plastic, metal, other inert waste	1.50%		
Justification of the	-			
choice of data or				
description of				
measurement methods				
and procedures actually				
applied :				
Any comment:	-			

Data / Parameter:	k <sub>i</sub>					
Data unit:	-					
Description:	Decay rate for t	he waste type <i>j</i>				
Source of data used:	2006 IPCC Gui	delines for National Greenhouse Gas	Inventories			
Value applied:						
		Waste type <i>j</i>	k <sub>i</sub>			
	Slowly	Pulp, paper, cardboard (other than sludge), textiles	0.070			
	degrading	Wood, wood products and straw	0.035			
	Moderately degrading	Other (non-food) organic putrescible garden and park waste	0.17			
	Rapidly degradingFood, food waste, sewage sludge, beverages and tobacco0.4					
Justification of the	Those values were adopted considering the climate of the Barueri (city					
choice of data or	next to Santana de Parnaíba):					





description of	
measurement methods	- $MAT_{historical} = 20.6^{\circ}C$ (data from EMBRAPA – Empresa
and procedures actually	Brasileira de Pesquisa Agropecuária <sup>7</sup> );
applied :	- MAP <sub>historical</sub> = 1,402 mm (data from EMBRAPA – Empresa
	Brasileira de Pesquisa Agropecuária <sup>7</sup> );
	- PET <sub>historical</sub> = 957.0mm (data from EMBRAPA – Empresa
	Brasileira de Pesquisa Agropecuária <sup>7</sup> )
Any comment:	

Tool to determine project emissions from flaring gases containing methane

Parameter	Description	Value
$MM_{CH4}$	Molecular mass of carbon methane	16.04 kg/kmol
$MM_{CO}$	Molecular mass of carbon monoxide	28.01 kg/kmol
MM <sub>CO2</sub>	Molecular mass of carbon dioxide	44.01 kg/kmol
$MM_{O2}$	Molecular mass of oxygen	32.00 kg/kmol
$MM_{H2}$	Molecular mass of hydrogen	2.02 kg/kmol
$MM_{N2}$	Molecular mass of nitrogen	28.02 kg/kmol
AM <sub>C</sub>	Atomic mass of carbon	12.00 kg/kmol
$AM_{H}$	Atomic mass of hydrogen	1.01 kg/kmol
AMo	Atomic mass of oxygen	16.00 kg/kmol
$AM_N$	Atomic mass of nitrogen	14.01 kg/kmol

#### **B.6.3** Ex-ante calculation of emission reductions:

#### a) LFG Generation

Applying the *Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site*, the following table resumes the calculation:

<sup>&</sup>lt;sup>7</sup> http://www.bdclima.cnpm.embrapa.br/resultados/balanco.php?UF=sp&COD=264



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Year	LFG emissions (Nm <sup>3</sup> <sub>lfg</sub> )	Methane Emissions (Nm <sup>3</sup> <sub>CH4</sub> )	Year	LFG emissions (Nm <sup>3</sup> <sub>lfg</sub> )	Methane Emissions (Nm <sup>3</sup> <sub>CH4</sub> )
2003	70,034	35,017	2021	2,469,290	1,234,645
2004	162,599	81,300	2022	1,725,258	862,629
2005	1,018,700	509,350	2023	1,216,917	608,458
2006	2,395,950	1,197,975	2024	867,987	433,993
2007	4,165,192	2,082,596	2025	627,119	313,560
2008	5,694,346	2,847,173	2026	459,710	229,855
2009	7,451,116	3,725,558	2027	342,408	171,204
2010	8,644,894	4,322,447	2028	259,429	129,714
2011	9,458,935	4,729,467	2029	200,080	100,040
2012	10,016,437	5,008,218	2030	157,100	78,550
2013	10,400,284	5,200,142	2031	125,543	62,772
2014	10,666,289	5,333,144	2032	102,026	51,013
2015	10,852,082	5,426,041	2033	84,223	42,112
2016	10,983,068	5,491,534	2034	70,528	35,264
2017	11,076,434	5,538,217	2035	59,823	29,912
2018	7,553,365	3,776,682	2036	51,324	25,662
2019	5,173,387	2,586,694	2037	44,476	22,238
2020	3,562,423	1,781,211	2038	38,883	19,441

Table 4. Estimative of methane emissions in the baseline

The following data was used to calculate *ex-ante* methane estimatives:

#### MFC (Methane Conversion Factor):

MCF value is adopted according with the type of SWDS. The Ventura landfill is a managed SWDS with more than 5 meters depth; thus, the MCF adopted is equal to **1.0**.

Applying a collection efficiency of 60%, the final result is:



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Year	LFG Collected (Nm <sup>3</sup> <sub>lfg</sub> )	Methane Collected (Nm <sup>3</sup> <sub>CH4</sub> )
2003	42,020	21,010
2004	97,560	48,780
2005	611,220	305,610
2006	1,437,570	718,785
2007	2,499,115	1,249,558
2008	3,416,607	1,708,304
2009	4,470,670	2,235,335
2010	5,186,936	2,593,468
2011	5,675,361	2,837,680
2012	6,009,862	3,004,931
2013	6,240,170	3,120,085
2014	6,399,773	3,199,887
2015	6,511,249	3,255,624
2016	6,589,841	3,294,920
2017	6,645,860	3,322,930
2018	4,532,019	2,266,009
2019	3,104,032	1,552,016
2020	2,137,454	1,068,727

Year	LFG Collected (Nm <sup>3</sup> <sub>lfg</sub> )	Methane Collected (Nm <sup>3</sup> <sub>CH4</sub> )
2021	1,481,574	740,787
2022	1,725,258	862,629
2023	1,216,917	608,458
2024	867,987	433,993
2025	627,119	313,560
2026	459,710	229,855
2027	342,408	171,204
2028	259,429	129,714
2029	200,080	100,040
2030	157,100	78,550
2031	125,543	62,772
2032	102,026	51,013
2033	84,223	42,112
2034	70,528	35,264
2035	59,823	29,912
2036	51,324	25,662
2037	44,476	22,238
2038	38,883	19,441

#### **b) Electricity Generation**

It's estimated that the project reaches a total installed capacity of 6.5 MW. The table below presents the electricity generation estimatives:

Year	Electricity Generation (MWh)	Ano	Electricity Generation (MWh)
2009	17,869	2020	37,296
2010	19,161	2021	31,131
2011	25,548	2022	25,548
2012	25,548	2023	19,161
2013	31,936	2024	18,710
2014	31,936	2025	12,774
2015	38,323	2026	12,774
2016	38,323	2027	11,852
2017	43,595	2028	6,387
2018	44,710	2029	6,387
2019	44,710		

#### c) Grid Emission Factor Calculation.

The data used to calculate the grid emission factor was taken from the Brazilian DNA. The factor will be updated every month, using dispatch data from the ONS from 2007:



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	BUILT MARGIN
	Average Emission Factor (tCO <sub>2</sub> /MWh) – ANNUAL
2007	0.0775

OPERATING MARGIN													
Average Emission Factor (tCO <sub>2</sub> /MWh) – MONTHLY													
MONTH													
2007	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	AVERAGE
	0.2292	0.1954	0.1948	0.1965	0.1606	0.2559	0.3096	0.324	0.355	0.3774	0.4059	0.4865	0.2909

The Combined Margin (CM) for the Projeto de Gás de Aterro TECIPAR - PROGAT is calculated as the weighted average of the Build Margin (BM) and Operating Margin (OM), as follows:

 $CM_{2007} = 0.5 \text{ x} (OM_{-2007} \text{ x BM}_{2007}) = 0.1842 \text{ tCO}_2/MWh$ 

<b>B.6.4</b> Summary of the ex-ante estimation of emission reductions:						
Year	Estimations of Project Activity Emissions (tCO <sub>2</sub> e/year)	Estimations of Baseline Emissions (tCO2e/year)	Estimation of Leakage (tCO <sub>2</sub> e/year)	Estimation of Emission Reductions (tCO <sub>2</sub> e/year)		
2009	639	67.223	0	66.583		
2010	742	77.704	0	76.962		
2011	812	85.865	0	85.053		
2012	859	90.648	0	89.789		
2013	892	95.118	0	94.226		
2014	915	97.400	0	96.485		
2015	931	100.171	0	99.240		
TOTAL	5.791	614.128	0	608.337		

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

#### **B.7.1** Data and parameters monitored:

Data / Parameter:	1. LFG <sub>total, y</sub>
Data unit:	m <sup>3</sup>
Description:	Total amount of landfill gas captured at Normal Temperature and
	Pressure
Source of data to be	Project participants.
used:	
Value of data applied	Variable (see item B.6.3.)
for the purpose of	
calculating expected	
emission reductions in	
section B.5	
Description of	Continuous readings from the turbine flow-meter installed. The
measurement methods	equipment is connected to a supervisory computer system, which
and procedures to be	registers continuously the LFG measured. Data to be aggregated monthly
applied:	and yearly.





QA/QC procedures to be applied:	Flow meters should be subject to a regular maintenance and testing regime to ensure accuracy, in compliance with national laws (example in Germany and in Italy, for turbine meters of this size, calibration is never required; in Brazil there are no requirements concerning the device's calibration). The calibration will be undertaken according with the manufacturer's recommendation.
	The equivalent errors of the flow-meter will be discounted from the total gas measured, in order to assure the conservadorism.
Any comment:	<ul> <li>Monitoring under responsibility of the Projeto de Gás de Aterro TECIPAR – PROGAT's operators (the team, the organizational structure and the management structure will be defined after the project's implementation).</li> <li>Automatic readings of temperature and pressure will be made by sensors connected to the flow-meter – these data will be used to convert the gas- flow to Nm<sup>3</sup>;</li> <li>All registrations will be kept for 2 years after the end of the crediting period;</li> <li>Initially, there will be one flare installed. While the power-house is not</li> </ul>
	operating, there is no need to measure the total gas collected and the total gas sent to flares, thus only the totalizer flow-meter will be installed and used to calculate ERs. Case a second flare is installed and after the construction of the power house, new flow-meters will be installed for each flare and for each engine, as per the Monitoring Methodology.

Data / Parameter:	2. LFG <sub>flares y</sub>
Data unit:	m <sup>3</sup>
Description:	Total amount of landfill gas sent to flares at Normal Temperature and
	Pressure
Source of data to be	Project participants.
used:	
Value of data applied	Variable (see itemB.6.3.)
for the purpose of	
calculating expected	
emission reductions in	
section B.5	
Description of	Continuous readings from the annubar + differential pressure transducer
measurement methods	installed. The equipments are connected to a supervisory computer
and procedures to be	system, which registers continuously the LFG measured. Data to be
applied:	aggregated monthly and yearly.
	There will be one annubar + differential pressure transducer for each flare
	installed.
QA/QC procedures to	Annubar + differential pressure transducer should be subject to a regular
be applied:	maintenance and testing regime to ensure accuracy. The calibration will
	be undertaken according with the manufacturer's recommendation.
Any comment:	- Monitoring under responsibility of the Projeto de Gás de Aterro
	TECIPAR – PROGAT's operators (the team, the organizational
	structure and the management structure will be defined after the





project's implementation).
- Automatic readings of temperature and pressure will be made by sensors
connected to the flow-meter – these data will be used to convert the gas-flow to Nm <sup>3</sup> ;
- All registrations will be kept for 2 years after the end of the crediting period;
initially, there will be one flare installed. While the power-nouse is not
gas sent to flares, thus only the totalizer flow-meter will be installed and
used to calculate ERs. Case a second flare is installed and after the
construction of the power house, new flow-meters will be installed for
each flare and for each engine, as per the Monitoring Methodology.

Data / Parameter:	<b>3.</b> LFG <sub>electricity, y</sub>
Data unit:	Nm <sup>3</sup>
Description:	Amount of landfill gas sent to the power house at Normal Temperature
	and Pressure
Source of data to be	Project Participants
ised:	
Value of data applied	Variable (see itemB.6.3.)
or the purpose of	
calculating expected	
emission reductions in	
section B.5	
Description of	Continuous readings from the turbine flow-meters installed. The
neasurement methods	equipments are connected to a supervisory computer system, which
ind procedures to be	registers continuously the LFG measured. Data to be aggregated monthly
ipplied:	and yearly.
	There will be one flow-meter for each engine installed.
QA/QC procedures to	I urbine flow meters should be subject to a regular maintenance and
be applied:	lesting regime to ensure accuracy, in compliance with national laws
	(example in Germany and in Italy, for turbine filters of this size, a calibration every 12 years is required; in Brazil there are no requirements
	concerning the device's calibration). The calibration will be undertaken
	according with the manufacturer's recommendation
Any comment.	Monitoring under responsibility of the Projeto de Cás de Aterro
any comment.	TECIPAR $-$ PROGAT operators (the team the organizational structure
	and the management structure will be defined after the project's
	implementation)
	- Automatic readings of temperature and pressure will be made by sensors
	connected to the flow-meter – these data will be used to convert the gas-
	flow to Nm <sup>3</sup> ;
	- All registrations will be kept for 2 years after the end of the crediting
	period;
or the purpose of calculating expected emission reductions in ection B.5 Description of neasurement methods and procedures to be applied: QA/QC procedures to be applied:	Continuous readings from the turbine flow-meters installed. The equipments are connected to a supervisory computer system, which registers continuously the LFG measured. Data to be aggregated month and yearly. There will be one flow-meter for each engine installed. Turbine flow meters should be subject to a regular maintenance and testing regime to ensure accuracy, in compliance with national laws (example in Germany and in Italy, for turbine meters of this size, a calibration every 12 years is required; in Brazil there are no requirement concerning the device's calibration). The calibration will be undertakent according with the manufacturer's recommendation. - Monitoring under responsibility of the Projeto de Gás de Aterro TECIPAR – PROGAT operators (the team, the organizational structu and the management structure will be defined after the project's implementation). - Automatic readings of temperature and pressure will be made by sens connected to the flow-meter – these data will be used to convert the g flow to Nm <sup>3</sup> ; - All registrations will be kept for 2 years after the end of the crediting period;

Data / Parameter:	4. w <sub>CH4</sub>
Data unit:	m <sup>3</sup> CH <sub>4</sub> /m <sup>3</sup> LFG
Description:	Methane fraction in the landfill gas





Source of data to be	Continuous measurement using a certified gas analyzer. The analyzer will
used:	measure the methane content directly.
Value of data applied	50%
for the purpose of	
calculating expected	
emission reductions in	
section B.5	
Description of	The gas samples are taken using a stream system. The analysis is made
measurement methods	on the main line for 1 minute. Then, after 1 minute of washing, is made
and procedures to be	on the first inner line. Then, after 1 minute of washing, the analysis is
applied:	made on the second inner line, and so on. Since there are 5 measuring
	points (4 inner + 1 main lines), the analysis on the main line takes place
	for 1 minute every 10 minutes
QA/QC procedures to	The gas analyzer should be subjected to a regular maintenance and
be applied:	testing regime to ensure accuracy. The calibration will be undertaken
	according with the manufacturer's recommendation.
Any comment:	- All registrations will be kept for 2 years after the end of the crediting
	period;
	- This factor reflects the fact that some degradable organic carbon does
	not degrade, or degrades very slowly, under anaerobic conditions in the
	SWDS. A default value of 0.5 is recommended by IPCC.

Data / Parameter:	5. EL <sub>LFG, y</sub>
Data unit:	MWh
Description:	Net amount of electricity generated using LFG
Source of data to be	Electricity meter
used:	
Value of data applied	Variable (see itemB.6.3.)
for the purpose of	
calculating expected	
emission reductions in	
section B.5	
Description of	Continuous readings from the electricity-meter installed. The equipment
measurement methods	is connected to a supervisory computer system, which registers
and procedures to be	continuously the electricity exported.
applied:	
	The net electricity generated will be registered every hour.
QA/QC procedures to	Electricity meter will be subject to regular (in accordance with stipulation
be applied:	of the meter supplier) maintenance and testing to ensure accuracy.
Any comment:	- In cases when the power house is not operating, this variable will
	correspond to the electricity consumption from the grid. The same
	QA/QC procedures will be applied;
	- All registrations will be kept for 2 years after the end of the crediting
	period;

Data / Parameter:	6. Operation hours of the energy plant
Data unit:	Hours
Description:	Operation of the energy plant
Source of data to be	Hour-meter
used:	





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Value of data applied	100%
for the purpose of	
calculating expected	
emission reductions in	
section B.5	
Description of	Continuous readings from the hour-meters installed for each engine. The
measurement methods	equipment is connected to a supervisory computer system, which
and procedures to be	registers continuously the operation time of the engines.
applied:	
	Each engine will have one hour-meter connected.
QA/QC procedures to	No QA/QC procedures are necessary.
be applied:	
Any comment:	- All registrations will be kept for 2 years after the end of the crediting
	period;

Data / Parameter:	PE <sub>Flare, y</sub>
Data unit:	tCO <sub>2</sub> e
Description:	Project emissions from flaring of the residual gas stream in year y
Source of data to be	Calculated as per the Tool to determine project emissions from flaring
used:	gases containing methane
Value of data applied	99% of Flare Efficiency, according with the manufacturers
for the purpose of	recommendation. The values calculated were presented in table from item
calculating expected	B.6.4.
emission reductions in	
section B.5	
Description of	As per the Tool to determine project emissions from flaring gases
measurement methods	containing methane
and procedures to be	
applied:	
QA/QC procedures to	As per the Tool to determine project emissions from flaring gases
be applied:	containing methane
Any comment:	Please, see the monitoring below – no number was indexed to this
	variable as all parameters to monitor the flare efficiency are presented
	below.

#### Tool to determine project emissions from flaring gases containing methane

Data / Parameter:	<b>7.</b> fv <sub>i,h</sub>
Data unit:	-
Description:	Volumetric fraction of component i in the residual gas in the hour h
	where $i = CH_4$ , CO, CO <sub>2</sub> , O <sub>2</sub> , H <sub>2</sub> , N <sub>2</sub>
Source of data to be	Measurements by project participants using a continuous gas analyser
used:	
Value of data applied	
for the purpose of	
calculating expected	
emission reductions in	
section B.5	
Description of	Ensure that the same basis (dry or wet) is considered for this





measurement methods	measurement and the measurement of the volumetric flow rate of the
and procedures to be	residual gas (FV <sub>RG,h</sub> ) when the residual gas temperature exceeds 60 $^{\circ}$ C
applied:	
QA/QC procedures to	Analysers will be periodically calibrated according to the manufacturer's
be applied:	recommendation. A zero check and a typical value check will be
	performed by comparison with a standard certified gas.
Any comment:	Please, refer to the measurements of <b>4</b> . $w_{CH4}$ above.
	As a simplified approach, only the methane content of the residual gas
	will be measured and the remaining part will be considered as $N_2$ .

Data / Parameter:	8. FV <sub>RG,h</sub>
Data unit:	m <sup>3</sup> /h
Description:	Volumetric flow rate of the residual gas in dry basis at normal conditions
	in the hour h
Source of data to be	Measurements by project participants using a flow meter
used:	
Value of data applied	
for the purpose of	
calculating expected	
emission reductions in	
section B.5	
Description of	Ensure that the same basis (dry or wet) is considered for this
measurement methods	measurement and the measurement of volumetric fraction of all
and procedures to be	components in the residual gas $(fv_{i,h})$ when the residual gas temperature
applied:	exceeds 60 °C
QA/QC procedures to	Flow meters are to be periodically calibrated according to the
be applied:	manufacturer's recommendation.
Any comment:	Please, refer to the measurements of <b>2. LFG</b> <sub>flare</sub> above.

Data / Parameter:	9. t <sub>O2, h</sub>
Data unit:	-
Description:	Volumetric fraction of $O_2$ in the exhaust gas of the flare in the hour $h$
Source of data to be	Measurements using a continuous gas analyser
used:	
Value of data applied	N/A, as the efficiency adopted to calculate ERs was considered as 99%
for the purpose of	
calculating expected	
emission reductions in	
section B.5	
Description of	The gas samples are taken using a stream system. The analysis is made
measurement methods	on the exhaust gas of the flare for 1 minute. Then, after 1 minute of
and procedures to be	washing, the exhaust gas is analyzed again. Since there will be initially 1
applied:	measuring points (1 flare), the analysis on the exhaust gas takes place for
	1 minute every 2 minutes.
	The point of measurement (sampling point) shall be in the upper section
	of the flare (80% of total flare height).
QA/QC procedures to	The gas analyzer should be subjected to a regular maintenance and
be applied:	testing regime to ensure accuracy. The calibration will be undertaken





	according with the manufacturer's recommendation.
Any comment:	All registrations will be kept for 2 years after the end of the crediting
	period;

Data / Parameter:	<b>10. fv</b> <sub>CH4, FG, h</sub>
Data unit:	mg/m <sup>3</sup>
Description:	Concentration of methane in the exhaust gas of the flare in dry basis at
-	normal conditions in the hour h
Source of data to be	Measurements using a continuous gas analyser
used:	
Value of data applied	N/A, as the efficiency adopted to calculate ERs was considered as 99%
for the purpose of	
calculating expected	
emission reductions in	
section B.5	
Description of	The gas samples are taken using a stream system. The analysis is made
measurement methods	on the exhaust gas of the flare for 1 minute. Then, after 1 minute of
and procedures to be	washing, the exhaust gas is analyzed again. Since there will be initially 1
applied:	measuring points (1 flare), the analysis on the exhaust gas takes place for
	1 minute every 2 minutes.
	The point of measurement (sampling point) shall be in the upper section
0.1/0.0	of the flare (80% of total flare height).
QA/QC procedures to	The gas analyzer should be subjected to a regular maintenance and
be applied:	testing regime to ensure accuracy. The calibration will be undertaken
	according with the manufacturer's recommendation.
Any comment:	All registrations will be kept for 2 years after the end of the crediting
	period;

Data / Parameter:	11. T <sub>flare</sub>
Data unit:	°C
Description:	Temperature in the exhaust gas of the flare
Source of data to be used:	Measurements using thermocouples
Value of data applied for the purpose of calculating expected emission reductions in section B.5	N/A, as the efficiency adopted to calculate ERs was considered as 99%
Description of measurement methods and procedures to be	Measurements by project participants, using thermocouples. There will be one thermocouple installed for each flare.
QA/QC procedures to be applied:	Thermocouples will be replaced or calibrated every year.
Any comment:	All registrations will be kept for 2 years after the end of the crediting period; An excessively high temperature at the sampling point (above 700 °C) may be an indication that the flare is not being adequately operated or





that its capacity is not adequate to the actual flow.

5 5	J J J J
Data / Parameter:	<b>12.</b> EF <sub>OM, 2007</sub>
Data unit:	tCO <sub>2</sub> e/MWh
Description:	Emission Factor of the Operating Margin for 2007
Source of data to be	Brazilian DNA
used:	
Value of data applied	0.2909
for the purpose of	
calculating expected	
emission reductions in	
section B.5	
Description of	This variable will be monitored <i>ex-post</i> by the Brazilian DNA and will be
measurement methods	updated monthly in their web-site.
and procedures to be	
applied:	
QA/QC procedures to	N/A
be applied:	
Any comment:	

Tool for calculation of emission factor for electricity systems

Data / Parameter:	<b>13.</b> EF <sub>BM, 2007</sub>
Data unit:	tCO <sub>2</sub> e/MWh
Description:	Emission Factor of the Built Margin of 2007
Source of data to be used:	Brazilian DNA
Value of data applied for the purpose of calculating expected emission reductions in section B.5	0.0775
Description of measurement methods and procedures to be applied:	This variable will be monitored <i>ex-post</i> by the Brazilian DNA and will be updated monthly in their web-site.
QA/QC procedures to be applied:	N/A
Any comment:	

Data / Parameter:	14. EF <sub>2007</sub>
Data unit:	tCO <sub>2</sub> e/MWh
Description:	Electricity Baseline Emission Factor for 2007
Source of data to be	Brazilian DNA
used:	
Value of data applied	0.1842
for the purpose of	
calculating expected	
emission reductions in	
section B.5	
Description of	This variable will be calculated according with the <i>ex-post</i> monitoring of





measurement methods and procedures to be applied:	$EF_{OM}$ and $EF_{BM}$ by the Brazilian DNA.
QA/QC procedures to	N/A
be applied:	
Any comment:	The EF will be calculated every hour, using data from the Brazilian DNA.

Data / Parameter:	<b>15.</b> EC <sub>PJ, EG, y</sub>
Data unit:	MWh
Description:	Electricity consumed from the grid, to operate the Gas Station
Source of data to be	Readings from the electricity-meter
used:	
Value of data applied	0, as electricity will be supplied by the Power House
for the purpose of	
calculating expected	
emission reductions in	
section B.5	
Description of	Continuous readings from the electricity-meter installed. The equipment
measurement methods	is connected to a supervisory computer system, which registers
and procedures to be	continuously the electricity exported.
applied:	
QA/QC procedures to	Electricity meter will be subject to regular (in accordance with stipulation
be applied:	of the meter supplier) maintenance and testing to ensure accuracy.
Any comment:	All registrations will be kept for 2 years after the end of the crediting
	period

<b>16.</b> TDL <sub>EG, y</sub>
%
Average technical transmission and distribution losses for providing
electricity to EG in year y
Tool to calculate baseline, project and/or leakage emissions from
electricity consumption
20%, according with the Tool.
TDL <sub>EG,y</sub> will be based on references from utilities, network operators or
other official documentation. An annually monitoring will be undertaken;
in the absence of data from the relevant year, most recent figures will be
used, but not older than 5 years.
All registrations will be kept for 2 years after the end of the crediting
period.

Data / Parameter:17. FC<br/>ECDG, D, y





Data unit:	Mass or volume unit
Description:	Quantity of diesel fired in the emergency captive diesel generator in year
	у
Source of data to be	Onsite measurements
used:	
Value of data applied	0, as the emergency captive diesel generator is a backup system and is
for the purpose of	expected to operate only in cases when the grid supply is interrupted.
calculating expected	
emission reductions in	
section B.5	
Description of	Weight or volume meters
measurement methods	
and procedures to be	
applied:	
QA/QC procedures to	The metered fuel consumption quantities will based on purchased
be applied:	quantities and stock changes.
Any comment:	All registrations will be kept for 2 years after the end of the crediting
	period.

Data / Parameter:	<b>18.</b> EG <sub>DG, y</sub>
Data unit:	MWh
Description:	Quantity of electricity generated by the emergency captive diesel
	generator in year y
Source of data to be	Onsite measurements
used:	
Value of data applied	0, as the emergency captive diesel generator is a backup system and is
for the purpose of	expected to operate only in cases when the grid supply is interrupted.
calculating expected	
emission reductions in	
section B.5	
Description of	Continuous readings from the electricity-meter, aggregated at least
measurement methods	annually.
and procedures to be	
applied:	
QA/QC procedures to	Cross check measurement results with records for sold electricity where
be applied:	relevant
Any comment:	All registrations will be kept for 2 years after the end of the crediting
	period.

Data / Parameter:	<b>19.</b> NCV <sub>D, t</sub>
Data unit:	GJ/mass or volume unit
Description:	Average net calorific value of the diesel used in the period t
Source of data to be	a) Values provided by the supplier;
used:	b) if not available, regional or national default values;
	c) if not available, default IPCC 2006 values at the upper limit
Value of data applied	N/A, as the emergency captive diesel generator is a backup system and is
for the purpose of	expected to operate only in cases when the grid supply is interrupted.
calculating expected	
emission reductions in	
section B.5	





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Description of measurement methods and procedures to be applied:	<ul><li>a) and b): The NCV will be obtained for the diesel, from which weighted average values for the year <i>y</i> will be calculated</li><li>For c): Any future revision of the IPCC Guidelines will be taken into account</li></ul>
QA/QC procedures to be applied:	Verify if the values under a), b) and c) are within the uncertainty range of the IPCC default values as provided in Table 1.2, Vol. 2 of the 2006 IPCC Guidelines. If the values fall out this range, there will be necessary to collect additional information from the testing laboratory to justify the outcome or conduct additional measurements. The laboratories in a), b) or c) should have ISO17025 accreditation or justify that they can comply with similar quality standards.
Any comment:	All registrations will be kept for 2 years after the end of the crediting period.

Data / Parameter:	<b>20.</b> EF <sub>CO2, e</sub>
Data unit:	tCO <sub>2</sub> /TJ
Description:	$CO_2$ emission factor of the diesel used in the period <i>t</i>
Source of data to be	a) Values provided by the supplier;
used:	b) if not available, regional or national default values;
	c) if not available, default IPCC 2006 values at the upper limit
Value of data applied	N/A, as the diesel generator is a backup system and is expected to operate
for the purpose of	only in cases when the grid supply is interrupted.
calculating expected	
emission reductions in	
section B.5	
Description of	a) and b): The $EF_{CO2, e}$ will be obtained for the diesel, from which
measurement methods	weighted average values for the period t will be calculated
and procedures to be	
applied:	For c): Any future revision of the IPCC Guidelines will be taken into
	account
QA/QC procedures to	
be applied:	
Any comment:	All registrations will be kept for 2 years after the end of the crediting
	period.

#### **B.7.2** Description of the monitoring plan:

The variables described in item B.7.1 will be measured continuously and the readings will be also registered continuously, in a supervisory computer system. In order to assure conservatism, the standard errors of each equipment will be subtracted from the readings.

The diagram below presents how the monitoring will be made Equipments are indexed to the corresponding number from item B.7.1.:









OBS 1: There will be one flow-meter and one O<sub>2</sub> and CH<sub>4</sub> analyzer installed for each flare; All data read will be continuously registered in a computer supervisory system, as presented in B.7.1.



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

The baseline study was initiaited by Econergy Brasil and finished on 02/03/2009 by *ARCADIS Tetraplan*. Contact information:

ARCADIS Tetraplan C/O Eduardo Cardoso Filho eduardo@tetraplan.com.br Tel: +55 (11) 3060-8457 www.tetraplan.com.br

#### SECTION C. Duration of the project activity / crediting period

#### C.1 Duration of the <u>project activity</u>:

#### C.1.1. <u>Starting date of the project activity:</u>

01/07/2008.

This date refers to the signature of a proposal for acquisition of LFG extraction and treatment equipments.

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

21 years.

#### C.2 Choice of the <u>crediting period</u> and related information:

#### C.2.1. <u>Renewable crediting period</u>

C.2.1.1. Starting date of the first <u>crediting period</u>:

01/01/2009 or the registration date, whichever is later.

#### C.2.1.2. Length of the first <u>crediting period</u>:

7 years -0 months

#### C.2.2. Fixed crediting period:

C.2.2.1.	Starting date:	

#### N/A

C.2.2.2. Length:

N/A



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#### **SECTION D.** Environmental impacts

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

Projeto de Gás de Aterro TECIPAR – PROGAT has received the Preliminary, Installation and Operational Licences for the installation of a complete collection and flaring system at the Ventura landfill (Preliminary Licence # 32001928 issued in 14/08/2008; Installation Licence # 32003440, issued in 27/08/2008; and Operational Licence # 32004609, issued in 18/12/2008). The licences foresee the following Technical Demands:

- Not emit any kind of odour substances to the atmosphere;
- Noise emission from the compressors must be in accordance with a National Standard;
- Compressors must be settled in proper bases, in order to avoid vibrations to the neighbourhood;
- Residual water and condensates must be sent to the leachate accumulation lagoon;

Additionally, the Ventura landfill has all environmental licence to the construction and operation of the landfill's. All impacts over soil, water, air and population were described and analyzed at the EIA developed for the landfill and the environmental impacts monitoring plans considered satisfactory by DAIA (Departamento de Avaliação de Impacto Ambiental) and CETESB, which issued the operational licence # 32002608 on 05/12/2005.

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

The above described impacts are not considered significant and the proper actions will be undertaken by the time of the Operational Licence's issuance:

- The use of enclosed flares assure a high rate of oxidation of all compounds, not allowing the emission of odour to the atmosphere;
- All noise and vibration will be properly treated the compressors will be installed with proper isolation;
- Condensate and residual water will be driven to the leachate lagoon;

Additionally, there are expected no transboundary impacts.

#### SECÇÃO E. <u>Stakeholders'</u> comments

#### E.1. Brief description how comments by local <u>stakeholders</u> have been invited and compiled:

The local stakeholder consultation process was carried out according with Resolução nº7 from the Brazilian DNA.

A copy from the PDD translated to Portuguese and an explanation on how the project will contribute to the promotion of sustainable development was sent to each of the following stakeholders:

Resolução nº7	Stakeholder invited
Prefeitura do município envolvido	Prefeitura de Santana de Parnaíba





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(City Hall of the host-city)	(City Hall of Santana de Parnaíba)					
Câmara dos vereadores do município envolvido (Legislative Chamber of the host-city)	Câmara dos Vereadores de Santana de Parnaíba (Legislative Chamber of Santana de Parnaíba)					
Órgão Ambiental Estadual	CETESB – Companhia de Tecnologia e Saneamento Ambiental (State Environmental Agency)					
(State Environmental Authority)	SMA – Secretaria de Estado do Meio Ambiente (Environmental State Secretariat)					
Órgão Ambiental Municipal (Municipal Environmental Authority)	Not identified. According with guidelines from the Brazilian DNA, a written justification must be presented when this stakeholder is not identified.					
Fórum Brasileiro de ONG's e Movimentos Sociais para o Meio Ambiente e Desenvolvimento (Brazilian NGO Forum)	Brazilian NGO Forum					
Ministério Público estadual do estado	Ministério Público de São Paulo					
(State Public Attorney)	(State Public Attorney)					
Ministério Público Federal (Feredal Public Attorney)	Federal Public Attorney					
	AVEMARE – Associação Vila Esperança de Materiais Recicláveis					
Entidade de classe (Other Stakeholders)	SIEMACO – Sindicato dos Trabalhadores em Empresas de Prestação de Serviços de Asseio e Conservação e Limpeza Urbana de São Paulo					
	Rotary Clube de Santana de Parnaíba					

#### E.2. Summary of the comments received:

The following stakeholders made comments about the project:

#### a) Brazilian NGO Forum

The NGO Forum stated that a 30-day period for comments is not enough to make a complete analysis of the project and suggest the adoption of Gold Standard sustainability criteria.

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

BIOPAR Soluções Ambientais Ltda. appreciated the comments and answered them as follows:

#### a) Brazilian NGO Forum

As per Resolução n°7, the local stakeholder consultation process is open until the request for registration of the project activity, not being limited to a 30-day length. Concerning the Gold Standard criteria, BIOPAR Soluções Ambientais Ltda. answered that the verification process of CERs already takes into account sustainability criteria, as hiring and training of personnel and





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compliance with the environmental licence. However, BIOPAR Soluções Ambientais Ltda. compromises to analyze the possibility of the criteria adoption.



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#### Annex 1

#### CONTACT INFORMATION ON PARTICIPANTS IN THE **<u>PROJECT ACTIVITY</u>**

Organization:	BIOPAR Soluções Ambientais Ltda.
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#### Annex 2

#### INFORMATION REGARDING PUBLIC FUNDING

There is no public funding involved in the development of the Projeto de Gás de Aterro TECIPAR – PROGAT.



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#### Annex 3

#### **BASELINE INFORMATION**

#### 1. Grid-Emission Factor Calculation

The calculation of the Built Margin (BM) and Operating Margin (OM) must be developed for each electric system which the CDM project will be implemented. The **project's electric system** is defined by the quantity of power plants which can be dispatched without significant transmission restrictions. Similarly, an **electric connected system** connected to the project's system is defined as an electric system connected by transmission lines to the project's electric system, which the power plants can be dispatched without significant transmission restrictions.

The *Tool for calculation of emission factor for electricity systems* recommends the use the delineation of grid boundaries as provided by the DNA of the host country if available. Initially, the DNA adopted the ONS (National Operator System) division of the national grid in four sub-systems: North (N), Northeast (NE), South (S) and Southeast/Mid-West (SE-CO). However, after a public consultation, analysts of the ONS, MME (Mines and Energy Ministry) and MCT (Science and Technology Ministry) decided do adopt only *one subsystem*, based that there are no significant looses in the transmission between two proposed subsystems (North-Northeast and South-Southeast/Center West). Simulations appointed that in only 70% of the hours in the year the transmission happened in 90% of more of the full capacity, indicating no significant transmission restrictions.

The unique subsystem is presented in Figure 3.









Figure 3. Brazilian Interconnected National System (Source: ONS)

The table below presents the thermoelectric power plants in each sub-market as defined by the ONS, with the type of fuel used.

	Name	Fuel Used Actually	State			
	FAFEN	Natural Gas	Bahia			
	S.C.JEREISATI	Natural Gas	Ceará			
Northeast	TERMOBAHIA	Natural Gas	Bahia			
Sub- markat	US.CAMACARI	Natural Gas	Bahia			
mai ket	UT PERNAMBUCO	Natural Gas	Pernambuco			
	UT. FORTALEZA	Natural Gas	Ceará			
	P.MEDICI	Coal	Rio Grande do Sul			
South	PORTO ALEGRE	Fuel Oil	Rio Grande do Sul			
Sub-	SAO JERONIMO	Coal	Rio Grande do Sul			
market	U. ALEGRETE	Fuel Oil	Rio Grande do Sul			
	U. CANOAS	Natural Gas	Rio Grande do Sul			

Table 5. Thermoelectric Power Plants dispatched by ONS (source: ONS)





	U.CHARQUEADAS	Coal	Rio Grande do Sul			
	U.JLACERDA-A	Coal	Santa Catarina			
	U.JLACERDA-B	Coal	Santa Catarina			
	U.JLACERDA-C	Coal	Santa Catarina			
	U.URUGUAIANA	Natural Gas	Rio Grande do Sul			
	US. FIGUEIRA	Coal	Paraná			
	ARAUCÁRIA	Natural Gas	Paraná			
	ANGRA 1	Nuclear	Rio de Janreiro			
	ANGRA 2	Nuclear	Rio de Janreiro			
	CAMPOS	Natural Gas	Rio de Janreiro			
	CARIOBA	Fuel Oil	São Paulo			
	CUIABA-ENRON	Natural Gas	Mato Grosso			
	IBIRITE	Natural Gas	Minas Gerais			
	IGARAPE	Fuel Oil	Minas Gerais			
Southeast-	JUIZ DE FORA	Natural Gas	Minas Gerais IS			
Midwest	MACAE MERCHAN	Natural Gas	Rio de Janreiro			
Sub-	NO.FLUMINENSE	Natural Gas	Rio de Janreiro			
market	NOVA PIRATININGA	Natural Gas	São Paulo			
	PIRATININGA	Natural Gas	São Paulo			
	SANTA CRUZ	Fuel Oil	Rio de Janreiro			
	TER BRASILIA	Diesel	Distrito Federal			
	TERMORIO	Natural Gas	Rio de Janreiro			
	TRES LAGOAS	Natural Gas	Mato Grosso do Sul			
	B.L.SOBRINHO	Natural Gas	Rio de Janreiro			
	U. W. ARJONA	Natural Gas	Mato Grosso do Sul			

More details of the LFG Estimatives were presented in B.6.2 and B.6.3.

#### 2. Methane Estimatives

The picture below presents the LFG generation estimative, the graphic of engines installation and the location of the wells burning and not-burning LFG in the landfill:



Value 0.9

Variable



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	0				
GWP	21				
OX	0				
F	50%				
DOCf	0.5				
MCF	1				
			DOCj	Wj	
	Wo	43%	0.13%		
	Pulp	o, paper and cardboard	40%	0.25%	
Food, fo	od waste, b	peverages and tobacco	15%	93.00%	
		Textiles	24%	0.13%	
	Garde	20%	5.00%		
Glas	s, plastic, n	netal, other inert waste	0%	1.50%	ſ

k 0.035 0.07 0.4 0.07 0.17

0

Year	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	BE <sub>CH4, SWDS</sub> (tCO <sub>2</sub> e/year)	Total Methane Emissions (t/year)	Total Methane Emissions (Nm3/year)	Total LFG Emissions (Nm3/year)	Total Collected (Nm3 <sub>LFG</sub> /year)	Total Collected BASELINE (Nm3/year)
2003	1,054															1,054	50	70,034	140,068	84,041	79,839
2004	713	1,734														2,448	117	162,599	325,199	195,119	185,363
2005	484	1,173	13,677													15,334	730	1,018,700	2,037,399	1,222,439	1,161,317
2006	329	796	9,254	25,687												36,066	1,717	2,395,950	4,791,899	2,875,140	2,731,383
2007	225	541	6,276	17,380	38,275											62,698	2,986	4,165,192	8,330,384	4,998,230	4,748,319
2008	154	370	4,270	11,788	25,897	43,237										85,716	4,082	5,694,346	11,388,691	6,833,215	6,491,554
2009	106	254	2,916	8,019	17,565	29,254	54,047									112,160	5,341	7,451,116	14,902,232	8,941,339	8,494,272
2010	74	175	2,000	5,476	11,949	19,842	36,568	54,047								130,130	6,197	8,644,894	17,289,787	10,373,872	9,855,179
2011	52	122	1,380	3,756	8,159	13,498	24,802	36,568	54,047							142,383	6,780	9,458,935	18,917,870	11,350,722	10,783,186
2012	37	85	959	2,592	5,597	9,217	16,872	24,802	36,568	54,047						150,775	7,180	10,016,437	20,032,874	12,019,724	11,418,738
2013	26	60	672	1,800	3,862	6,323	11,521	16,872	24,802	36,568	54,047					156,553	7,455	10,400,284	20,800,567	12,480,340	11,856,323
2014	19	43	475	1,261	2,683	4,362	7,904	11,521	16,872	24,802	36,568	54,047				160,558	7,646	10,666,289	21,332,578	12,799,547	12,159,569
2015	14	31	340	892	1,879	3,031	5,453	7,904	11,521	16,872	24,802	36,568	54,047			163,354	7,779	10,852,082	21,704,163	13,022,498	12,371,373
2016	10	23	246	638	1,329	2,123	3,788	5,453	7,904	11,521	16,872	24,802	36,568	54,047		165,326	7,873	10,983,068	21,966,136	13,179,682	12,520,698
2017	8	17	181	463	951	1,502	2,654	3,788	5,453	7,904	11,521	16,872	24,802	36,568	54,047	166,731	7,940	11,076,434	22,152,867	13,291,720	12,627,134
2018	6	13	136	341	690	1,075	1,877	2,654	3,788	5,453	7,904	11,521	16,872	24,802	36,568	113,699	5,414	7,553,365	15,106,729	9,064,038	8,610,836
2019	5	10	103	255	507	779	1,343	1,877	2,654	3,788	5,453	7,904	11,521	16,872	24,802	77,874	3,708	5,173,387	10,346,775	6,208,065	5,897,662
2020	4	8	80	194	379	573	974	1,343	1,877	2,654	3,788	5,453	7,904	11,521	16,872	53,624	2,554	3,562,423	7,124,845	4,274,907	4,061,162
2021	3	6	63	150	288	428	717	974	1,343	1,877	2,654	3,788	5,453	7,904	11,521	37,170	1,770	2,469,290	4,938,581	2,963,149	2,814,991
2022	3	5	50	118	223	326	536	717	974	1,343	1,877	2,654	3,788	5,453	7,904	25,970	1,237	1,725,258	3,450,517	2,070,310	1,966,795
2023	2	4	41	94	176	252	407	536	717	974	1,343	1,877	2,654	3,788	5,453	18,318	872	1,216,917	2,433,833	1,460,300	1,387,285
2024	2	4	34	77	141	198	315	407	536	717	974	1,343	1,877	2,654	3,788	13,066	622	867,987	1,735,973	1,041,584	989,505
2025	2	3	28	63	114	159	248	315	407	536	717	974	1,343	1,877	2,654	9,440	450	627,119	1,254,239	752,543	714,916
2026	1	3	24	53	94	129	198	248	315	407	536	717	974	1,343	1,877	6,920	330	459,710	919,421	551,652	524,070
2027	1	2	21	45	79	107	161	198	248	315	407	536	717	974	1,343	5,154	245	342,408	684,817	410,890	390,346
2028	1	2	18	39	67	89	133	161	198	248	315	407	536	717	974	3,905	186	259,429	518,858	311,315	295,749
2029	1	2	15	33	57	76	112	133	161	198	248	315	407	536	717	3,012	143	200,080	400,160	240,096	228,091
2030	1	2	14	29	50	65	95	112	133	161	198	248	315	407	536	2,365	113	157,100	314,200	188,520	179,094
2031	1	1	12	26	43	56	81	95	112	133	161	198	248	315	407	1,890	90	125,543	251,087	150,652	143,119
2032	1	1	11	23	38	49	70	81	95	112	133	161	198	248	315	1,536	73	102,026	204,052	122,431	116,310
2033	1	1	10	20	34	43	61	70	81	95	112	133	161	198	248	1,268	60	84,223	168,446	101,068	96,014
2034	1	1	9	18	30	38	54	61	70	81	95	112	133	161	198	1,062	51	70,528	141,056	84,634	80,402
2035	0	1	8	16	27	34	48	54	61	70	81	95	112	133	161	901	43	59,823	119,646	71,788	68,198
2036	0	1	7	15	24	30	42	48	54	61	70	81	95	112	133	773	37	51,324	102,648	61,589	58,509
2037	Ó	1	6	13	22	27	38	42	48	54	61	70	81	95	112	669	32	44,476	88,953	53,372	50,703
2038	0	1	6	12	20	25	34	38	42	48	54	61	70	81	95	585	28	38,883	77,766	46,659	44,326
2039	Ó	1	5	11	18	22	31	34	38	42	48	54	61	70	81	516	25	34,256	68,513	41,108	39,052

Figure 4. LFG Generation calculated using the approved tool



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**Figure 5. Engines Installation Chronogram** 







Figure 6. Lay-out of the wells at Ventura Landfill





#### Annex 4

#### MONITORING INFORMATION

The whole monitoring of the project will be made via a PLC system. The PLC will also register all data read in the hard disk. Proper back-up procedures will be implemented to assure the data won't be lost.

Data of accumulated gas-flow measured by each flow-meter will be registered every hour and the counter will reset in the end of the day, after the last reading (at 23:59).

The PLC will also calculate the average methane concentration in the collected gas and register it every hour in the PLC's database. The same applies for the methane and oxygen concentrations in the exhaust gas.

Electricity imported/exported will be accumulatively registered by the PLC every hour and the counter will reset in the end of the day, after the last reading.

The operators will be trained to make manual registrations of the data above mentioned in a proper sheet.

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