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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 04 Date: 02/04/2009

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





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(*) 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 Esergia Estratégias Energéticas Ambientais 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 CO₂e 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;



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- 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 ϕ 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 Nm³/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 Nm³/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 ≥ 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 ³ /h		
Load	Minimum: 500 Nm ³ /h		
	Air ratio: 5:1		
Burner	Automatic		
Flame Stabilizer:	Continuous control, through UV-sond flame detection		
Combustion Chamber	Refractory, 150 mm thick		
Combustion Temperature	$> 850^{\circ}$ C, for more than > 0.3 sec;		
Crictical Temperature	1,330°C;		
Combustion	Min. 99% (CO ₂ /CO+CO ₂);		
Temperature Controller	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.



DATE: DATE:

Years	Annual estimation of emission reductions in tonnes of CO ₂ e
2009	63,292
2010	73,432
2011	80,347
2012	85,083
2013	88,343
2014	90,603
2015	99,054
Total estimated reductions (tonnes of CO ₂ e)	580,154
Total Number of crediting years	7
Annual average over the crediting period of estimated reductions (tonnes of CO ₂ e)	82,879

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.3 .	Description of the sour	ces and	gases include	d in the <u>project boundary</u>
	Source	Gas	Included?	Justification / Explanation



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	Emissions from electricity consumption	<i>CO</i> ₂	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 ₄	No	Excluded for simplification. This is conservative.
Baseline		N_2O	No	Excluded for simplification. This is conservative.
	Emissions from	CO ₂	No	This emission source was neglected because the project activity won't consume/generate thermal energy
thermal energy generation Emissions from decomposition of waste at the landfill site	thermal energy generation	CH ₄	No	Excluded for simplification. This is conservative.
		N ₂ O	No	Excluded for simplification. This is conservative.
	Emissions from decomposition of waste at the landfill site	CO ₂	No	CO ₂ emissions from the decomposition of organic waste are not accounted.
		CH ₄	Yes	<i>The major source of emissions in the baseline.</i>
		N ₂ O	No	N_2O emissions are small compared to CH_4 emissions from landfills. Exclusion of this gas is conservative.
On-site fo fuel consumpt	On-site fossil fuel consumption	CO ₂	No	This source of project emissions will be neglected as no fossil fuel will be used on- site.
	due to the project activity	CH ₄	No	Excluded for simplification. This emission source is assumed to be very small.
other than for electricity generation Project Activity Emissions from on-site electricity use	N ₂ O	No	Excluded for simplification. This emission source is assumed to be very small.	
	Emissions from on-site electricity use	<i>CO</i> ₂	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 ₄	No	Excluded for simplification. This emission source is assumed to be very small.
		N ₂ O	No	Excluded for simplification. This emission source is assumed to be very small.

The following diagram presents the boundaries of the project:





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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 05.2:

- 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	~	 Ventura landfill has an authorization to operate, emitted from the environmental authority;
LFG destruction in flares	\checkmark	 There is no law which obligates the landfill do destroy the gas produced nor due to local environmental regulations,





		nor due to GHG reductions;
		There is no law which obligates the
		landfill do destroy the gas produced nor
	1	due to local environmental regulations,
LFG use to generate eleculcity	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 heat	1	due to local environmental regulations,
		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. Despite of
landfill gas and its flaring and/or its use)	the incomes from the electricity sale, the project
undertaken without being registered as a CDM	is not financially attractive and the CERs
project activity.	revenues are an additional income which
	amortizes the investments in the LFG collection
	system and electricity generation (please, refer
	to STEP 2 of the Additionality Assessment).
<i>LFG2</i> 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. Despite of
undertaken without being registered as CDM	the incomes from the electricity sale, the project
project activity.	is not financially attractive and the CERs
	revenues are an additional income which
	amortizes the investments in the LFG collection
	system and electricity generation (please, refer
	to STEP 2 of the Additionality Assessment).
P2 Existing or construction of a new on-site or	This alternative is not applicable 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
	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.
P5 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
	grid if no power 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.

Saanania	-	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.
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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):

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 3rd 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				
					R\$
]	ΓΟΤΑL		3,513,330.62.
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, which is expected to be operational from 2015 on. 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	€	R \$ (1 € = 2.7 R \$)
	A = Supervision, control and anti-fire system	-	R\$ 280,800.00
LEC cleaning	B = LFG cleaning	-	R\$ 1,358,100.00
cystems	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
Engines and	E = 1 individual modular engine (container)	€ 503,000.00	R\$ 1,358,100.00
auxiliary	F = 01 Auxiliary installations and assembly	€ 126,666.67	R\$ 342,000.00
	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 tariff¹;
- Initial operational cost = 71.54 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:

¹<u>http://www.nae.gov.br/cadernos_nae/04caderno_mudancasclimaticasquioto.pdf</u>. 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
R\$ 0.00	R\$ 0.00	R\$ 0.00	R\$ 0.00	R\$ 0.00	R\$ 0.00	R\$ 0.00	R\$ 8,298,620.59	R\$ 8,630,565.41	R\$ 10,244,049.10	R\$ 10,932,624.89	
R\$ 0.00	R\$ 0.00	R\$ 0.00	R\$ 0.00	R\$ 0.00	R\$ 0.00	R\$ 0.00	R\$ 6,306,269.61	R\$ 6,306,269.61	R\$ 7,197,333.01	R\$ 7,385,689.65	
R\$ 0.00	R\$ 0.00	R\$ 0.00	R\$ 0.00	R\$ 0.00	R\$ 0.00	R\$ 0.00	R\$ 8,298,620.59	R\$ 8,630,565.41	R\$ 10,244,049.10	R\$ 10,932,624.89	
R\$ 0.00	R\$ 0.00	R\$ 0.00	R\$ 0.00	R\$ 0.00	R\$ 0.00	R\$ 0.00	R\$ 8,298,620.59	R\$ 8,630,565.41	R\$ 10,244,049.10	R\$ 10,932,624.89	
-R\$ 438.880,25	-R\$ 2,066,711.19	-R\$ 2,249,381.70	-R\$ 2,853,344.66	-R\$ 2,967,478.45	-R\$ 3,642,106.68	-R\$ 3,787,790.95	-R\$ 4,540,595.49	-R\$ 4,722,219.31	-R\$ 5,447,980.26	-R\$ 5,783,925.15	
-R\$ 438,880.25	-R\$ 456,435.46	-R\$ 474,692.88	-R\$ 493,680.59	-R\$ 513,427.82	-R\$ 533,964.93	-R\$ 555,323.53	-R\$ 577,536.47	-R\$ 600,637.93	-R\$ 624,663.45	-R\$ 649,649.98	
R\$ 0.00	R\$ 0.00	R\$ 0.00	R\$ 0.00	R\$ 0.00	R\$ 0.00	R\$ 0.00	-R\$ 3,963,059.02	-R\$ 4,121,581.39	-R\$ 4,823,316.81	-R\$ 5,134,275.17	
-R\$ 3.513.330,62						-R\$ 30,546,015.81			-R\$ 4,079,430.63		
-R\$ 3.513.330,62											
						-R\$ 30,546,015.81					
									-R\$ 4,079,430.63		
R\$ 0.00	R\$ 0.00	R\$ 0.00	R\$ 0.00	R\$ 0.00	R\$ 0.00	R\$ 0.00	-R\$ 912,848.26	-R\$ 949,362.20	-R\$ 1,126,845.40	-R\$ 1,202,588.74	
-R\$ 3,952,210.87	-R\$ 456,435.46	-R\$ 474,692.88	-R\$ 493,680.59	-R\$ 513,427.82	-R\$ 533,964.93	- R\$ 31,101,339.34	R\$ 2,845,176.83	-R\$ 1,120,446.72	R\$ 3,669,223.44	R\$ 3,946,111.00	
1.0000	1.0400	1.0816	1.1249	1.1699	1.2167	1.2653	1.3159	1.3686	1.4233	1.4802	
-R\$ 3,952,210.87	-R\$ 438,880.25	- R\$ 24,579,840.25	R\$ 2,162,100.56	-R\$ 818,699.44	R\$ 2,577,947.72	R\$ 2,665,851.20					
Inflation to discount the Cash-Flow											
Free Cash-Flow (R\$) - CONSTANT											





	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
Gross Incomes (R\$)	R\$ 11,369,929.88	R\$ 9,818,742.77	R\$ 8,476,570.69	R\$ 7,182,006.05	R\$ 5,525,311.79	R\$ 5,603,613.34	R\$ 3,873,574.41	R\$ 4,028,517.39	R\$ 3,861,143.54	R\$ 1,992,102.19	R\$ 2,071,786.28
(+) Incomes from Electricity Sale CONSTANT	R\$ 7,385,689.65	R\$ 6,132,757.77	R\$ 5,090,808.70	R\$ 4,147,429.54	R\$ 3,068,009.51	R\$ 2,991,814.97	R\$ 1,988,589.47	R\$ 1,988,589.47	R\$ 1,832,662.53	R\$ 909,169.44	R\$ 909,169.44
(+) Incomes from Electricity Sale NOM	R\$ 11,369,929.88	R\$ 9,818,742.77	R\$ 8,476,570.69	R\$ 7,182,006.05	R\$ 5,525,311.79	R\$ 5,603,613.34	R\$ 3,873,574.41	R\$ 4,028,517.39	R\$ 3,861,143.54	R\$ 1,992,102.19	R\$ 2,071,786.28
(=) Gross incomes from electricity sale (R\$)	R\$ 11,369,929.88	R\$ 9,818,742.77	R\$ 8,476,570.69	R\$ 7,182,006.05	R\$ 5,525,311.79	R\$ 5,603,613.34	R\$ 3,873,574.41	R\$ 4,028,517.39	R\$ 3,861,143.54	R\$ 1,992,102.19	R\$ 2,071,786.28
(-) Operational Costs and Expenditures (R\$)	-R\$ 6,015,282.16	-R\$ 5,406,732.99	-R\$ 4,888,586.30	-R\$ 4,392,593.02	- R\$ 3 ,745,385.87	-R\$ 3,834,789.83	-R\$ 3,160,948.97	-R\$ 3,287,386.93	-R\$ 3,279,817.73	-R\$ 2,554,440.81	-R\$ 2,656,618.45
O&M 1 - Gas - NOM	-R\$ 675,635.98	-R\$ 702,661.42	-R\$ 730,767.88	-R\$ 759,998.59	-R\$ 790,398.54	-R\$ 822,014.48	-R\$ 854,895.06	-R\$ 889,090.86	-R\$ 924,654.50	-R\$ 961,640.67	-R\$ 1,000,106.30
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 6 engines 2014) NOM											
CAPEX 3 (Acquisition of +1 engine 2016) NOM											
(=) EBIT (R\$)	R\$ 5,354,647.72	R\$ 4,412,009.78	R\$ 3,587,984.39	R\$ 2,789,413.04	R\$ 1,779,925.92	R\$ 1,768,823.51	R\$ 712,625.44	R\$ 741,130.46	R\$ 581,325.81	-R\$ 562,338.62	-R\$ 584,832.17
	•										
(-) Income Taxes (IR & CSLL = 11%) (R\$)	-R\$ 1,250,692.29	-R\$ 1,080,061.71	-R\$ 932,422.78	-R\$ 790,020.67	-R\$ 607,784.30	-R\$ 616,397.47	-R\$ 426,093.19	-R\$ 443,136.91	-R\$ 424,725.79	-R\$ 219,131.24	-R\$ 227,896.49
	•										
Free Cash-Flow (R\$) – NOM	R\$ 4,103,955.44	R\$ 3,331,948.08	R\$ 2,655,561.61	R\$ 1,999,392.37	R\$ 1,172,141.62	R\$ 1,152,426.04	R\$ 286,532.26	R\$ 297,993.55	R\$ 156,600.02	-R\$ 781,469.86	-R\$ 812,728.66
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
Free Cash-Flow (R\$) – CONSTANT	R\$ 2,665,851.20	R\$ 2,081,124.94	R\$ 1,594,861.49	R\$ 1,154,599.28	R\$ 650,848.64	R\$ 615,289.68	R\$ 147,098.00	R\$ 147,098.00	R\$ 74,329.01	-R\$ 356,652.64	-R\$ 356,652.64



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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_{exported}) and the reference operational cost was R\$ 71.54/MWh_{exported}.

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 value undetermined 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, the CAPEX 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

² 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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system (CAPEX_{Gas}), from -5% to -15% in the CAPEX of the Electricity Generation (CAPEX_{Electricity}) 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%	N/A
CAPEX Gas	-10%	N/A
	-15%	N/A
	-5%	N/A
OPEX Gas	-10%	N/A
	-15%	N/A
CADEX	-5%	N/A
CAPEX Electricity	-10%	N/A
Licementy	-15%	N/A
ODEV	-5%	N/A
OPEX Electricity	-10%	N/A
Licementy	-15%	N/A
D	+ 5%	N/A
Flectricity	+ 10%	N/A
Licentry	+ 15%	1.437%

The result of no values of IRR calculated is due to the non-existence of positive incomes in the period analyzed.

The results of the sensitivity analysis resulted that even if the electricity sale (the main source of income) vary more than 15%, the project IRR will still be way below the NTNF 010117.

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

Alternative	Financial Conclusion									
BAU situation (landfill's operation)	N/A, as this situation does not involve any kind of investment.									
Only flaring of landfill gas	Investment in a gas collection and flaring system will neve return, as the only source of income is the sale of CERs.									
Generation of electricity	Even when the electricity generation (the main source of income) varies 15%, the result of the cash-flow's IRR, 1.437%, is still below the values of NTNF 010117 (13.35%)									

STEP 3. Barrier analysis

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



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STEP 4. Common practice analysis

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

The main national data concerning the actual stage of landfills in Brazil are from SNIS – Sistema Nacional de Informações sobre Saneamento. SNIS evaluated, among other topics, if the Solid Waste Disposal Sites (including open dumps, controlled landfills and sanitary landfills) have implemented a system of LFG use (for electricity/heat generation or other uses). Data was consolidated in the table Up03³, as presented below:

CITY/STATE	Name of the Site
Alagoinhas/BA	Aterro Sanitário
Alcântara/MA	LIXÃO DO PAVÃO
Alta Floresta D'Oeste/RO	Lixão Municipal
Altos/PI	Lixão
Alvorada do Gurguéia/PI	Lixão do Alvorada do Gurgueia
Amargosa/BA	Lixão
Anápolis/GO	Aterro Sanitário de Anápolis
Antonina/PR	Lixão Antonina
Aparecida de Goiânia/GO	Aterro Sanitário
Aparecida de Goiânia/GO	Lixão desativado e em recuperação
Aquiraz/CE	Aterro Sanitário
Aracaju/SE	Aterro Controlado do Bairro Santa Maria
Araçuaí/MG	Aterro
Araguaína/TO	Aterro Controlado de Resíduos Sólidos
Arapiraca/AL	Aterro Sanitário
Araraquara/SP	Aterro Controlado
Arcos/MG	Aterro Amâncio Alves
Avelino Lopes/PI	Lixão
Bagé/RS	Aterro Sanitário Municipal
Barbacena/MG	Aterro Controlado
Barra do Piraí/RJ	Vazadouro de Lixo Municipal
Bauru/SP	Aterro Sanitário de Bauru
Belém/PA	Aterro Sanitário do Aurá
Belo Horizonte/MG	CTRS BR040
Benevides/PA	Lixão Bairro das Flores
Betim/MG	Aterro Sanitário
Biguaçu/SC	Aterro Proactiva
Biguaçu/SC	Aterro Sanitário Tijuquinhas
Blumenau/SC	Aterro Controlado
Boa Vista/RR	Aterro Sanitário
Bom Jesus/PI	Lixão
Brasília/DF	Aterro do Jóquei
Brumadinho/MG	Aterro Controlado

Table 1. Landfills identified in Table Up03 of SNIS

³ SNIS – Sistema Nacional de Informações sobre Saneamento; available at

http://www.snis.gov.br/arquivos_snis/5_DIAGNOSTICOS/5.2_Residuos_solidos/5.2.5_Diagnostico2006/RSD05_Planilhas.zip (Table RSD05_Up03); accessed on 02 Apr 2009.



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Buritis/MG	Lixão
Cáceres/MT	Aterro Controlado de Cáceres
Caicó/RN	Sítio Várzea Redonda ou Gruta do Seridó
Camaçari/BA	Aterro Integrado Camaçari / Dias D'Ávila
Campina Grande/PB	Lixão
Campinas/SP	Aterro Sanitário
Campo Grande/MS	Aterro Sanitário Municipal
Campo Verde/MT	Lixão
Canindé de São Francisco/SE	Unidade de Disposição Final - Lixão
Canto do Buriti/PI	Lixão
Cariacica/ES	Célula de Resíduos Classe II
Carlos Chagas/MG	Aterro Controlado
Caruaru/PE	Aterro Sanitário
Cascavel/PR	Aterro Sanitário
Castanhal/PA	Lixão do Pantanal
Caxias do Sul/RS	Aterro São Giacomo
Chapecó/SC	Aterro Sanitário
Cianorte/PR	Aterro Sanitário SANEPAR
Coimbra/MG	Usina de Lixo
Colatina/ES	CETREU / Aterro Sanitário
Colinas do Tocantins/TO	Lixão
Contagem/MG	Aterro Sanitário Perobas
Corumbá/MS	Aterro Municipal de Corumbá
Criciúma/SC	SANTEC - Resíduos
Cuiabá/MT	Aterro Sanitário
Curaçá/BA	Lixão de Curaçá
Curitiba/PR	Aterro Sanitário da Caximba
Diamantina/MG	Aterro Controlado do Município de Diamantina
Dois Irmãos/RS	Aterro Sanitário
Dourados/MS	Aterro controlado
Dourados/MS	Aterro Sanitário
Engenheiro Coelho/SP	Aterro Sanitário
Erechim/RS	Aterro Controlado
Extremoz/RN	Aterro Controlado Comunidade de Capim
Farroupilha/RS	Aterro Sanitário
Feira de Santana/BA	Aterro Sanitário de Feira de Santana
Floriano/PI	Aterro Sanitário de Floriano-PI
Foz do Iguaçu/PR	Aterro Sanitário
Franca/SP	Aterro Fazenda Municipal
Franca/SP	Aterro Sanitario Ivan Vieira
Goiânia/GO	Aterro Sanitário de Goiânia
Goiás/GO	Lixão
Governador Valadares/MG	Aterro Controlado
Gravataí/RS	Aterro Sanitário Metropolitano de Santa Tecla
Gravataí/RS	Aterro Santa Tecla
Guarapuava/PR	SURG - Cia de Serviços de Urbanização de Guarapuav
Guararema/SP	Aterro Sanitário
Guarulhos/SP	Aterro Sanitário de Guarulhos - Ouitauna
Cuiabá/MT Curaçá/BA Curitiba/PR Diamantina/MG Dois Irmãos/RS Dourados/MS Dourados/MS Engenheiro Coelho/SP Erechim/RS Extremoz/RN Farroupilha/RS Feira de Santana/BA Floriano/PI Foz do Iguaçu/PR Franca/SP Franca/SP Goiânia/GO Goiás/GO Governador Valadares/MG Gravataí/RS Guarapuava/PR Guarapuava/PR Guararema/SP Guarulhos/SP	Aterro SanitárioLixão de CuraçáAterro Sanitário da CaximbaAterro Controlado do Município de DiamantinaAterro Controlado do Município de DiamantinaAterro SanitárioAterro SanitárioAterro SanitárioAterro SanitárioAterro ControladoAterro ControladoAterro SanitárioAterro ControladoAterro SanitárioAterro SanitárioAterro Controlado Comunidade de CapimAterro SanitárioAterro Sanitário de Feira de SantanaAterro Sanitário de Floriano-PIAterro SanitárioAterro Sanitário Ivan VieiraAterro Sanitário de GoiâniaLixãoAterro Sanitário Metropolitano de Santa TeclaAterro Sanitário Metropolitano de Santa TeclaSURG - Cia de Serviços de Urbanização de GuarapuavAterro SanitárioAterro Sanitário





Guarulhos/SP	Lixão Quitauna
Horizonte/CE	Aterro da Pedreira
Ibiporã/PR	Aterro Controlado de Ibiporã
Iguape/SP	Aterro Sanitario
Imperatriz/MA	Aterro Controlado
Independência/CE	São Jerônimo
Ipameri/GO	Aterro Controlado de Ipameri
Itabira/MG	Aterro Controlado
Itabuna/BA	Volta da Cobra
Itajaí/SC	Aterro Sanitário Canhanduba
Itajubá/MG	Aterro Controlado do Município de Itajubá
Itapissuma/PE	Lixão
Jaboatão dos Guararapes/PE	Aterro da Muribeca
Jataizinho/PR	PREFEITURA MUNICIPAL DE JATAIZINHO
João Câmara/RN	Liffe
João Monlevade/MG	
João Monlevade/MG	Lixão do Andrade
João Pessoa/PB	Aterro Sanitário Metropoltano
João Pessoa/PB	Lixão do Róger
Joinville/SC	aterro sanitário
José de Freitas/PI	Lixão José de Freitas
Juazeiro/BA	Secretaria de Transporte e Serv. Publicos
Juína/MT	Aterro Controlado
Juiz de Fora/MG	Aterro Sanitário
Lages/SC	Aterro Sanitário do Município de Lages
Lages/SC	Aterro Sanitário do Município de Lages
Lagoa Grande/PE	LIXÃO
Londrina/PR	Aterro Controlado
Macapá/AP	Carapirás
Maceió/AL	Lixão de Cruz das Almas /SLUM
Manaus/AM	Aterro do KM 19
Marabá/PA	Aterro Sanitário de Marabá
Maracaju/MS	Aterro Controlado de Maracaju
Marau/RS	Central Regional de Resíduos Sólidos
Marechal Cândido Rondon/PR	Lixão
Maringá/PR	Aterro Controlado de Maringa
Mauá/SP	LARA Central de Trat. Resíduos
Miracema do Tocantins/TO	Lixão
Monteiro/PB	Unid. de Reciclagem e Compostagem de Res. Sólidos
Montes Claros/MG	Aterro Municipal
Mossoró/RN	Lixão de Cajazeiras
Nísia Floresta/RN	LIXÃO
Niterói/RJ	Aterro Controlado do Morro do Céu
Nossa Senhora da Glória/SE	Lixão
Nossa Senhora do Socorro/SE	ATERRO CONTROLADO DA PALESTINA
Nova Esperança/PR	Aterro Controlado
Nova Friburgo/RJ	Aterro Controlado
Nova Hartz/RS	Lixão



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Nova Iguaçu/RJ	CTR - Nova Iguaçu
Nova Lima/MG	Aterro de Inertes
Nova Lima/MG	Aterro Sanitário Norte
Novo Hamburgo/RS	Aterro Sanitário do Bairro Roselândia
Olinda/PE	Aterro de Resíduos Sólidos de Aguazinha
Paço do Lumiar/MA	Lixão
Padre Bernardo/GO	Aterro Sanitário
Palmas/TO	Aterro Sanitário de Palmas
Paracatu/MG	Aterro Controlado de Paracatu
Paranaguá/PR	Lixão do Imbocuí
Parnaíba/PI	Aterro Controlado de Parnaíba
Passo Fundo/RS	Aterro Controlado
Pau dos Ferros/RN	Lixão
Paulínia/SP	Aterro Sanitário de Paulinia - Estre
Paulo Afonso/BA	USINA DE TRIAGEM E COMPOSTAGEM DE LIXO DE PAULO AF
Pelotas/RS	Aterro Colina do Sol
Penápolis/SP	Aterro Sanitário
Picos/PI	Lixão
Piranhas/AL	Lixão
Pocos de Caldas/MG	Aterro Controlado
Porto Alegre/RS	Aterro da Extrema
Porto Nacional/TO	Diretoria de Limpeza Urbana (Aterro)
Porto Velho/RO	Lixão Km 18
Presidente Prudente/SP	Lixão
Registro/SP	Lixão Carapiranga
Rio Branco/AC	Aterro Controlado de Lixo
Rio de Janeiro/RJ	CTR - Rio
Rio de Janeiro/RJ	CTR Gericinó
Rio Formoso/PE	Aterro Sanitário, Usina de Recilágem e Compostagem
Rio Grande/RS	Rio Grande
Rio Verde/GO	Aterro Controlado
Rondonópolis/MT	Lixão de Rondonópolis
Sabará/MG	Centro de Disposição de Resíduos - Macaúbas
Salvador/BA	Aterro Controlado de Canabrava
Salvador/BA	Aterro Metropolitano Centro
Santa Bárbara d'Oeste/SP	Aterro Sanitario Municipal de Santa Bárbara d'Oest
Santa Cecília do Pavão/PR	Aterro Sanitário
Santa Cruz/RN	Lixão Municipal de Santa Cruz
Santa Luzia/MA	S. Pinho Costa Limpeza/ME
Santa Maria/RS	Aterro da Gaturrita
Santarém/PA	Aterro Municipal do Perema
Santo André/SP	Aterro Sanitário Municip. (Empreit. Pajoan)
Santos/SP	Aterro Sanitário Sítio das Neves
São Félix do Araguaia/MT	Lixão
São Gonçalo/RJ	Aterro de Itaoca - CTR Alcantara
São João Batista do Glória/MG	Aterro Controlado
São José do Rio Preto/SP	Aterro Municipal
São José dos Campos/SP	Estação de Tratamento de Resíduos Sólidos
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CDM – Executive Board

São Leopoldo/RS	Aterro Sanitario Municipal
São Luís/MA	Aterro Municipal da Ribeira
São Mamede/PB	Aterro Sanitário
São Mamede/PB	ATERRO SANITÁRIO DE SÃO MAMEDE
São Miguel do Araguaia/GO	Aterro Controlado
São Paulo/SP	Aterro Bandeirantes
São Paulo/SP	Aterro São João
Senhor do Bonfim/BA	Lixão
Serra/ES	Aterro Sanitário de Vila Nova de Colares
Sete Lagoas/MG	Disposição Final de Resíduos Sólidos
Sobral/CE	Aterro Sanitário de Sobral
Sobral/CE	Central de Controle de Lixo do Distr. de Aprazível
Sobral/CE	Central de Controle de Lixo do Distr. de Caracará
Sobral/CE	Central de Controle de Lixo do Distr. de Taperuaba
Sobral/CE	Central de Controle de Lixo do Distr.de Aracatiaçu
Tabatinga/AM	Lixeira Municipal
Taiobeiras/MG	Aterro Controlado
Teresina/PI	Aterro Sanitário
Timbó/SC	Serviço Municipal de Água e Esgoto
Timon/MA	Aterro Sanitário
Toledo/PR	Aterro Sanitário
Torres/RS	Aterro Controlado
Tremembé/SP	Sarpi Sistema Ambiental Cia. Ltda
Uberaba/MG	Aterro Sanitário
Uberlândia/MG	Aterro Sanitário Municipal
União da Vitória/PR	Aterro Sanitário Municipal
Uruguaiana/RS	Lixão
Urussanga/SC	CIRSURES
Valparaíso de Goiás/GO	Lixão do Pacaembú
Vargem Bonita/MG	Aterro Controlado
Vera Cruz/BA	Aterro
Vitória da Conquista/BA	Aterro
Vitória da Conquista/BA	Vala para RSS
Volta Redonda/RJ	Aterro Controlado

From the 211 landfills sampled, only 17 of them answered "Yes" for the question "Gas Final Use". Excluding those projects developed under the CDM (registered or published for GSC), the result is that only 7 of the 211 projects were implemented without the CDM, or 3.32% of the sample:

Table 2. Solid Waste Disposal Sites indentified in table Up03, which have answered	l ''Yes''	to the
question "Gas Final Use"		

1		
City	Landfill Name	CDM Project (Y/N)
Cariacica (ES)	Célula de Resíduos Classe II	Y (Brazil MARCA Landfill Gas to Energy Project)
Cascavel (PR)	Aterro Sanitário	Ν
Cuiabá (MT)	Aterro Sanitário	Ν



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Goiânia (GO)	Aterro Sanitário de Goiânia	Ν
Juína (MT)	Aterro Controlado	Ν
Nova Iguaçu (RJ)	CTR - Nova Iguaçu	Y (NovaGerar Landfill Gas to Energy Project)
Paulínia (SP)	Aterro Sanitário de Paulinia - Estre	Y (ESTRE's Paulínia Landfill Gas Project)
Rio de Janeiro (RJ)	CTR - Rio	Ν
Salvador (BA)	Aterro Controlado de Canabrava	Y (Canabrava Landfill Gas Project)
Salvador (BA)	Aterro Metropolitano Centro	Y (Salvador da Bahia Landfill Gas Management Project)
Sta Bárbara d'Oeste (SP)	Aterro Sanitario Municipal de Santa Bárbara d'Oest	N
Santos (SP)	Aterro Sanitário Sítio das Neves	Y (Terrestre Ambiental Landfill Gás Project)
São José dos Campos (SP)	Estação de Tratamento de Resíduos Sólidos	Y (URBAM/ARAUNA - Landfill Gas Project)
São Leopoldo (RS)	Aterro Sanitario Municipal	Ν
São Paulo (SP)	Aterro Bandeirantes	Y (Bandeirantes Landfill Gas to Energy Project)
São Paulo (SP)	Aterro São João	Y (São João Landfill Gas to Energy Project)
Tremembé (SP)	Sarpi Sistema Ambiental Cia. Ltda	Y (Onyx gas recovery project – Tremembé, Brazil)

Source: adapted from SNIS – Table Up03

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

This discussion will be focused on those landfills which implemented some kind of gas final use and which were not developed under the CDM. Excluding the CDM projects from Table 2, the table 3 below lists and analyzes how each of the 7 landfills had implemented the "Gas final use" project.

incentives of CDM.	Table 3. Discussion about pro	jects which had implemented	"Gas Final Use'	' projects, without the
	incentives of CDM.			

City	Landfill Name	Type of project implemented
Cascavel	Atomo Sonitório	Power generation for lightning –
(PR)	Aterio Sanitario	pilot-scale.
Cuiabá	Aterro Sanitário	Wrongly answered – the landfill





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(MT)		drains the gas and destroy part in
		the top of the wells (phone call
		confirmation)
Gojânja		Enclosed flare voluntarily, not
GOD	Aterro Sanitário de Goiânia	operating (phone call
(00)		confirmation)
Iuína		Wrongly answered – the landfill
(MT)	Aterro Controlado	does not even have a gas draining
		system (phone call confirmation)
		Wrongly answered. The landfill
		does not exist and the project was
Pio de Janeiro		never approved to receive the
	CTR – Rio	Environmental Permit ⁴ . However,
(KJ)		the project encompasses the
		installation of a degassing unit,
		with a LFG flaring system.
		Wrongly answered – the landfill
Sta Bárbara d'Oeste	Aterro Sanitario Municipal de Santa	drains the gas and destroy part in
(SP)	Bárbara d'Oest	the top of the wells (internet
		search confirmation ⁵)
São Leopoldo	Aterro Sanitario Municipal	Leachate evaporation and
(RS)	Auto Santano Municipal	incineration system

Thus, it can be concluded that only 2 landfills had implemented projects without the CDM revenues, from which only one of them is operating and none of them is about the electricity generation, which proves that similar activities to the proposed project activity (landfill gas flaring and electricity generation to the grid) are not widely observed and commonly carried out.

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

- 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; similar activities are not widely observed and commonly carried out, being restricted into pilot-scale systems;
- 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: ACM0001

a) Baseline Emissions

⁴ <u>http://www.inea.rj.gov.br/downloads/ata_audit_public_ctr.pdf</u>

⁵ http://www.santabarbara.sp.gov.br/v3/index.php?pag=pag_noticia&dir=noticias&id=27715



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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 <i>y</i> (tCO ₂ e);
MD _{project, y}	The amount of methane that would have been destroyed/combusted during the year
	y (tCH ₄) 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 ₂ e/tCH ₄)
$EL_{LFG, y}$	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 _{elec, BL, y}	CO_2 emissions intensity of the baseline source of electricity displaced
	(tCO ₂ 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 ₂ emissions intensity of the fuel used by boiler to generate thermal energy which
	is displaced by LFG based thermal energy generation (tCO ₂ 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



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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 $37\%^6$.

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)

Where:

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)

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

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_{project,v}.

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

⁶ http://www.mnp.nl/ipcc/Archive/AR4FOD/ExpRevFOD/FODrev/FOD_AChapter10.doc



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Where:

MD _{flared,y}	Quantity of methane destroyed by flaring (tCH ₄)
$MD_{electricity,y}$	Quantity of methane destroyed by generation of electricity (tCH ₄)
$MD_{thermal,y}$	Quantity of methane destroyed for the generation of thermal energy (tCH ₄)
$MD_{PL,v}$	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:

$LFG_{flare, y}$	Quantity of landfill gas fed to the flare(s) during the year measured in cubic meters (m ³)
LFG _{electricity, y}	Quantity of landfill gas sent to the power house (m^3)
W _{CH4,y}	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 ₂ 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 _{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*":



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

Where:

MD _{project, y}	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)
φ	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
$W_{j,x}$	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_j	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 $(x = y)$
v	Year for which methane emissions are calculated

According with USEPA⁷, 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

⁷ USEPA; Turning a Liability into an Asset: A Landfill Gas-to-Energy Project Development Handbook; September 1996





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 nº 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 (EFgrid,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

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

STEP 6. Calculate the combined margin emissions factor 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 _{Grid, CM, y}	Emission factor for the Brazilian electric grid in year y (tCO ₂ /MWh)
EF _{Grid, OM, y}	Operating margin CO_2 emission factor in year y (t CO_2/MWh)
EF _{Grid, BM, y}	Build margin CO_2 emission factor in year y (t CO_2/MWh)
W _{OM}	Weighting of operating margin emissions factor (%)
W _{BM}	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^{st} crediting period and 0.25 and 0.75, respectively, for the 2^{nd} and 3^{rd} crediting periods.



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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)

Where:

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

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 (N₂).

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 _{j, h}	Mass fraction of element j in the residual gas in hour h
fv _{i, h}	Volumetric fraction of component i in the residual gas in the hour h
AMj	Atomic mass of element <i>j</i> (kg/kmol)
NA _{j, i}	Number of atoms of element <i>j</i> in component <i>i</i>
j	The elements carbon, hydrogen, oxygen and nitrogen
P _n	Atmospheric pressure at normal conditions (101 325 Pa)



R _n	Universal ideal gas constant (8 314 Pa.m ³ /kmol.K)
T _n	Temperature at normal conditions (273.15 K)
fv _{i, h}	Volumetric fraction of component i in the residual gas in the hour h
MM _i	Molecular mass of residual gas component <i>i</i> (kg/kmol)
FV _{RG, h}	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:

$$TV_{n,FG,h} = V_{n,FG,h} \times FM_{RG,h} \tag{14}$$

Where:

TV _{n, FG, h}	Volumetric flow rate of the exhaust gas in dry basis at normal conditions in hour h (m ³ /h)
V _{n, FG, h}	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 _{RG, h}	Mass flow rate of the residual gas in the hour h

$$\mathbf{V}_{n, FG, h} = \mathbf{V}_{n, CO_2, h} + \mathbf{V}_{n, O_2, h} + \mathbf{V}_{n, N_2, h}$$
(15)

Where:

V _{n, FG, h}	Volumetric flow rate of the exhaust gas in dry basis at normal conditions in hour h
	(m^3/h)
V _{n, CO2, h}	Quantity of CO 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 _{n, O2, h}	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 _{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 $h (m^3/kg_{residual gas})$

$$\mathbf{V}_{\mathbf{n},\mathbf{O}_{2},\mathbf{h}} = \mathbf{n}_{\mathbf{O}_{2},\mathbf{h}} \times \mathbf{M} \mathbf{V}_{\mathbf{n}}$$

(16)

Where:

V _{n, O2, h}	Quantity of O ₂ volume free in the exhaust gas of the flare at normal conditions per kg of
	residual gas in the hour $h (m^3/kg_{residual gas})$
n _{O2, h}	Quantity of moles O_2 in the exhaust gas of the flare per kg residual gas flared in hour h
	(kmol/kg _{residual gas})
MV _n	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 $h (m^3/kg_{residual gas})$
MV _n	Volume of one mole of any ideal gas at normal temperature and pressure (22.4 L/mol)
n _{O2, h}	Quantity of moles O_2 in the exhaust gas of the flare per kg residual gas flared in hour h
	(kmol/kg _{residual gas})
fm _{N, h}	Volumetric fraction of Nitrogen in the residual gas in the hour h
AM _N	Atomic mass of element Nitrogen (kg/kmol)
MF ₀₂	O ₂ volumetric fraction of air
F _h	Stochiometric quantity of moles of O ₂ required for a complete oxidation of one kg
	residual gas in hour h (kmol/kg _{residual gas})

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

(18)

Where:

V _{n, CO2, h}	Quantity of CO ₂ volume free in the exhaust gas of the flare at normal conditions per kg
	of residual gas in the hour $h (m^3/kg_{residual gas})$
fm _{C, h}	Volumetric fraction of Carbon in the residual gas in the hour h
MV_n	Volume of one mole of any ideal gas at normal temperature and pressure (22.4 L/mol)
AM _C	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 _{O2, h}	Quantity of moles O_2 in the exhaust gas of the flare per kg residual gas flared in hour h
	(kmol/kg _{residual gas})
t _{O2, h}	Volumetric fraction of O_2 in the exhaust gas in the hour <i>h</i>
MF ₀₂	Volumetric fraction of O_2 in the air (0.21)
F _h	Stochiometric quantity of moles of O ₂ required for a complete oxidation of one kg
	residual gas in hour h (kmol/kg _{residual gas})
fm _{j, h}	Mass fraction of element j in the residual gas in hour h
j	The elements carbon (C) and nitrogen (N)



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(20)

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Atomic mass of element j (kg/kmol)

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

Where:

F _h	Stochiometric quantity of moles of O ₂ required for a complete oxidation of one kg
	residual gas in hour h (kmol/kg _{residual gas})
fm _{j, h}	Mass fraction of element j in the residual gas in hour h
j	The elements carbon (C), hydrogen (H) and oxigen (O)
AM_j	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)

Where:

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

STEP 5: Determination of methane mass flow rate in the residual gas on a dry basis

$$TM_{RG,h} = FV_{RG,h} \times fv_{CH_4,FG,h} \times \rho_{CH_4,n}$$
(22)

Where:

TM _{FG, h}	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 _{n, RG, h}	Volumetric flow rate of the residual gas in dry basis at normal conditions in hour h
	$(m^3/h))$
$fv_{CH4,\;FG,\;h}$	Concentration of methane in the exhaust gas of the flare in dry basis at normal conditions in hour $h (mg/m^3)$
$\rho_{\rm CH4,n}$	Density of methane at normal conditions (0.716 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




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- 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 _{FG, h}	Methane mass flow rate in exhaust gas averaged in hour h (kg/h)
TM _{RG, h}	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:

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

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:

PE _{EC, Scenario A, y}	Project emissions from electricity consumption in Scenario A, in year y (tCO ₂ /yr)	
EC _{PJ, j, y}	Quantity of electricity consumed by the project electricity consumption source <i>j</i> in year	
	y (MWh/yr)	
EF _{EJ, j, y}	Emission factor for electricity generation for source j in year y (tCO ₂ /MWh)	
TDL _{j, y}	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:

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

Where:

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



	y (MWh/yr)
EF _{EJ, j, y}	Emission factor for electricity generation for source <i>j</i> in year <i>y</i> (tCO ₂ /MWh)
TDL _{j, y}	Average technical transmission and distribution losses for providing electricity to
	source j in year y

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)

Where:

EF _{EL, ECDG, y}	Emission factor for the Emergency Captive Diesel Generator (ECDG) in year y
	(tCO_2/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 _{i, t}	Average net calorific value of fossil fuel type i used in the period t (GJ/mass or volume
	unit)
EF _{CO2, i, t}	Average CO ₂ emission factor of fossil fuel type <i>i</i> used in the period <i>t</i> (tCO ₂ /GJ)
EG _{n, t}	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
	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 _{EC, Scenario B, y}	Project emissions from electricity consumption in year y (tCO ₂ /yr)	
EC _{PJ, ECDG, y}	Quantity of electricity consumed from the Emergency Captive Diesel Generator	
	(ECDG) in year y (MWh/yr)	
FC _{ECDG, D, y}	Quantity of Diesel fired in the Emergency Captive Diesel Generator (ECDG) in the	
	time period t (mass or volume unit)	
NCV _{D, y}	Average net calorific value of the Diesel used in the period <i>t</i> (GJ/mass or volume unit)	



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EF _{EJ, j, y}	Emission factor for the Diesel in year y (tCO ₂ /MWh)
EG _{ECDG, y}	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.

d) Emission Reductions

Emission Reductions will be calculated according with the equation below:

$ER_{y} = BE_{y} - PE_{y}$	(33)
----------------------------	------

Where:

ER_y	Emission Reductions in year y (tCO ₂ e)	
BE _y	Baseline Emissions due to the natural emissions of methane to the atmosphere and du	
-	to the displacement of grid-fossil fuel electricity generation in year y (tCO ₂ e)	
PE_{y}	Project Emissions from flare efficiency and electricity consumption from the grid and	
-	from the captive diesel generator in year y (tCO ₂ 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 ³
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:	0, as there are no regulatory requirements nor legal obligations to destroy		
	the LFG.		
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 _{reg,y} at renewal of the credit period		
	– variable <i>updated at renewal of each credit period</i> . The DNA was		
	contacted and provided information that there are no federal		
	laws/regulations which obligates the destruction of methane in landfills.		
	A conservative value of 5% was adopted as the AF.		

Data / Parameter:	GWP _{CH4}			
Data unit:	tCO ₂ e/tCH ₄			
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 _{CH4}
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 _{CH4,SWDS,y}	
Data unit:	tCO ₂ 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:	Please, refer to Annex 3.	
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 _f
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.			

Data / Parameter:	DOCi			
Data unit:	-			
Description:	Fraction of degrad	dable 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 _i	Weste type :		
	(% 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 the version of the <i>Tool to determine methane emissions</i>			
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:	W _i				
Data unit:	Tons				
Description:	Total amount of c	organic waste prevent	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	008 on are estimative	es		
Justification of the					
choice of data or					
description of					
measurement methods					
and procedures actually					
applied :					
Any comment:					

Data / Parameter:	p _{n, j, x}					
Data unit:	-					
Description:	Weight fraction of the waste type <i>j</i> in the same	ple <i>n</i> collected	l during the			
	year x					
Source of data used:	BIOPAR Soluções Ambientais Ltda.					
Value applied:						
	Type of Wester					
	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 _i					
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 _i			
	Slowly	Pulp, paper, cardboard (other than sludge), textiles	0.070			
	degrading	Wood, wood products and straw	0.035			
	Moderately degradingOther(non-food)organic organic0.17					
	Rapidly degradingFood, food waste, sewage sludge, beverages and tobacco0.4					
Justification of the choice of data or description of measurement methods and procedures actually	 Those values were adopted considering the climate of the Barueri (city next to Santana de Parnaíba): MAT_{historical} = 20.6°C (data from EMBRAPA – Empresa Brasileira de Pesquisa Agropecuária⁸); 					
applied :	- MAP _{historical} = 1,402 mm (data from EMBRAPA – Empresa					
	Brasileira de Pesquisa Agropecuária ⁸);					
	- PET _{historical} = 957.0mm (data from EMBRAPA – Empresa					
	Brasile	ira de Pesquisa Agropecuária ⁸)				
Any comment:						

Tool to determine	nroiect	emissions	from	flaring	gases con	taining	methane
	projeci	chilosions.	mom_{j}	iuiiis	guses con	iaining	memane

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 _{CO2}	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

⁸ <u>http://www.bdclima.cnpm.embrapa.br/resultados/balanco.php?UF=sp&COD=264</u>





AM _C	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:

Year	LFG emissions (Nm ³ _{lfg})	Methane Emissions (Nm ³ _{CH4})	Year	LFG emissions (Nm ³ _{lfg})	Methane Emissions (Nm ³ _{CH4})
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 ³ _{lfg})	Methane Collected (Nm ³ _{CH4})
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 ³ _{lfg})	Methane Collected (Nm ³ _{CH4})
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 exportation estimatives (electricity generated minus the electricity consumed internally):

	Electricity		Electricity
Year	Export	Ano	Export
	(MWh)		(MWh)
2015	37,315	2023	18,154
2016	37,315	2024	17,703
2017	42,588	2025	11,767
2018	43,702	2026	11,767
2019	43,702	2027	10,844
2020	36,289	2028	5,380
2021	30,123	2029	5,380
2022	24,541		

The electricity consumed internally is estimated as 115 kW times a conservative capacity factor of 8760 hours/year.

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:

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

OPERATING MARGIN													
Average Emission Factor (tCO ₂ /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.6.4 Summary of the ex-ante estimation of emission reductions:

Year	Estimations of Project Activity Emissions (tCO ₂ e/year)	Estimations of Baseline Emissions (tCO ₂ e/year)	Estimation of Leakage (tCO ₂ e/year)	Estimation of Emission Reductions (tCO ₂ e/year)
2009	639	63,931	0	63,292
2010	742	74,174	0	73,432
2011	812	81,159	0	80,347
2012	859	85,942	0	85,083
2013	892	89,235	0	88,343
2014	915	91,518	0	90,603
2015	931	99,985	0	99,054
TOTAL	5,791	585,944	0	580,154

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

B.7.1 Data and parameters monitored:

Data / Parameter:	1. LFG _{total, y}
Data unit:	m^3
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:	 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 Nm³; 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-house is not 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 _{flares y}
Data unit:	m^3
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



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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 ³ ;
- 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-house is not 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:	3. LFG _{electricity, y}
Data unit:	m^3
Description:	Amount of landfill gas sent to the power house 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 turbine flow-meters installed. The
measurement methods	equipments are connected to a supervisory computer system, which
and procedures to be	registers continuously the LFG measured. Data to be aggregated monthly
applied:	and yearly.
	There will be one flow-meter for each engine installed.
QA/QC procedures to	Turbine flow meters should be subject to a regular maintenance and
be applied:	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 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 Gas de Aterro
	TECIPAR – PROGAT operators (the team, the organizational structure
	and the management structure will be defined after the project s
	Automatic readings of temperature and pressure will be made by concerns
	- Automatic readings of temperature and pressure will be used to convert the gas
	connected to the now-meter – these data will be used to convert the gas- flow to Nm^3 :
	All registrations will be kent for 2 years after the end of the crediting
	- An registrations will be kept for 2 years after the end of the crediting
	ponou,

Data / Parameter:4. w_{CH4}





Data unit:	m ³ CH ₄ /m ³ 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 _{LFG, v}
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:	
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 _{Flare, y}
Data unit:	tCO ₂ 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.

T 1		1	• ,	• •	C	<i>(</i> 1 ·		, . .	.1
1001	to i	determine	proiect	emissions	trom	flaring	gases	containing	methane
1000			project	0	<i></i>	,	00000	001110110	

Data / Parameter:	7. fv _{i,h}
Data unit:	-
Description:	Volumetric fraction of component i in the residual gas in the hour h
	where $i = CH_4$, CO, CO ₂ , O ₂ , H ₂ , N ₂
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 _{RG,h}) 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 4 . 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 _{RG,h}
Data unit:	m ³ /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 2. LFG _{flare} above.

Data / Parameter:	9. t _{O2, h}
Data unit:	-
Description:	Volumetric fraction of O_2 in the exhaust gas of the flare in the hour <i>h</i>
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:	10. fv _{CH4, FG, h}
Data unit:	mg/m ³
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
	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 _{flare}
Data unit:	°C
Description:	Temperature in the exhaust gas of the flare
Source of data to be	Measurements using thermocouples
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	Measurements by project participants, using thermocouples.
measurement methods	
and procedures to be	There will be one thermocouple installed for each flare.
applied:	
QA/QC procedures to	Thermocouples will be replaced or calibrated every year.
be applied:	
Any comment:	All registrations will be kept for 2 years after the end of the crediting
	period;



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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.

Tool for calculation of emission factor for electricity systems

Data / Parameter:	12. EF _{OM, 2007}
Data unit:	tCO ₂ 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:	

Data / Parameter:	13. EF _{BM, 2007}
Data unit:	tCO ₂ e/MWh
Description:	Emission Factor of the Built Margin of 2007
Source of data to be	Brazilian DNA
used:	
Value of data applied	0.0775
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:	

Data / Parameter:	14. EF ₂₀₀₇
Data unit:	tCO ₂ 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	EF_{OM} and EF_{BM} by the Brazilian DNA.
and procedures to be	
applied:	
QA/QC procedures to	N/A
be applied:	
Any comment:	The EF will be calculated every hour, using data from the Brazilian
	DNA.

Tool to calculate baseline, project and/or leakage emissions from electricity consumption

Data / Parameter:	15. EC _{PJ, EG, y}	
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	

Data / Parameter:	16. TDL _{EG, y}
Data unit:	%
Description:	Average technical transmission and distribution losses for providing
	electricity to EG in year y
Source of data to be	<i>Tool to calculate baseline, project and/or leakage emissions from</i>
used:	electricity consumption
Value of data applied	20%, according with the Tool.
for the purpose of	
calculating expected	
emission reductions in	
section B.5	
Description of	TDL _{EG,y} will be based on references from utilities, network operators or
measurement methods	other official documentation. An annually monitoring will be undertaken;
and procedures to be	in the absence of data from the relevant year, most recent figures will be
applied:	used, but not older than 5 years.
QA/QC procedures to	
be applied:	
Any comment:	All registrations will be kept for 2 years after the end of the crediting
	period.





Data / Parameter:	17. FC _{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:	18. EG _{DG, v}
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:	19. NCV _{D, t}
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	



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emission reductions in section B.5	
Description of measurement methods and procedures to be	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
applied:	For c): Any future revision of the IPCC Guidelines will be taken into account
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:	20. EF _{CO2, e}
Data unit:	tCO ₂ /TJ
Description:	CO_2 emission factor 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 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 O₂ and CH₄ analyzer installed for each flare; All data read will be continuously registered in a computer supervisory system, as presented in B.7.1.



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 02/04/2009 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.

The environmental licences from the Power House were not requested yet, but will be once it is necessary to the construction/operation of the installation.

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 n°7 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:





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Resolução nº7	Stakeholder invited
Prefeitura do município envolvido	Prefeitura de Santana de Parnaíba
(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 <i>(Brazilian NGO Forum)</i>	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 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.
Street/P.O.Box:	Alameda Madeira, 222 – 11° andar, cj 112 – Alphaville Industrial
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Represented by:	Director
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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)





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	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:



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Variable	Value																				
•	0,9																				
f	0																				
GWP	21																				
OX	0																				
F	50%																				
DOCf	0.5																				
MCF	1																				
		1	Г	DOCi	Wi	k															
	Woo	d and woo	d products	43%	0.13%	0.035															
	Puln	naner and	cardboard	40%	0.25%	0.07															
Food foo	d wasto bo	vorages ar	nd tobacco	15%	93.00%	0.4															
1000,100	Food, food waste, beverages and tobacco 15% 93,00% 0,4																				
	Cardon	word and	Textiles	24 /0	6,00%	0,07															
Class	plastia m	yaru anu j	Dark waste	20 /0	1,00%	0,17															
Glass,	plasue, me	etal, other i	nent waste	076	1,50%	U															
																· · · ·	1			1	ı
																	Total Methane	Total Methane	Total LFG	TALON	Total Collected
Year	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	BECH4, SWDS	Emissions	Emissions	Emissions	Total Collected	BASELINE
																(tCO ₂ e/year)	(t/year)	(Nm3/year)	(Nm3/year)	(Nm3 _{LFG} /year)	(Nm3/year)
																	(0)0017	((,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,		
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 4 7 6	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
2012	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
2013	19	43	475	1.000	2.683	4 362	7 904	11.521	16.872	24 802	36.568	54.047				160.553	7.646	10.400.204	21 332 578	12.400.540	12 150 560
2014	14	43	240	902	1 970	2.021	F 452	7 904	11.521	16 972	24 902	26 669	F4 047			162.350	7.770	10.000.203	21.332.370	12.002.409	12.133.303
2015	14	31	340	632	1.075	3.031	3.433	T.304	7.004	11.072	16.970	30.300	34.047	54.047		105.334	7.072	10.002.002	21.704.103	13.022.430	12.511.515
2010	- 10	23	240	4030	054	2.123	3.700	3.433	T.304	7.004	11.072	24.002	30.500	34.047	E4 047	105.320	7.073	11.303.000	21.300.130	13.173.002	12.520.090
2017	0	17	101	403	951	1.502	2.004	3.700	5.455	7.904	7.004	10.072	24.002	30.500	54.047	100.731	7.940	7.552.205	22.152.007	13.291.720	12.021.134
2010	6	13	130	341	690	1.075	1.0//	2.004	3.700	5.455	7.904	7.004	10.072	24.002	30.500	77.074	5.414	7.553.305	15.100.729	9.064.036	0.010.030
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	11.814	3.708	5.1/3.38/	10.346.775	6.208.065	5.897.002
2020	4	8	80	194	379	5/3	9/4	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	4.001.102
2021	3	6	63	150	288	428	/1/	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	/1/	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	1.900.795
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	0	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
2030	0	1	5	11	18	22	31	34	38	42	48	54	61	70	81	516	25	34.256	68 513	41 108	30.052
2033	v	1	J	11	10	~~~	91		50	74	40	5	VI	1.0	01	50	20	34.230	00.010	41.100	33.002

Figure 4. LFG Generation calculated using the approved tool







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Av. Paslisla, 2073 - Honsa I - 50 ander-Ce, 119122-São Pasio 2 55 11 2284-9090 - e nail maliantierieguetornit 6 PROBIDO PELA LE A DIVLIGAÇÃO E A REPRODUÇÃO DO PRESENTE DESENTO SEM UMA PREVIA AUTORIZAÇÃO

Legend Existing not-bunning wells -12 wells Existing burning wells –
 03 wells Et Budeto dos Prepar e Dranos RDV. MOTIVO 14/10/2008 APRENDO BIOPAR Ventura Landfill MultiAmhiente Ltda Av. Paulista, 2073 - Horsa I - 1º Andar ejs. 119/120 - Conj. Nacional CEP 01311 - 300 São Paulo - SP. - Brasil M????A? VENTURA LANDFILL Centralization and combustion of LFG, with verification of quality and quantity **EXECUTIVE PROJECT** 08JE70 Actual Situation Outubro 2008 7.2.1e ESCALA

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


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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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