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

CONTENTS

Annexes

SECTION A. General description of project activity

A.1 Title of the project activity:

Gramacho Landfill Gas Project
Version 03.1
Date: 06/01/2009

A.2. Description of the project activity:

The Gramacho Landfill Gas Project aims to capture the landfill gas (LFG) generated by the Gramacho Landfill and sell it to a local Town Gas producer (GPC Quimica- **GPC**) and to an independent power producer (**IPP**). **GPC** has a plant located about 25 Km from the landfill and uses Town Gas for methanol production. **GPC** plant has been using Natural Gas as its primary feedstock for more than 25 years.

Applying the state-of-the-art on LFG capture technology, Novo Gramacho Energia Ambiental will install a collecting system covering most of surface of the Gramacho Landfill (200 hectares), as part of its effort to avoid the free emission of methane to the atmosphere. The LFG captured will be primarily sold to GPC and the remaining volume, if any, will be flared in the Novo Gramacho flaring system. Alternatively Novo Gramacho Energia Ambiental is considering also to sell a smaller portion of the LFG captured to an **IPP**. Novo Gramacho Energia Ambiental understands that flaring shall be always the very last option of any CDM project related to LFH destruction.

The actual practice of execution of the Gramacho Landfill since its opening for urban waste disposal (the Baseline Scenario, as presented in item B.4) has never been adequate for LFG gas destruction at any level. The Gramacho Landfill does not have the typical covered intermediate layer forming separated “waste cells”. In addition to that, instead of having deep vertical wells draining LFG across different waste layers, the LFG permeates through the whole waste body up to the surface which is not properly covered with impermeable material. Therefore LFG flow cannot be currently controlled to avoid free emission to the atmosphere. The existent wells are shallow with less than 4 meters depth and very inefficient even for just venting.

The LFG supplied to GPC will displace the consumption of natural gas currently used to produce Town Gas. GPC is presently ranked among the top ten largest consumer of natural gas in the City of Rio de Janeiro and the local gas distribution company CEG is its sole gas supplier until now. The LFG supplied to the independent power producer (IPP) will be used as fuel for power engines to generate electricity. However, the construction and operation of the power house will be in charge of the IPP and only the CERs derived from the LFG combustion in the engines will be claimed by Novo Gramacho.

As said before the Novo Gramacho Project will have a substantial positive impact in terms of sustainable development as it will the first LFG project in Brazil aimed to displace natural gas consumption directly.

a) Environmental Benefits

An environmental benefit with the implementation of the Gramacho Landfill Gas Project is the destruction of methane that otherwise would be emitted to the atmosphere, increasing the impact on global warming. Despite of being possibly flared if necessary, the landfill gas collected will be primarily injected into the gas pipeline built by the utility company CEG to transport the LFG to the GPC plant. As a consequence GPC will be able to avoid the consumption of the same amount of natural gas which is used today to produce town gas as part of its methanol production process.

Besides its direct global environmental benefits related to the avoidance of emission of LFG to the atmosphere, Novo Gramacho will invest largely also for the environmental recovery of the landfill and its surroundings, including:

- Installation of a new leachate plant to control and treat all liquid effluents to the satisfaction of the local legislation for discharge in the Baía de Guanabara;
- Design and execution of the landfill closure once the Rio de Janeiro Municipal Waste Agency (COMLURB) decides to finish the waste disposal in the Gramacho landfill;
- Continuous monitoring of the landfill's general conditions including geotechnical and environmental features.

b) Social / Income Generation Benefits
The CERs issued for the project will be used partially to finance the urban recovery of the landfill surroundings (Jardim Gramacho district). Moreover, Novo Gramacho will donate an annual contribution to a special purpose fund aimed train the people who lives nowadays from picking the waste during its disposal in the landfill.

c) Contribution to labour capacitating
As LFG projects are still recent in Brazil, there are not qualified people in the market. Given that, each new project must invest on training engineers and operators to the qualification level required by these new activities. Novo Gramacho will make use of the experience of its own shareholders as well as its international consultants to train and qualify the human resources necessary for the implementation and operation of the magnitude of the Gramacho Landfill Gas Project.

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)	• Companhia Municipal de Limpeza Urbana – COMLURB (Brazilian public entity) • Novo Gramacho Energia Ambiental S.A. (Brazilian Private Entity)	No
(*) In accordance with the CDM modalities and procedures, at the time of making the CDM-PDD public at the stage of validation, a Party involved may or may not have provided its approval. At the time of requesting registration, the approval by the Party(ies) involved is required.		

Novo Gramacho Energia Ambiental has as shareholders three well known Brazilian companies: Biogás Energia Ambiental S/A, J. Malucelli Construtora e Obras S/A and S.A. Paulista de Construção e Comércio.

Biogás Energia Ambiental S/A is the company that owns the concession for the development and operation of the two largest landfillgas-to-energy projects in Brazil: "Bandeirantes Landfill Gas to Energy Project" and "São João Landfill Gas to Energy Project".

J. Malucelli Construtora e Obras S/A is part of the J. Malucelli Group, one of the largest groups in Brazil, present on banking services, heavy construction, road concession, communication, insurance services, tourism and with investments of the energy sector.

S.A. Paulista de Construções e Comércio is a construction company and the majority shareholder of the well known "Brazil NovaGerar Landfill Gas to Energy Projects".

Companhia Municipal de Limpeza Urbana – COMLURB is a public company controlled by the Municipality of Rio de Janeiro and its responsible for all municipal services related to waste collection and disposal.

A.4. Technical description of the project activity:

A.4.1. Location of the project activity:

Gramacho Landfill Gas Project is located in the city of Duque de Caxias, Rio de Janeiro State, Brazil, at Avenida Monte Castelo, 1760.

A.4.1.1. Host Party(ies):

Brazil

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

Rio de Janeiro

A.4.1.3. City/Town/Community etc:

Duque de Caxias

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

The Gramacho Landfill is located at the following coordinates:

Latitude: 22º45'03" South
Longitude: 43º16'06" West

The difference between version 01 and this version is that the reference of the coordinates is the Weighting Machine of the Gramacho Landfill.

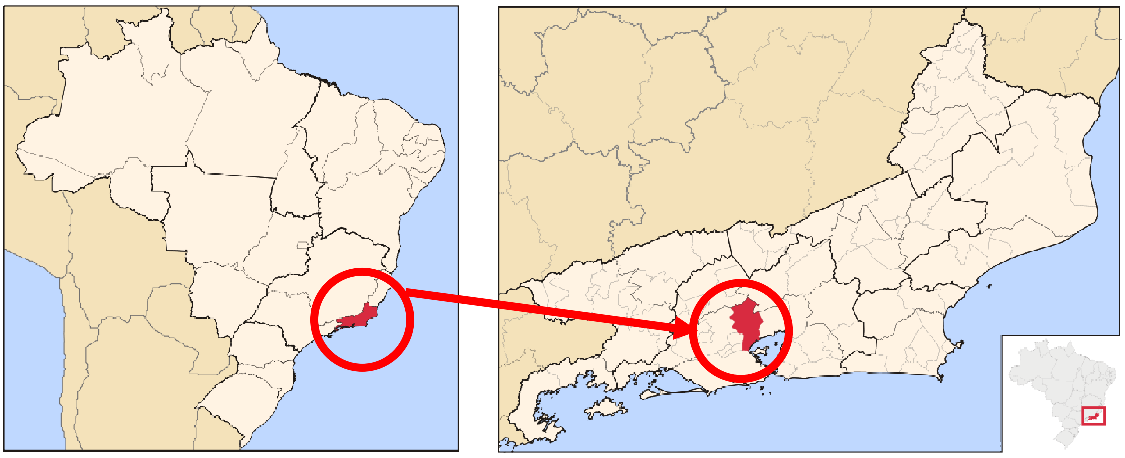
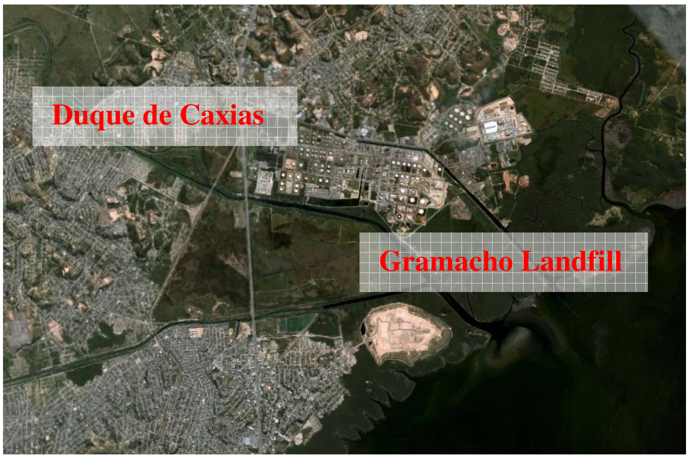


Figure 1. Gramacho Landfill location



Source: Wikipedia (http://pt.wikipedia.org)

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

The Gramacho Landfill Gas Project is categorized in the following Sectoral Scopes:

- *Sectoral Scope 13 – Waste Handling and Disposal:* used to calculate emission reductions due to the production of methane from the decomposition of municipal solid waste to the atmosphere; and

- *Sectoral Scope 1 – Energy industries (renewable - / non-renewable sources):* applied to calculate the grid-emission factor of CO_2e as a source of project emission;

- *Sectoral Scope 5 – Chemical Industries*: applied to calculate the emission reductions from the natural gas consumption avoided to produce Town Gas.

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

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

- a collection pipeline;
- a transportation pipeline network;
- a Gas Station, composed by blowers and compressors, and LFG treatment (moisture and

contaminant removal);
- a flaring system; and
- a pipeline for gas sale to GPC and to the independent power producer.

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

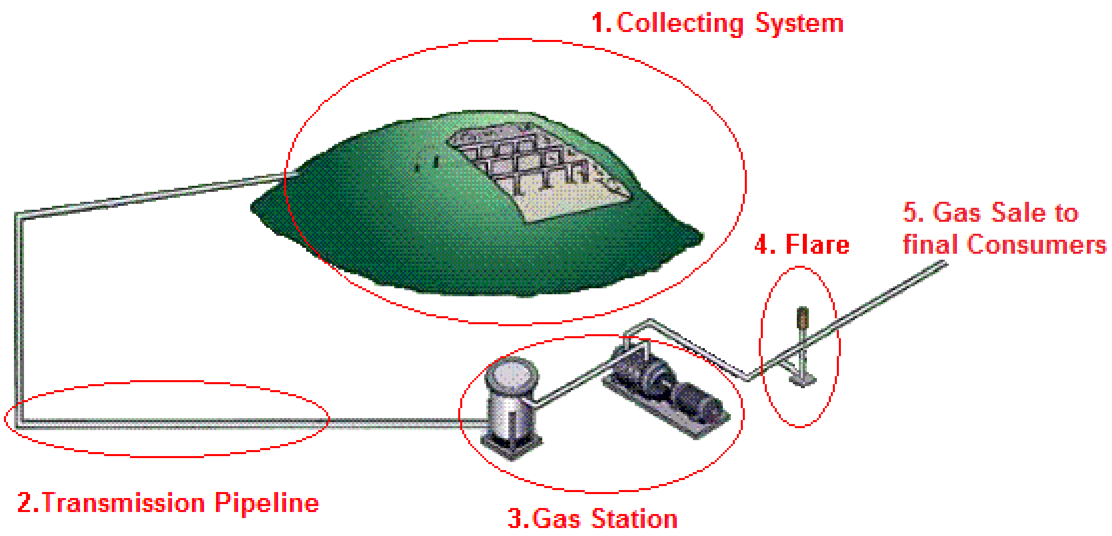


Figure 2. Schematic situation of a landfill with active gas recovery (Source: Adapted from City of Ann Arbon, accessed on April 12th, 2007[1])

1. Collecting System

Following well known technologies applied global wide , the Gramacho Landfill Gas Project will involve the perforation of about 200 new vertical wells as well as the installation of wellheads on top of them to collect the LFG presently emitted directly to the atmosphere. An example of wellhead and the detail of its construction are shown in Figure 3 and Figure 4.

[1] City of Ann Arbor, available at < http://www.a2gov.org/PublicServices/SystemsPlanning/Energy/LandfillEnergy.html>, accessed on April 12th, 2007.

Figure 3. Example of wellhead

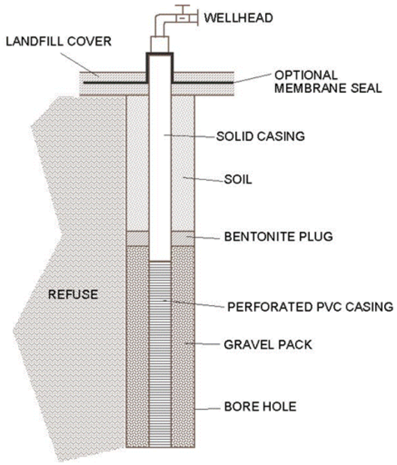


Figure 4. Internal detail of a well and wellhead (source: USEPA, 1996[2])

The use of the few existing wells is not recommended as they are quite shallow and not properly placed across the landfill surface. An extensive number of new wells will be drilled in order to guarantee the efficiency of the controlled drainage of the landfill as well as of the LFG collection. The well system will cover the entire surface of the landfill and its implementation will be carefully planned in order to mitigate interferences caused by the going-on operation of the landfill. Otherwise the wellheads and the collection pipeline might have to be frequently moved, what can reduce the overall efficiency of the system besides introducing extra operational costs.

Usually, the wellheads are made of PCV of HDPE, due to their characteristics in terms of flexibility and corrosion resistance. Novo Gramacho Energia Ambiental foresees the installation of 200 wells all over the landfill's area (the correct number of wells will be determined in the Executive Project).

The wellheads are connected to a collecting pipeline. This pipeline transports the LFG to the manifolds/gas regulation stations. These facilities can regulate the gas flow and the concentrations of O_2 in the gas collected. Case the concentrations are above a certain value, it means that maybe some air is infiltrating in the landfill and the valve corresponding to the wellhead must be closed. These facilities transfer the collected gas to the transmission pipeline and can be connected to more than ten wellheads.Usually, the manifolds are made of stainless-steel and are built under a roof. Novo Gramacho Energia Ambiental foresees the installation of 20 manifolds all over the landfill's area.

As a matter of fact the collection system as described above is quite similar to the design concept used successfully for BIOGAS in the Bandeirantes and São João Projects. Most of the pictures shown below are indeed taken from those projects with the authorization of Biogas which is also the main shareholder of Novo Gramacho. However, the final design concept to be used in the Gramacho landfill is still under analysis by SCS Engineers which is the engineering company contracted by Novo Gramacho. Should a different design concept be eventually applied for the collecting system it is certain that such a decision will be justified for better operation results.

[2] USEPA – United States Environmental Agency; *Turning a Liability into an Asset: a Landfill Gas-to-Energy Project Development Handbook*; LMOP – Landfill Methane Outreach Program, 1996

Figure 5. Example of manifold, connected to the transmission pipeline

Figure 6. Example of Gas Regulation Station (source: Multiambiente, accessed on January 31st, 2006[3])

2. Transmission Pipeline

From the manifolds, the gas is sent to a main HDPE pipeline of ø315 mm, which rounds the whole landfill area. The gas is transported to the Gas Station.

Figure 7. Example of a transmission pipeline

3. Gas Station

The Gas Station is the facility where the gas is suctioned from the landfill and where the gas receives the proper treatment, depending on the final use of the gas. Usually, the Gas Station is composed by blowers, condensate knock-outs and CO_2 removal system. Considering the scope of the Gramacho Landfill Gas Project, the LFG will be compressed to 16 bar for sale to GPC via CEG´s pipeline and there is no need to remove CO_2.

[3] Multiambiente; available at <http://www.multiambiente.com.br/tecnologias/html/biogas.asp>; accessed on Jan 31st, 2006

Figure 8. Example of a blowering system (source: John Zink, accessed on January 31st, 2006[4])

Figure 9. Example of Absorption Chiller (source: Biogás Ambiental, acessed on January 31st, 2006[5])

There will be installed 4 blowers, each with a maximum capacity of 5,000 Nm^3/h, adjustable to 2,500 Nm^3/h.

4. Flare System

The destruction of the methane content in the landfill gas collected will be made via an enclosed flare, in order to assure a higher methane destruction (above 99%) – via a temperature above 900ºC and retention time > 0.7 seconds.

Basically, the flare is constructed using refractory material, a gas inlet, dampers to control the air inlet, an ignition spark, e flame viewer and points to sample collection, as presented in the pictures below:

[4] John Zink Company LLC, available at http://www.johnzink.com/products/flares/pdfs/biog_advanced_flare_wastewater.pdf, accessed on January 31st, 2006

[5] Biogás Ambiental, available at <http://www.biogas-ambiental.com.br>, acessed on Jasnuary 31st, 2006

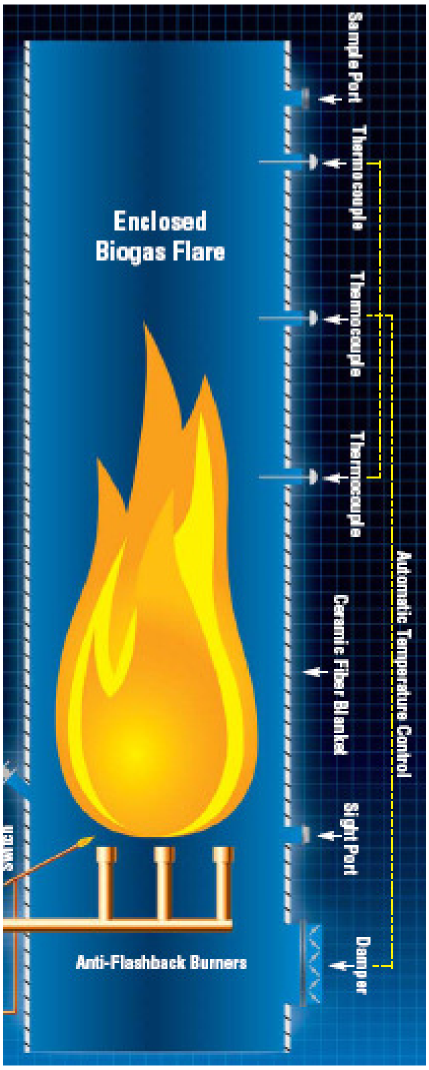


Figure 10. Detail of an Enclosed Flare (source: John Zink, accessed on January 31st, 2006)

Figure 11. Enclosed Flares

5. Gas Sale to final consumers

As a source of methane, LFG can be used to replace the consumption of Natural Gas. In the specific case of the Gramacho Landfill Gas Project, LFG will be sold directly to GPC and to an independent power producer (IPP) via a dedicated pipeline built and operate by the local gas distribution utility company (CEG), without any connection to the natural gas distribution grid. The LFG consumed by GPC will replace the actual consumption of natural gas currently used for the production of Town Gas. A smaller volume of LFG might be used for energy production by an independent power producer which will build a new power plant for such a purpose in the landfill vicinities.

Despite the fact that LFG projects can be of great potential in Brazil, the local market does not have yet technology for flare production. Technology will have to come from abroad and mainly from the United States and Europe. Hence, technology transfer will occur from countries with strict environmental legislative requirements and environmentally sound technologies.

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

Years	Annual estimation of emission reductions in tonnes of CO_2e
2009	776,289
2010	1,226,332
2011	999,799
2012	835,442
2013	713,697
2014	621,373
2015	549,558
2016	244,083
Total estimated reductions (tonnes of CO_2e)	**5,966,573**
Total Number of crediting years	**7**
Annual average over the crediting period of estimated reductions (tonnes of CO_2e)	**852,367**

A.4.5. Public funding of the project activity:

There is no public funding involved in Gramacho Landfill Gas Project.

SECTION B. Application of a baseline and monitoring methodology

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

Gramacho Landfill Gas Project applies two methodologies:

- Version 09 of *ACM0001 – Consolidated methodology for landfill gas project activities;*
- Version 01 of *AM0069 – Biogenic methane use as feedstock and fuel for town gas production;*
- 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 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 project activity:

a) ACM0001
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 – Consolidated methodology for landfill gas project activities is applicable to the Gramacho Landfill Gas Project because the baseline scenario is the partial or total atmospheric release of the gas (usual practice of the Gramacho Landfill management) and the project activity includes the flaring of the captured gas and the sale of the LFG to two final consumers.

b) AM0069
This methodology is applicable to project activities where biogas captured at a wastewater treatment facility or a landfill is used to fully or partially substitute natural gas or other fossil fuels of higher carbon content as feedstock and fuel for the production of town gas.

The project will indeed replace the actual consumption of Natural Gas for the production of Town Gas by the landfill gas generated at the Gramacho Landfill, as feedstock or fuel.

The methodology is applicable under the following conditions:

- *The town gas produced using biogas as feedstock and fuel is distributed through town gas grids and is combusted for energy purpose;*

The Town Gas will be produced at GPC using landfill gas and, instead of distributing it through a grid, will be directly used by GPC.

- *Use of biogas as feedstock does not lead to a change in the quality of the produced town gas, i.e. Wobbe index should not vary more than 10%;*

As presented in B.6.3, the Wobbe Index of the Town Gas produced through the landfill gas won`t change more than 10%.

- *The geographic extent of the town gas distribution grid is within the host country boundaries;*

GPC, which will also act as the Town Gas Distribution Grid, is within the Brazilian boundaries.

- *The biogas used in the project activity is captured at an existing landfill site or an existing wastewater treatment facility, which has at least three-year record of venting or flaring of biogas. Biogas would continue to be vented or flared in the absence of the project activity. The project participants shall demonstrate this through documented evidence of venting or flaring prior to the implementation of the project activity;*

The Gramacho Landfill has been operating since 1979 (in a controlled manner since 1993) emitting naturally the landfill gas to the atmosphere, As will be demonstrated in the identification of the baseline scenario, the gas would continue to be emitted to the atmosphere in the absence of the project activity.

- *The project activity is implemented in an existing Town Gas Factory, which used only fossil fuels, no biogas, prior to the start of implementation of the project activity. The town gas factory shall have at least three-year record of using fossil fuel(s) as feedstock for the production of town gas. The Town Gas Factory has to have data on the quantity and quality of town gas produced as well as the quantity and quality of fossil fuels used for the most recent three years prior to the start of the project activity.*

Prior to the implementation of the Gramacho Landfill Gas Project, GPC has always consumed natural gas for the production of Town Gas. A three-year recording of natural gas consumption was evidenced by the invoices emitted from CEG (the local natural gas utility) to GPC. Moreover, GPC monitors the flow and the quality (main gases concentration) of Town Gas produced. All data was used to determine the baseline scenario.

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

The boundaries of the project are:

ACM0001

- Gramacho Landfill;
- all the power generation sources connected to the Brazilian National Grid, as electricity will be consumed from the grid;
- the independent power producer.

AM0069:

- the pipeline supplying the LFG to GPC;
- all auxiliary equipment installed to transport and clean the LFG;
- GPC, which will work as the Town Gas Factory (TGF) and as the Town Gas distribution grid;

No Town Gas distribution grid is necessary, once the Town Gas will be consumed directly by GPC in its own industrial plant.

	Source	Gas	Included?	Justification / Explanation
Baseline	GPC (Town Gas Factory) **AM0069**	***CO_2***	***Yes***	***Emissions due to the use of fossil fuels as feedstock and fuel for production of town gas***
		CH_4	No	Emissions due to methane venting will not be accounted since those will not change with the implementation of the project
		N_2O	No	Emissions are considered negligible from this source and will not change with the implementation of the project activity
	GPC (Town gas distribution grid) **AM0069**	***CO_2***	***Yes***	***The town gas is combusted in the distribution grid.*** ***In the specific case of the Gramacho Landfill Gas Project, the town gas will be used directly by GPC, the producer of the town gas.***
		CH_4	No	Emissions due to methane venting will not be accounted since those will not change with the implementation of the project
		N_2O	No	Emissions are considered negligible from this source and will not change with the implementation of the project activity
	Emissions from decomposition of waste at the landfill site **ACM0001**	CO_2	No	CO_2 emissions from the decomposition of organic waste are not accounted.
		CH_4	***Yes***	***The major source of emissions in the baseline.***
		N_2O	No	N_2O emissions are small compared to CH_4 emissions from landfills. Exclusion of this gas is conservative.
	Emissions from electricity consumption **ACM0001**	CO_2	No	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.
		N_2O	No	Excluded for simplification. This is conservative.
	Emissions from thermal energy generation **ACM0001**	CO_2	No	According with the methodology ACM0001, *"If thermal energy generation is included in the project activity"*. As in the baseline scenario there is no consumption of fossil fuel to operate the landfill, this source will be excluded.
		CH_4	No	Excluded for simplification. This is conservative
		N_2O	No	Excluded for simplification. This is conservative
Project Activity	Emissions from on-site electricity use **ACM0001**	*CO_2*	***Yes***	***Electricity to supply the internal needs of the project will be consumed from the grid.***
		CH_4	No	Excluded for simplification. This emission source is assumed to be very small.
		N_2O	No	Excluded for simplification. This emission source is assumed to be very small.
	On-site fossil fuel consumption due to the project activity other than for electricity generation **ACM0001**	CO_2	No	According with ACM0001, fossil fuel consumption *"may be an important emission source"*. However, Gramacho Landfill Gas Project will not consume any kind of fossil fuel to generate on-site thermal energy, thus this source will be excluded.
		CH_4	No	Excluded for simplification. This emission source is assumed to be very small.
		N_2O	No	Excluded for simplification. This emission source is assumed to be very small.
	Town Gas Factory and Auxiliary equipment **AM0069**	***CO_2***	***Yes***	***Emissions due to electricity or fossil fuel consumption***
		CH_4	No	Emissions are considered negligible from this source
		N_2O	No	Emissions are considered negligible from this source

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

a) ACM0001

According with *ACM0001 – Consolidated methodology for landfill gas project activities*, 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:

Additionality Tool – Sub-step 1a: Define alternatives to the project activity:

According with this Sub-step, it's necessary to identify realistic and credible alternatives to the project participants that provide outputs or services comparable with the proposed CDM project activity. Considering that the project is about methane capture in a landfill and use, the following alternatives are identified:

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 to generate electricity;

e) Implementation of the CDM project activity considering LFG use in boilers to generate heat;

Additionality Tool – Sub-step 1b: Consistency with mandatory laws and regulations

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

Concerning the solid waste final disposal, the *Política Nacional de Resíduos Sólidos* (National Solid Waste Policy) has been under discussion since 2000, but no further regulation has been put in place. 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 obligation on landfill gas destruction for GHG reductions or in order to accomplish local environmental regulations nor the promotion of organic waste processing.

Concerning energetic use of the landfill gas, the *PROINFA – Programa de Incentivo a Fontes Alternativas* was created in 2002, in order to incentive the use of renewable sources to generate electricity. The goal of the program was to generate 3.300 MW of renewable energy, 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-gas-to-energy project was implemented due to the low price paid for the MWh produced. The calls for PROINFA were closed in 2003, before the beginning of the Gramacho Landfill Gas Project's operation.

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 – continuation of the landfill's operation, with passive emission of landfill gas to the atmosphere.	✓	▪ The area where the Gramacho Landfill is installed was donated by the Federal Government and the landfill's implementation was made feasible by FUNDREM – Fundação para Desenvolvimento da Região Metropolitana.
LFG destruction in flares	✓	▪ There is no law which obligates the landfill do destroy the gas produced nor due to local environmental regulations, nor due to GHG reductions.
LFG use to generate electricity	✓	▪ 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 are no policies to promote or obligate the use of LFG to produce electricity
LFG use to generate heat	✓	▪ 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 are no policies to promote or obligate the use of LFG to produce heat

Outcome of Sub-Step 1b: all alternatives comply with local laws/regulations and none of them are mandatory.

As there is no law regulating the destruction of LFG, the AF = 0. However, a conservative AF of 5% will be applied (please, refer to B.6.1).

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.

Without the Gramacho Landfill Gas Project, the Gramacho Landfill would continue to emit the LFG produced to the atmosphere, in an uncontrolled and passive manner, as the usual practice once there are no obligations to collect and destroy the gas and this usual practice is in accordance with environmental laws/regulations. Thus, the Gramacho Landfill Gas Project corresponds to *Scenario **LFG2** – Atmospheric release of the landfill gas or partial capture of landfill gas and destruction to comply with regulations or contractual requirements, or to address safety and odour concerns*.

As the project does not foreseen the production of electricity, on-site energy needs will be attended by the grid-electricity consumption – thus, there is no Scenario for Power applicable to the project.

As the project does not foreseen the production of heat and does not need heat for internal purposes, no scenario for Heat is applicable to the project.

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

The fuel to be considered in the Gramacho Landfill Gas Project baseline is the Natural Gas which will be replaced by the LFG supplied to GPC. In the baseline, GPC uses the natural gas supplied by CEG – Companhia Distribuidora de Gás do Rio de Janeiro (Rio de Janeiro Gas Distribution Utility) to produce Town Gas. The gas is produced by Petrobrás and is originated in the Bacia de Campos petroleum field.

According with the statistics from ANP – Agência Nacional de Petróleo (National Petroleum Agency)[6], in 2006 Brazil produced around 17,706 millions of m^3 of natural gas, being 8,218 millions from the State of Rio de Janeiro, as presented in the table below.

TOTAL NATURAL GAS PRODUCTION (1.000 m^3)

2006	Brazil	State of Rio de Janeiro	
		Production	% National Production
January	1,456,525	699,534	48.03%
February	1,335,771	650,571	48.70%
March	1,476,417	701,586	47.52%
April	1,467,439	681,118	46.42%
May	1,542,849	706,644	45.80%
June	1,472,320	623,024	42.32%
July	1,552,907	689,524	44.40%
August	1,518,976	686,330	45.18%
September	1,427,135	660,741	46.30%
October	1,522,304	725,255	47.64%
November	1,447,438	676,154	46.71%
December	1,486,079	717,194	48.26%
TOTAL 2006	**17,706,161**	**8,217,676**	**46.41%**

Still according with CEG and CEG-Rio[7], the sales of gas in the State of Rio de Janeiro in 2006 were 3,733 millions of m^3 of natural gas. Thus, it's concluded that most of the gas produced in Bacia de Campos is exported to other states, mainly to the State of Minas Gerais, and Rio de Janeiro consumes around 21% of the national production.

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.

[6] http://www.anp.gov.br/doc/dados_estatisticos/Producao_de_Gas_Natural_m3.xls
[7] http://ww2.ceg.com.br/ApresentacaoInstitucional.pdf

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).

Thus, the most plausible baseline scenario for the landfill gas identified is the atmospheric release of landfill gas, which assures the applicability of the methodology.

b) AM0069
According with *AM0069 – Biogenic methane use as feedstock and fuel for town gas production*, the procedure to select the most plausible baseline scenario is:

Step 1: Identify all realistic and credible alternative scenarios to the proposed project activity and eliminate alternatives that do not comply with legal or regulatory requirements
The most plausible baseline scenarios should be determined regarding:

(a) What would happen to LFG in the absence of the project activity;
(b) How town gas would be produced in the absence of the project activity.

The realistic and credible scenarios concerning what would happen with the LFG were identified in STEP 1 of the procedure to select the most plausible baseline scenario according with ACM0001 (continuation of the landfill's operation with passive emission of LFG to the atmosphere).

Concerning the Town Gas production, the following alternatives are identified:
T 1: Town gas is produced using fossil fuel(s) as feedstock and fuel for the production process;
T 2: Town gas is produced using biomass and fossil fuels as feedstock and fuel for the production process;
T 3: Town gas is produced using biogas, delivered from sites not included in the project activity, as feedstock and fuel for the production process;
T 4: The proposed project activity undertaken without being registered as a CDM project activity.

According with *BEN – Balanço Energético Nacional* (National Energetic Balance), Town Gas had always been produced in Brazil in the past mainly from coal sources. However, the production of Town Gas derived from coal decreased largely since 1970 to levels close to 0 (the last register of Town Gas consumed in Brazil is from 2002), not attributed to any legal/regulatory constrains but due to incentives in the application of natural gas as feedstock. In the specific case of the Gramacho Landfill Gas Project, GPC has been using natural gas to produce Town Gas due to natural gas to be the sole feedstock source for such a purpose in the state of Rio de Janeiro. Thus, alternative **T1** is in accordance with legal constrains.

Alternatives **T2** and **T3** are also in accordance with the legislation. There exist no particular obligations for GPC to use biomass (such as wood, bagasse, rice husk) or biogas to generate Town Gas. Besides not being a common practice the use of biomass for town gas production, biomass is not available in Rio de Janeiro. Alternative **T4** is also in accordance with the legislation once GPC is not obligated to produce Town Gas from the landfill gas collected at the Gramacho Landfill.

Thus, none of the alternatives were excluded, once all are in accordance with the existing laws/regulations.

Step 2: Eliminate alternatives that face prohibitive barriers
As per analyzed at the STEP 3 of the demonstration of additionality, the only alternative concerning the production of Town Gas which does not face any barrier is the continuation of the actual practice, using natural gas as feedstock. Concerning the landfill gas, the only alternative which does not face any barrier is the continuation of the landfill's operation.

Step 3: Conduct an investment analysis
Please, refer to B.5. The investment analysis can conclude that the only attractive alternative to the project activity is the continuation of the landfill's operation and the continuation of the natural gas use to produce Town Gas.

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 version 05 of the *Tool for the demonstration and assessment of additionality*.

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 for LFG and Town Gas were presented in the Item B.4.

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

All alternatives for LFG and Town Gas 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 comparing the IRR of the project without the CERs revenues.

The economic analysis will be made through a 15-years period (as per the contract signed between COMLURB and Novo Gramacho Energia Ambiental) from the point of emission of the "Termo de Encerramento da Etapa de Operação do Aterro" (term of landfill's closure).

Moreover, the contract foreseen annual payments to *"Fundo de Participação dos Catadores"* (a fund aimed to help the professional qualification of people currenly working as garbage pickers) as well as to COMLURB as a concession fee. The investments and costs of other activities, such as leachate plant, landfill's boundaries re-vegetation, landfill's closure and capping will be included in the Investment Analysis as they are part of the concession contract signed by Novo Gramacho.

Below, the cash-flow is presented for a 15-years period without CERs revenues, estimating that the term of landfill closure will be emitted in 31/12/2009.

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

For the LFG capture investment, Novo Gramacho calculated the IRR and compared it to the Brazilian Federal Treasury Bonds, a low-risk long-term investment indicator from the Federal Treasury. For the Gramacho Landfill Gas Project, the average of July's NTNF 010117 (governmental bond with 14.47%[8] rate) was used for comparison. As will be shown ahead, these government bonds pay much higher interest than the 7.0% IRR determined for the project activity without CER's revenues. The Project IRR was determined by Novo Gramacho having as input figures: LFG sale price to GPC as the most relevant revenue source, fixed costs, operating variable costs, VAT (COFINS / PIS), depreciation, financial expenses, income taxes (IR / CSLL) and loan payments.

[8] 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

R$ MM

	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Net Incomes from Gas Sale	0.0000	33.3565	28.2486	25.1418	22.6909	20.7472	17.1746	16.1459	15.3531	14.7015	14.0578	13.6346	13.2808	12.9751	12.7031	12.3702
Incomes from the landfill's operation (R$ MM/month)	0.0000	12.9931	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Gross Incomes from Gas Sale (R$ MM)	0.0000	21.6650	29.3310	26.1066	23.5611	21.5408	17.8283	16.7624	15.9410	15.2643	14.6948	14.2143	13.8023	13.4416	13.1225	12.8388
Gross Incomes (R$ MM)	0.0000	34.6581	29.3310	26.1066	23.5611	21.5408	17.8283	16.7624	15.9410	15.2643	14.6948	14.2143	13.8023	13.4416	13.1225	12.8388
VAT (PIS + COFINS)	0.0000	-1.3016	-1.0824	-0.9649	-0.8703	-0.7936	-0.6537	-0.6165	-0.5879	-0.5627	-0.6370	-0.5798	-0.5215	-0.4665	-0.4194	-0.4686
OPEX - Operational Costs and Expenditures	0.0000	-7.3510	-10.6176	-10.1756	-9.8798	-9.7003	-9.1884	-10.2047	-10.3447	-10.5278	-10.7470	-10.9993	-11.2812	-11.5900	-11.9243	-7.2301
O&M Gas & Energy for Compression	0.0000	4.3891	5.9421	5.2889	4.7732	4.3639	3.6118	3.3959	3.2294	3.0924	2.9770	2.8796	2.7962	2.7231	2.6585	1.5172
Expenditures Administration and Gas Collection	0.0000	2.3112	2.6320	2.7505	2.8743	3.0036	3.1388	4.3576	4.5537	4.7587	4.9728	5.1966	5.4304	5.6748	5.9302	2.7112
Concession Fixed Expenditures	0.0000	0.6507	0.6812	0.7121	0.7441	0.7776	0.8126	0.8171	0.8538	0.8922	0.9324	0.9744	1.0182	1.0640	1.1119	0.6778
Expenditures "Fundo de participação dos Catadores"	0.0000	0.0000	1.3623	1.4242	1.4883	1.5552	1.6252	1.6341	1.7077	1.7845	1.8648	1.9487	2.0364	2.1280	2.2238	2.3239
EBIT	0.0000	26.0056	17.6310	14.9661	12.8110	11.0469	7.9862	5.9412	5.0084	4.1738	3.3108	2.6353	1.9996	1.3851	0.7788	5.1401
IR & CSLL	0.0000	-1.0675	-0.9034	-0.8041	-0.7257	-0.6635	-0.5491	-0.5163	-0.4910	-0.4701	0.0000	0.0000	0.0000	0.0000	0.0000	-0.3954
GROSS CASH-FLOW	0.0000	24.9381	16.7276	14.1620	12.0854	10.3834	7.4371	5.4249	4.5174	3.7036	3.3108	2.6353	1.9996	1.3851	0.7788	4.7446
Internal Capital	0.0000	-2.1473	0.6795	0.2229	0.1793	0.1469	0.2548	0.1689	0.0777	0.0696	0.0719	0.0563	0.0530	0.0512	0.0505	-0.3634
Activity's Cash-Flow	0.0000	22.7908	17.4071	14.3850	12.2646	10.5303	7.6919	5.5938	4.5952	3.7732	3.3827	2.6916	2.0526	1.4363	0.8293	4.3812
CAPEX	-32.5000	-32.1523	-13.2573	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
CAPEX 1 - Gas Collection System (R$ MM)	20.8333	4.3924														
CAPEX 2 - Gas Compression System (R$ MM)	5.0000	21.0834														
CAPEX 3 - Leachate Treatment (R$ MM)	6.6667	1.4056														
CAPEX 4 - Landfill's Closure (R$ MM)			13.2573													
CAPEX 5 - Environmental Compensation (R$ MM)		5.2709														
FREE CASH-FLOW - Nom	-32.5000	-9.3614	4.1498	14.3850	12.2646	10.5303	7.6919	5.5938	4.5952	3.7732	3.3827	2.6916	2.0526	1.4363	0.8293	4.3812
inflation to Discount the Cash-flow	1.0423	1.0924	1.1418	1.1932	1.2469	1.3030	1.3617	1.4229	1.4870	1.5539	1.6238	1.6969	1.7732	1.8530	1.9364	2.0236
FREE CASH-FLOW - Ctes	-31.1815	-8.5695	3.6343	12.0556	9.8360	8.0814	5.6489	3.9312	3.0903	2.4282	2.0832	1.5862	1.1575	0.7751	0.4283	2.1651

As already mentioned above, the Free Cash Flow for concession period of 15-years project's operation has a result of 7.0% as IRR.

Sub-step 2d. Sensitivity analysis

To make the sensitivity analysis, the following hypotheses were adopted:

- variation in the price of the LFG sold in + 10%;
- variation of the operational costs in - 10%;
- variation of the Gas collection System CAPEX in - 10%;
- variation of the Gas compression CAPEX in - 10%;

The results were:

	Variation	*IRR*
Gas Price	***+10%***	13.7%
O&M	***-10%***	8.4%
CAPEX Gas Collection	***-10%***	8.4%
CAPEX Gas Compression	***-10%***	8.3%

Thus, the project will still be not financially/economically attractive in all of the scenarios.

STEP 3. Barrier analysis

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

The proposed use of LFG from the Gramacho Landfill Gas Project will be the first of a kind in Brazil. Projects of LFG capture in Brazil have been undertaken considering only the CDM revenues and none of them has been developed so far considering Town Gas feedstock switching from fossil fuels to LFG.

- *Barriers due to prevailing practice:*

Final solid waste disposal in landfills is not a common practice from the cities in Brazil. The cities which dispose solid waste in landfills represent a small portion of the total analyzed by PNSB (please, refer to **Table 1 – STEP 4**). The existing landfills operate with passive emission of methane to the atmosphere, as controlled landfill gas collection and destruction is not mandated by laws/regulations nor due to local environmental regulations, nor due to GHG emission reduction (the DNA has informed that there are no national law which obligates the destruction of methane in landfills), thus, investments in a collection/flaring system are voluntary. Being voluntary means that some kind of income are expected to overcome the capital invested, what does not happen in such cases, as the Government, NGOs and private entities has no obligation/interest in acquiring the LFG destroyed in flares, except for the Kyoto Protocol.

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

Landfills which have implemented a complete collection and flaring system were necessarily implemented under the CDM, the only source of revenue for such projects. As the Gramacho Landfill Gas Project was the first one to make use of methodology AM0069 for the production of Town Gas using the LFG (please, refer to **Table 3 – STEP 4**), it can be concluded the the project is indeed the "first-of-its kind".

- *Technological barriers:*
  a) Collecting and destroying the biogas from landfill are still a new technology which is being employed in Brazil. Due to the lack of LFG projects in Brazil (please, refer to *Barriers due to prevailing practice* above), manufacturers of flares, flow-meters, gas analyzers, engines, etc. are not encouraged to develop equipments adapted to landfill gas projects, thus it's necessary to go for international suppliers at least as regards technology. CDM Projects, such as Bandeirantes Landfill Gas to Energy Project, São João Landfill Gas to Energy Project, Brazil NovaGerar Landfill Gas to Energy Project, ESTRE's Paulínia Landfill Gas Project, Onyx Landfill Gas Recovery Project – Trémembé, Brazil and ESTRE Itapevi Landfill Gas Project used only imported equipments, as presented in the table below: from Italian (flares), German (flow-meters and flares), Americans (power generators) and Dutch (flow-meters and methane analyzers) manufacturers. Most recently the American supplier John Zinc has licensed two Brazilian manufacturers to fabricate flares under their supervision and responsibility as supplier.

PROJECT NAME	FLARE	FLOW-METER	METHANE ANALYZER	POWER GENERATORS
Bandeirantes Landfill Gas to Energy Project (CDM Reg. Number: 0164)	Hoffstetter (Dutch)	Instromet(Dutch) TZ (German)	E + H (Dutch)	Catterpilar (American)
São João Landfill Gas to Energy Project (CDM Reg. Number: 0373)	Hoffstetter (Dutch)	Instromet (Dutch) Endress & Hauser (Dutch)	Fisher & Rosemount (German)	Catterpilar (American)
ESTRE's Paulínia Landfill Gas Project (CDM Reg. Number: 0165)	Biotecnogas (Italian)	RMG Messtechnik (German)	SIEMENS (German)	N/A
Brazil NovaGerar Landfill Gas to Energy Project (CDM Reg. Number 0008)	John Zink (American)	Landtec Field Service Unit (Amreican)	Landtec Field Service Unit (Amreican)	N/A
ESTRE Itapevi Landfill Gas Project (CDM Reg. Number 0911)	Biotecnogas (Italian)	RMG Messtechnik (German)	SIEMENS (German)	N/A
Onyx Landfill Gas Recovery Project – Trémembé, Brazil (CDM Reg. Number 0027)	E-vap (American)	Landtec Field Service Unit (Amreican)	Landtec Field Service Unit (Amreican)	N/A

All above taken into due account, it can be concluded that

a) the Gramacho Landfill Gas Project is indeed the "first of its kind"; and

b) other similar project activities have always been implemented using foreign technology

Sub-step 3 b. Show that the identified barriers would not prevent the implementation of at least one of the alternatives (except the proposed project activity):
From all alternatives raised in STEP 1 of ACM0001 baseline scenario identification:

Alternative	Barriers due to prevailing practice	Technological barriers
Project Activity undertaken without being registered as a CDM Project Activity	This alternative is not realistic as no LFG project in Brazil was implemented without the CDM revenues.	This alternative is not realistic as no LFG project in Brazil was implemented without the CDM revenues.
BAU scenario	Not applicable, as the project involves only the regular operation of	Not applicable, as the project involves only the regular

	the landfill	operation of the landfill
LFG destruction in flares	Considering the actual situation of landfills in Brazil (refer to **STEP 4**), this alternative can't be considered a common practice; however, similar projects were implemented in Brazil. Thus, this alternative would face a common practice barrier, but less strong than the proposed for the CDM Project Activity. Moreover, only flaring the gas does not have positive impacts over sustainable development, as no good is being supplied to a final consumer.	As there are no national manufacturers of equipment (flow-meters, flares and methane analyzers), this alternative would also face the same barriers from the proposed CDM Project Activity. Thus, this alternative would face a technological barrier as strong as for the proposed CDM Project Activity.
LFG use to generate electricity	Considering the actual situation of landfills in Brazil (refer to **STEP 4**), this alternative can't be considered a common practice; however, similar projects were implemented in Brazil (Bandeirantes Landfill Gas to Energy Project and São João Landfill Gas to Energy Project). Thus, this alternative would face a common practice barrier, but less strong than the proposed for the CDM Project Activity.	As there are no national manufacturers of equipment (flow-meters, flares and methane analyzers), this alternative would also face the same barriers from the proposed CDM Project Activity. Thus, this alternative would face a technological barrier as strong as for the proposed CDM Project Activity.
LFG use in boilers to generate heat	Considering the actual situation of landfills in Brazil (refer to **STEP 4**), this alternative can't be considered a common practice; also, there are no project activities in Brazil which uses the LFG to generate heat. Thus, this alternative would face a common practice barrier as strong as the proposed CDM Project Activity.	As there are no national manufacturers of equipment (flow-meters, flares and methane analyzers), this alternative would also face the same barriers from the proposed CDM Project Activity. Thus, this alternative would face a technological barrier as strong as for the proposed CDM Project Activity.

As presented in the table above, technological and prevailing practice barriers would prevent the implementation of all alternatives, except for the landfill's operation – BAU scenario.

STEP 4. Common practice analysis

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

According to the latest official statistics on urban solid waste in Brazil – *Pesquisa Nacional de Saneamento Básico 2000* (PNSB 2000) – the country produces 228,413 tons of waste per day, which corresponds to 1.35 kg/inhabitant/day. And though there is a worldwide trend towards reducing, reusing and recycling, therefore reducing the amount of urban solid waste to be disposed in landfills, the situation in Brazil is peculiar. Most of the waste produced in the country is sent towards open dumps which are, in most of the cases, areas without any sort of proper infrastructure to avoid environmental hazards. Table 1 shows the final destination of the waste per municipality, according to PNSB 2000.

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

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

Source: IBGE, Diretoria de Pesquisas, Departamento de População e Indicadores Sociais, Pesquisa Nacional de Saneamento Básico 2000.
Note: one same district might have more than one final destination of waste collected.
Note: This table was adapted from the original table from PNSB

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

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

Table 2. Statistics from ABRELPE

Final Destination	%
Open Dump	6.30
Other	4.72
Sanitary Landfill	62.20
Controlled Landfill	21.26
No Answer	4.72

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

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

Sub-step 4b. Discuss any similar options that are occurring:
Some landfills operate with a forced LFG extraction and destruction using blowers, collection systems and flaring systems and were developed only under the CDM:

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

Project Title	Period for Comments	Situation	Municipalities Attended	Type of Project
Salvador da Bahia Landfill Gas Management Project	12 Dec 03 - 12 Jan 04	Registered (registration number 0052)	1 (Salvador)	▪ LFG Flare
NovaGerar Landfill Gas to Energy Project	05 Apr 04 - 06 May 04	Registered (registration number 0008)	1 (Nova Iguaçu)	▪ LFG Flare ▪ Electricity Generation
Landfill gas to energy project at Lara landfill, Maua, Brazil	21 May 04 - 21 Jun 04	Registered (registration number 0091)	8 [9] (Diadema Mauá Praia Grande Ribeirão Pires Rio Grande da Serra São Bernardo do Campo São Caetano do Sul São Vicente)	▪ LFG Flare ▪ Electricity Generation

[9] Source: CETESB – Inventário Estaduao de Resíduos Sólidos Domiciliares; Relatório 2005

Project Title	Period for Comments	Situation	Municipalities Attended	Type of Project
Brazil MARCA Landfill Gas to Energy Project	24 May 04 - 24 Jun 04	Registered (registration number 0137)	9 [10] (Cariacica Domingos Martins Marechal Floriano Santa Leopoldina Santa Teresa Serra Venda Nova do Imigrante Viana Vitória)	▪ LFG Flare ▪ Electricity Generation
Onyx gas recovery project – Tremembé, Brazil	25 Oct 04 - 25 Nov 04	Registered (registration number 0027)	7 [9] (Campos do Jordão Caçapava Cunha Ilhabela São José do Barreiro São Bento do Sapucaí São Sebastião)	▪ LFG Flare
Caieiras landfill gas emission reduction	04 Dec 04 - 04 Jan 05	Registered (registration number 0171)	5 [9] (Caieiras Cajamar Franco da Rocha São Paulo Taboão da Serra)	▪ LFG Flare
ESTRE's Paulínia Landfill Gas Project (EPLGP)	24 Dec 04 - 24 Jan 05	Registered (registration number 0165)	12 [9] (Americana Artur Nogueira Capivari Cesário Lange Hortolândia Jaguariúna Paulínia Pereiras Santo Antônio de Posse Sumaré Tietê Valinhos)	▪ LFG Flare
Bandeirantes Landfill Gas to Energy Project (BLFGE)	28 Jan 05 - 28 Feb 05	Registered (registration number 0164)	1 [9] (São Paulo)	▪ LFG Flare ▪ Electricity Generation
São João Landfill Gas to Energy Project (SJ)	17 Feb 05 - 20 Mar 05	Registered (registration number 0373)	1 [9] (São Paulo)	▪ LFG Flare ▪ Electricity Generation
Project Anaconda	30 Apr 05 - 31 May 05	Registered (registration number 0226)	4 [9] (Francisco Morato Jandira Nazaré Paulista Santa Isabel)	▪ LFG Flare
Canabrava Landfill Gas Project	18 Aug 05 - 17 Sep 05	Registered (registration	1 (Salvador)	▪ LFG Flare

[10] http://www.marcaambiental.com.br/clipublicos.asp

Project Title	Period for Comments	Situation	Municipalities Attended	Type of Project
		number 0893)		
Aurá Landfill Gas Project	02 Dec 05 - 01 Jan 06	Registered (registration number 0888)	1 (Belém)	▪ LFG Flare
Manaus Landfill Gas Project	07 Dec 05 - 06 Jan 06	Validation	1 (Manaus)	▪ LFG Flare
Central de Resíduos do Recreio Landfill Gas Project	09 Mar 06 - 08 Apr 06	Registered (registration number 0648)	105	▪ LFG Flare
Alto-Tiete landfill gas capture project	13 Mar 06 – 12 Apr 06	Registered (registration number 1636)	9 [9] (Arujá Carapicuíba Ferraz de Vasconcelos Itaquaquecetuba Mairiporã Mogi das Cruzes Poá Suzano Vargem Grande Paulista)	▪ LFG Flare
ESTRE Itapevi Landfill Gas Project (EILGP)	22 Mar 06 - 21 Apr 06	Registered (registration number 0911)	3 [9] (Cotia Itapevi São Roque)	▪ LFG Flare
Quitauna Landfill Gas Project	05 May 06 - 04 Jun 06	Registered (registration number 0912)	1 [9] (Guarulhos)	▪ LFG Flare
Natal Landfill Gas Recovery Project	26 Jul 06 - 24 Aug 06	Validation	1 (Natal)	▪ LFG Flare
SANTECH – Saneamento & Tecnologia Ambiental Ltda. – SANTEC Resíduos landfill gas emission reduction Project Activity	15 Aug 06 - 13 Sep 06	Requesting Registration	19	▪ LFG Flare
CTRVV Landfill emission reduction project	30 Sep 06 - 29 Oct 06	Registered (registration number 1491)	1 (Vila Velha)	▪ LFG Flare
Probiogas – JP – João Pessoa Landfill Gas Project	05 Dec 06 - 03 Jan 07	Registered (registration number 1165)	5 (Bayeux Cabedelo Conde João Pessoa Santa Rita)	▪ LFG Flare
Proactiva Tijuquinhas Landfill Gas Capture and Flaring project	20 Feb 07 - 21 Mar 07	Registered (registration number 1506)	6 (Biguaçu Bombinhas Florianópolis Gov. Celso Ramos Porto Belo Tijuquinhas)	▪ LFG Flare
ESTRE Pedreira Landfill Gás Project (EPLGP)	03 Mar 07 - 01 Apr 07	Registered (registration number 1134)	1 (São Paulo)	▪ LFG Flare
Terrestre Ambiental Landfill Gás Project	03 Mar 07 -	Registered	3 [9]	▪ LFG Flare

Project Title	Period for Comments	Situation	Municipalities Attended	Type of Project
	01 Apr 07	(registration number 1133)	(Bertioga Cubatão Santos)	
Embralixo/Araúna - Bragança Landfill Gas Project (EABLGP)	10 Mar 07 - 08 Apr 07	Registered (registration number 1179)	1 [9] (Bragança Paulista)	▪ LFG Flare
URBAM/ARAUNA - Landfill Gas Project (UALGP)	10 Mar 07 - 08 Apr 07	Registered (registration number 1247)	2 [9] (Paraibuna São José dos Campos)	▪ LFG Flare
Feira de Santana Landfill Gas Project	18 Aug 07 - 16 Sep 07	Registered (registration number 1626)	1 (Feira de Santana)	▪ LFG Flare

Source: CDM-EB

From the total of 1,452 districts attended by sanitary landfills, only 210 (as presented in the table above) dispose the waste in landfills with an active system of recovery and destruction of LFG. It's considered that all landfills with active LFG recovery are developed as CDM Project Activities because there is no legal obligation to destroy the methane and because such projects would not be implemented without the CDM as the CERs revenues are their only source of income.

From those projects presented above, 22 are of LFG Flaring, while 6 are of Electricity Generation (an important reminder: only two of the electricity generation projects have actually installed facilities for electricity generation). Also, none of the project activities listed previously considers the injection of the LFG into a gas distribution grid. Thus, this kind of project activity is not widely spread in Brazil and the landfills that operate this type of project represent only a small portion of the total existing landfills.

Thus, it can be concluded that the proposed CDM Project Activity is additional.

B.6. Emission reductions:

B.6.1. Explanation of methodological choices:

a) Explanation of ACM0001

a.1) Baseline Emissions

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

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

Where:

BE_y	Baseline emissions in year *y* (tCO_2e);
$MD_{project,y}$	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_2e/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_2e/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_2e/TJ)

As the Gramacho Landfill Gas Project will not produce electricity and will not replace the heat generation by fossil fuel:

$EL_{LFG, y} = 0$
$ET_{LFG, y} = 0$

The equation is updated to:

$$BE_y = \left(MD_{project,y} - MD_{BL,y}\right) \times GWP_{CH4} \qquad \textbf{(2)}$$

As presented in B.4, the Gramacho Landfill Gas Project does not have any contractual obligations to burn methane and there is no national/sectoral regulation obligating the landfill gas destruction; so $MD_{BL, y}$ is calculated based on the "Adjustment Factor" (*AF*).

The actual practice of execution of the Gramacho Landfill is not adequate for gas flaring at any level as it does not have built a continuous set of wells to drain gas through the landfill with some control. Although the Gramacho Landfill has a total area of about 140 hectares , only 49 PDR shallow wells are installed which are about 5 meters deep. Moreover given the disposal methodology applied in Gramacho , most of the built wells are not permanent and are destroyed as each new landfill layer is placed. However, out of the 49 wells venting LFG existing in June 2008, only 15 of them were burning somehow the methane emitted to the atmosphere.

As shown by the landfill practice, the horizontal radius of influence of a given well is limited to the double of the well depth. Therefore the existing 49 wells have their horizontal radius of influence limited to 10 meters. Even assuming a larger radius of influence equal to 15 meters for each well, the total area available for LFG collection of the 49 wells is limited to no more than 3.46 hectares, which corresponds to 2.47% of the total area. This limited venting capacity associated with the high permeability of the landfill surface explains the high rate of free LFG methane emission through the landfill surface which can be observed by monitoring.

According with the *"Tool to determine methane emissions avoided from dumping waste at a solid waste disposal site"*, the LFG generation will reach its flow peak of 27,295 Nm^3/h by the time of the landfill closure in 2009. Should only the 49 wells continue to exist by the time of the LFG generation peak of 27,295 Nm3, the total gas being collected by the 49 wells would be limited to their radius of influence above verified. As a direct result of that, it is reasonable to assume that the LFG flow vented by them would be limited as to the total LFG flow, in the same proportion of their influence area to the total landfill surface ,i.e., 2,47% of 27,295 Nm3/h which is equal to 675 Nm^3/h. However, as only 15 from the 49 wells are in fact burning gas somehow, the total gas being destroyed is at most equal to 675 Nm^3/h multiplied by 15/49 (ratio of wells actually destroying the LFG), resulting in 207 Nm^3/h.

It can be considered yet that the built PDR wells destroy the methane in the same way as in an open flare, once there is no control of the combustion temperature and in the mixture of air to the gas, thus the efficiency of methane destruction in the PDR wells are assumed to be at most equal to 50%, based on the *Tool to determine project emissions from flaring gases containing methane*. Thus:

$$AF = \frac{49 \times \pi \times r_{influence}^{2}}{Area_{landfill}} \times \frac{15}{49} \times 27{,}295 \times 50\% \quad \textbf{(3)}$$

Where:

AF	Adjustment Factor
49	Number of wells actually installed at Gramacho Landfill
$r_{influence}$	Radius of influence of each PDR well (15 meters)
$Area_{landifill}$	Total area of Gramacho Landfill (140 hectares)
15	Number of PDR wells which are burning the LFG emitted to the atmosphere
27,295	Maximum gas generation ratio (Nm^3/h)
50%	Efficiency of methane destruction in the PDR wells

The calculation results in an AF = 0.38%. In order to adopt a conservative approach, an AF = 5% was applied for the Gramacho Landfill Gas Project. Thus:

$$MD_{BL,\,y} = 0{,}05 \times MD_{project,\,y} \quad \textbf{(4)}$$

and

$$BE_{y} = (0{,}95 \times MD_{project,\,y}) \times GWP_{CH4} \quad \textbf{(5)}$$

$MD_{project,\,y}$ will be calculated as the sum of the quantities fed to the flare(s), to the power plant(s), to the boiler(s) and to the natural gas distribution network (estimated using equation **5**).

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

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)
$MD_{PL,y}$	Quantity of methane sent to the dedicated pipeline (tCH_4)

Right Hand Side of the equation **(5)** 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 produce electricity nor heat,

$MD_{electricity,\ y} = 0$
$MD_{thermal,\ y} = 0$

And the equation is updated to:

$$MD_{project,y} = MD_{flare,y} + MD_{PL,y} \quad \textbf{(7)}$$

As there will be two possible end-users, (1) LFG sold to final users (GPC) via a pipeline not connected to the distribution grid methane sent to the power generator ($MD_{PG,\ y}$) and (2) LFG sold for the IPP ($MD_{IPP,\ y}$) the equation **(7)** must be updated accordingly to:

$$MD_{project,y} = MD_{flare,y} + MD_{GPC,y} + MD_{IPP,y} \quad \textbf{(7)}$$

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

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

And

$$MD_{GPC,y} = LFG_{GPC,y} \times w_{CH4,y} \times D_{CH4} \quad \textbf{(9)}$$

$$MD_{IPP,y} = LFG_{IPP,y} \times w_{CH4,y} \times D_{CH4} \quad \textbf{(9)}$$

Where:

$LFG_{flare,y}$	Quantity of landfill gas fed to the flare(s) during the year measured in cubic meters (m^3)
$LFG_{GPC,y}$	Quantity of landfill gas sold to GPC (m^3)
$LFG_{IPP,y}$	Quantity of landfill gas sold to the independent power producer (m^3)
$w_{CH4,y}$	Average methane fraction of the landfill gas as measured during the year and expressed as a fraction (in m^3CH_4/m^3_{LFG})
D_{CH4}	Methane density expressed in tones of methane per cubic meter of methane (tCH_4/m^3CH_4)
$PE_{flare,y}$	Project emissions from flaring of the residual gas stream in year *y* (tCO_2e) 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.

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 dumping waste at a solid waste disposal site"*:

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

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
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)
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 *j*
k_j	Decay rate for the waste type *j*
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)
y	Year for which methane emissions are calculated

According with USEPA[11], 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". Considering this statement and considering the gas sold will have a great economic value for Novo Gramacho, an average value of 80% was adopted, thus equation **(10)** is updated to:

$$MD_{project,y} = 80\% \times \frac{\varphi \times (1-f) \times GWP_{CH_4} \times (1-OX) \times \frac{16}{12} \times F \times DOC_f \times MCF \times \sum_{x=1}^{y} \sum_{j} W_{x,j} \times DOC_j \times e^{-k_j (y-x)} \times \left(1-e^{-k_j}\right)}{GWP_{CH_4}} \quad \textbf{(11)}$$

a.2) Project Emissions

Project Emissions become from two different sources: efficiency of flare emissions and electricity consumption from the grid.

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

a.2.1) Project Emissions from flare efficiency:
Project emissions are related to the amount of methane not destroyed in the flares and will be calculated as per the "*Tool to determine project emissions from flaring gases containing methane*". The project will install enclosed flares and Gramacho Landfill Gas Project 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

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

Where:

$FM_{RG,h}$	Mass flow rate of the residual gas in hour *h* (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* (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,H2, N2

As a simplified approach, Gramacho Landfill Gas Project 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

$$fm_{j,h} = \frac{\sum fv_{i,h} \times AM_j \times NA_{j,i}}{\sum\left(fv_{i,h} \times MM_i\right)} \quad \textbf{(13)}$$

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*
AM_j	Atomic mass of element *j* (kg/kmol)
$NA_{j,i}$	Number of atoms of element *j* in component *i*
j	The elements carbon, hydrogen, oxygen and nitrogen
MM_i	Molecular mass of residual gas component *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:

$$TV_{n,FG,h} = V_{n,FG,h} \times FM_{RG,h} \quad \textbf{(14)}$$

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*

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

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* ($m^3/kg_{residual\ gas}$)

$$V_{n,O_2,h} = n_{O_2,h} \times MV_n \quad \textbf{(16)}$$

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)

$$V_{n,N_2,h} = MV_n * \left\{ \frac{fm_{N,h}}{200AM_N} + \left(\frac{1 - MF_{O_2}}{MF_{O_2}} \right) * \left[F_h + n_{O_2,h} \right] \right\} \quad \textbf{(17)}$$

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*
MV_n	Volume of one mole of any ideal gas at normal temperature and pressure (22.4 L/mol)
AM_N	Atomic mass of element Nitrogen (kg/kmol)
MF_{O2}	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* ($kmol/kg_{residual\ gas}$)

$$V_{n,CO_2,h} = \frac{fm_{C,h}}{AM_C} * MV_n \quad \textbf{(18)}$$

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)

$$n_{O_2,h} = \frac{t_{O_2,h}}{\left(1-(t_{O_2,h} / MF_{O_2})\right)} \times \left[\frac{fm_{C,h}}{AM_C} + \frac{fm_{N,h}}{2AM_N} + \left(\frac{1-MF_{O_2}}{MF_{O_2}} \right) \times F_h \right] \quad \textbf{(19)}$$

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 *h*
MF_{O2}	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)
AM_j	Atomic mass of element *j* (kg/kmol)

$$F_h = \frac{fm_{C,h}}{AM_C} + \frac{fm_{H,h}}{4AM_H} - \frac{fm_{O,h}}{2AM_O} \quad \textbf{(20)}$$

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 *j* (kg/kmol)

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

$$TM_{FG,h} = \frac{TV_{n,FG,h} * fv_{CH4,FG,h}}{1000000} \quad \textbf{(21)}$$

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

$$TM_{RG,h} = FV_{RG,h} \times fv_{CH4,RG,h} \times \rho_{CH4,n} \quad \textbf{(22)}$$

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)
$\rho_{CH4,n}$	Density of methane at normal conditions (0.716 kg/m^3)

STEP 6: Determination of the hourly flare efficiency

As the Gramacho Landfill Gas Project will install enclosed flares and the monitoring of methane concentration will be made continuously, the flare efficiency in the hour *h* ($\eta_{flare,h}$) is

- 0% if the temperature of the exhaust gas of the flare (T_{flare}) is below 500 °C during more than 20 minutes during the hour *h*.

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

$$\eta_{flare,h} = 1 - \frac{TM_{FG,h}}{TM_{RG,h}} \qquad \textbf{(23)}$$

Where:

$\eta_{flare,\ h}$	Flare efficiency in the hour *h*
$TM_{FG,\ h}$	Methane mass flow rate in exhaust gas averaged in hour *h*
$TM_{RG,\ h}$	Mass flow rate of methane in the residual gas in the hour *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:

$$PE_{flare,y} = \sum_{h=1}^{8760} TM_{RG,h} \times \left(1 - \eta_{flare,h}\right) \times \frac{GWP_{CH4}}{1000} \qquad \textbf{(24)}$$

Where:

$PE_{flare,\ y}$	Project emissions from flaring of the residual gas stream in year *y* (tCO_2e)
$TM_{RG,\ h}$	Mass flow rate of methane in the residual gas in the hour *h* (kg/h)
$\eta_{flare,\ h}$	Flare efficiency in the hour *h*
GWP_{CH4}	Global Warming Potential (tCO_2e/tCH_4) valid for the commitment period

a.2.2) Project Emissions electricity consumption:

This source of project emissions are calculated as the sum of the electricity consumed from the grid plus any additional quantity of fossil fuel consumed on site, as presented in the equation below:

$$PE_y = PE_{EC,y} + PE_{FC,j,y} \qquad \textbf{(25)}$$

Where:

$PE_{EC,y}$	Emissions from consumption of electricity in the project case. The project emissions from electricity consumption ($PE_{EC,y}$) will be calculated following the *"Tool to estimate the baseline, project and-or leakage emissions from electricity consumption"* – version 01. If in the baseline a part of LFG was captured then the electricity quantity used in calculation is electricity used in project activity net of that consumed in the baseline.
$PE_{FC,j,y}$	Emissions from consumption of heat in the project case. The project emissions from fossil fuel combustion ($PE_{FC,j,y}$) will be calculated following the *"Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion"* – version 01. For this purpose, the processes *j* in the tool corresponds to all fossil fuel combustion in the landfill, as well as any other on-site fuel combustion for the purposes of the project activity. If in the baseline part of a LFG was captured then the heat quantity used in calculation is fossil fuel used in project activity net of that consumed in the baseline.

As the Gramacho Landfill Gas Project will not consume any kind of fossil fuel for heat purposes, $PE_{FC,j,y} = 0$. Thus:

$$PE_y = PE_{EC,y} \tag{26}$$

The Gramacho Landfill Gas Project will not have any captive electricity from an on-grid and/or off-grid fossil fuel power plant. Thus, the project will consume electricity from the grid, which corresponds to **Scenario A – Electricity consumption from the grid**, from the *"Tool to estimate the baseline, project and-or leakage emissions from electricity consumption"* – version 01.

Project emissions from consumption of electricity from the grid are calculated based on the power consumed by the project activity and the emission factor of the grid, adjusted for transmission losses, using the following formula:

$$PE_{EC,y} = \sum_j EC_{PJ,j,y} \times EF_{EL,j,y} \times \left(1 + TDL_{j,y}\right) \tag{27}$$

Where:
P

$PE_{EC,y}$	Project emissions from electricity consumption by the project activity during the year *y* (tCO_2/year);
$EC_{PJ,y}$	Quantity of electricity consumed by the project electricity consumption source *j* in year *y* (MWh)
$EF_{EL,j,,y}$	Emission factor for electricity generation for source *j* in year (tCO_2/MWh)
$TDL_{j,y}$	Average technical transmission and distribution losses for providing electricity to source *j* in year *y*

As electricity will be consumed from the grid, the index *j* refers to the Brazilian Electric Grid. For the Gramacho Landfill Gas Project, it's expected to install 3 MW compressors. Assuming an operation of 8,760 hours/year of the compressor, electricity consumed from the grid is equal to:

$$EC_{PJ,grid,y} = 3\,MW \times 8{,}760\,\frac{hours}{year} = 26{,}280\,\frac{MWh}{year} \tag{28}$$

For Scenario A, the emission factor will be calculated according with the *Tool for calculation of emission factor for electricity systems*. 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. Thus, $EF_{EL,j,,y} = EF_{grid,CM,,y}$.

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

The *Tool for calculation of emission factor for electricity systems* presents the following steps to calculate the Emission Factor:

STEP 1. Identify the relevant electric power system.
According with the Tool, *"If the DNA of the host country has published a delineation of the project electricity system and connected electricity systems, these delineations should be used"*. The Brazilian DNA published Resolução n° 8, which makes official the use of a single Electric Grid for CDM project activities applying the tool.

STEP 2. Select an operating margin (OM) method
The Brazilian DNA has calculated the Grid Emission Factor applying option *c) Dispatch data analysis OM*.

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

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

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

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:

$$EF_{Grid,\,CM,\,y} = EF_{Grid,\,OM,\,y} \times w_{OM} + EF_{Grid,\,BM,\,y} \times w_{BM} \quad \textbf{(29)}$$

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* (tCO_2/MWh)
$EF_{Grid,\,BM,\,y}$	Build margin CO_2 emission factor in year *y* (tCO_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 1st crediting period and 0.25 and 0.75, respectively, for the 2nd and 3rd crediting periods.

a.3) Leakage
According with ACM0001, there is no need to account for leakage.

a.4) Emission Reductions
Emission reductions will be calculated according with the formula below:

$$ER_{y,\,ACM0001} = BE_y - PE_y \quad \textbf{(30)}$$

Where:

$ER_{Y.\ ACM0001}$	Emission Reductions in year *y*, applying ACM0001 (tCO_2e);
BE_y	Baseline emissions in year y (tCO_2e), calculated in item *a.1)*;
PE_y	Project emissions in year y (tCO_2e), calculated in item *a.2)*;

b) Explanation of AM0069

According with *AM0069 – Biogenic methane use as feedstock and fuel for town gas production*, Emission Reductions are calculated as the difference between Baseline Emissions and Project Emissions.

b.1) Baseline Emissions

The main source of baseline emission refers to the amount of Town Gas produced using natural gas as feedstock, as follows:

$$BE_y = \frac{Q_{PR,\,TG,\,y} \times NCV_{TG,\,y} \times CEF_{NG}}{\eta_{BL,\,y}} \quad \textbf{(31)}$$

Where:

BE_y	Baseline emissions in year y (tCO_2e);
$Q_{PR,\,TG,\,y}$	Quantity of project activity town gas produced in year *y* (kg or m^3)
$NCV_{TG,\,y}$	average net calorific value of the Town Gas in year *y* (TJ/kg or TJ/m^3)
CEF_{NG}	Carbon emission factor of the natural gas (tCO_2e/TJ);
$\eta_{Bl,\,y}$	Baseline process efficiency in year *y*

The amount of Town Gas produced will be adopted as a comparsion of the lowest value between Town Gas produced in year *y* and the maximum production in the three previous years to the project implementation, as follows:

$$Q_{PR,\,TG,\,y} = \min\left(Q_{TG,\,y}; Q_{TG,\,hist}\right) \quad \textbf{(32)}$$

Where:

$Q_{PR,\,TG,\,y}$	Quantity of project activity town gas produced in year *y* (kg or m^3)
$Q_{TG,\,y}$	Measured quantity of Town Gas produced in year *y* (kg or m^3)
$Q_{TG,\,hist}$	Maximum annual quantity of town gas produced in the historic period of three most recent years prior to the start of the project activity (kg or m^3)

Baseline process efficiency in year *y* is determined as the highest value among efficiencies experienced with different fossil fuels used as feedstock and fuel at the Town Gas Factory during the most recent three years prior to the start of the project activity and the actual efficiency in year *y*. As GPC has been using natural gas to produce Town Gas, the equation to calculate the efficiency is:

$$\eta_{BL,y} = \max\left[\max\left(\frac{Q_{TG,x} \times NCV_{TG,x}}{Q_{NG,x} \times NCV_{NG,x}}; \frac{Q_{TG,x-1} \times NCV_{TG,x-1}}{Q_{NG,x-1} \times NCV_{NG,x-1}}; \frac{Q_{TG,x-2} \times NCV_{TG,x-2}}{Q_{NG,x-2} \times NCV_{NG,x-2}}\right); \frac{Q_{TG,y} \times NCV_{TG,y}}{Q_{BG,y} \times NCV_{BG,y}}\right] \quad \textbf{(33)}$$

Where:

$\eta_{Bl,y}$	Baseline process efficiency in year *y*
$Q_{TG,x}$; $Q_{TG,x-1}$; $Q_{TG,x-2}$	Annual quantity of Town Gas produced in the three most recent years prior to the start of the project activity *x*, *x-1* and *x-2* (kg or m^3)
$NCV_{TG,x}$; $NCV_{TG,x-1}$; $NCV_{TG,x-2}$	average net calorific value of the Town Gas in the three most recent years prior to the start of the project activity *x*, *x-1* and *x-2* (TJ/kg or TJ/m^3)
$Q_{NG,x}$; $Q_{NG,x-1}$; $Q_{NG,x-2}$	Annual quantity of natural gas used as feedstock and fuel for the production of Town Gas in the three most recent years prior to the start of the project activity *x*, *x-1* and *x-2* (kg or m^3)
$NCV_{NG,x}$; $NCV_{NG,x-1}$; $NCV_{NG,x-2}$	average net calorific value of the natural gas used as feedstock and fuel for the production of Town Gas in the three most recent years prior to the start of the project activity *x*, *x-1* and *x-2* (TJ/kg or TJ/m^3)
x, x-1, x-2	Three most recent years prior to the start of the project activity
$Q_{TG,y}$	Annual quantity of Town Gas produced in year y (kg or m^3)
$NCV_{TG,y}$	Average net calorific value of town gas in year y (TJ/kg or TJ/m^3)
$Q_{NG,y}$	Annual quantity of natural gas used as feedstock and fuel for the production of Town Gas in year *y* (kg or m^3)
$NCV_{NG,y}$	Average net calorific value of the natural gas used as feedstock and fuel for the production of Town Gas in year *y* (TJ/kg or TJ/m^3)
$Q_{BG,y}$	Annual quantity of biogas used as feedstock and fuel in the Town Gas Factory in year *y* (kg or m^3)
$NCV_{BG,y}$	Average net calorific value of biogas in year *y* (TJ/kg or TJ/m^3)

b.2) Project Emissions

The project emissions accounted are those related to the energy consumption (electricity and fuels) of auxiliary equipment used for transportation of the LFG from its source to the Town Gas Factory and to clean the LFG before entering the facility, and those from fossil fuel(s) used as feedstock and fuel for process at the Town Gas Factory in the case when LFG only partially substitutes fossil fuel(s), as follows:

$$PE_y = PE_{FC,y} + PE_{EC,y} \quad \textbf{(34)}$$

Where:

PE_y	Project emissions (t_{CO2e})
$PE_{FC,y}$	Project emissions form fossil fuel combustion in year *y* (tCO_2e)
$PE_{EC,y}$	Project emissions due to electricity consumption in year *y* (tCO_2e);

Project emissions from electricity consumption were already presented in equation **(27)**.

Project emissions from the consumption of Natural Gas for the production of Town Gas will be calculated according with the *Tool to calculate project or leakage CO2 emissions from fossil fuel combustion*, as follows:

$$PE_{FC,\,j,\,y} = \sum_{i} FC_{i,\,j,\,y} \times COEF_{i,\,y} \quad \textbf{(35)}$$

Where:

$PE_{FC,\,j,\,y}$	Are the CO_2 emissions from fossil fuel combustion in process *j* during the year *y* (tCO2/yr);
$FC_{i,\,j,\,y}$	Is the quantity of fuel type *i* combusted in process *j* during the year *y* (mass or volume unit/yr);
$COEF_{i,y}$	Is the CO_2 emission coefficient of fuel type *i* in year *y* (tCO_2/mass or volume unit)
i	Are the fuel types combusted in process *j* during the year *y*

The process *j* is the Town Gas Production (TGP) and the only fossil fuel *i* which will be consumed is the Natural Gas (NG); thus equation **(35)** is updated to:

$$PE_{FC,\,TGP,\,y} = \sum_{i} FC_{NG,\,TGP,\,y} \times COEF_{NG,\,y} \quad \textbf{(36)}$$

For the calculation of the $COEF_{NG,\,y}$, Option B of the Tool will be applied:

$$COEF_{NG,\,y} = NCV_{NG,\,y} \times EF_{CO_2,\,NG,\,y} \quad \textbf{(37)}$$

Where:

$COEF_{NG,y}$	Is the CO_2 emission coefficient of the Natural Gas in year *y* (tCO_2/mass or volume unit)
$NCV_{NG,\,y}$	Is the net calorific value of the Natural Gas in year *y* (GJ/mass or volume unit)
$EF_{CO2,\,NG,\,y}$	Is the CO_2 emission factor of the Natural Gas in year *y* (tCO_2/GJ)

It will be assured in the biogas purchase agreement between Novo Gramacho Energia Ambiental and GPC and between Novo Gramacho Energia Ambiental and the independent power producer that CERs will only be claimed by Novo Gramacho Energia Ambiental.

b.3) Leakage
According with AM0069, there is no need to account for leakage.

b.4) Emission Reductions
Emission reductions will be calculated according with the formula below:

$$ER_{y,\,AM0069} = BE_{y} - PE_{y} \quad \textbf{(38)}$$

Where:

$ER_{Y.\,AM0069}$	Emission Reductions in year *y*, applying AM0069 (tCO_2e);
BE_y	Baseline emissions in year y (tCO_2e), calculated in item *a.1)*;
PE_y	Project emissions in year y (tCO_2e), calculated in item *a.2)*;

c) Emission Reductions achieved by the project
Emission Reductions achieved by the project are calculated as the sum of emissions reductions calculated using ACM0001 and AM0069, as follows:

$$ER_{y,\ Project} = ER_{y,\ ACM0001} + ER_{y,\ AM0069} \quad (39)$$

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:	The DNA shall be contacted to provide information regarding host country regulation.
Value applied:	5%
Justification of the choice of data or description of measurement methods and procedures actually applied :	Conservative value applied – please, refer to B.6.1.
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. Relevant regulations for LFG project activities shall be ***updated at renewal of each credit period.*** Changes to regulation should be converted to the amount of methane that would have been destroyed/combusted during the year in the absence of the project activity ($MD_{reg,y}$). Project participants should explain how regulations are translated into that amount of gas.

Data / Parameter:	**GWP_{CH4}**
Data unit:	tCO_2e/tCH_4
Description:	Global Warming Potential of Methane
Source of data used:	IPCC
Value applied:	21
Justification of the choice of data or description of measurement methods and procedures actually applied :	21 for the first commitment period. Shall be updated according to any future COP/MOP decisions.
Any comment:	-

Data / Parameter:	**D_{CH4}**
Data unit:	t_{CH4}/m^3_{CH4}
Description:	Methane Density
Source of data used:	-
Value applied:	0.0007168
Justification of the	At standard temperature and pressure (0^oC 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_2e
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 dumping waste at a solid waste disposal site"*
Value applied:	Please, refer to B.6.3
Justification of the choice of data or description of measurement methods and procedures actually applied :	As per the *"Tool to determine methane emissions avoided from dumping waste at a solid waste disposal site"*
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 choice of data or description of measurement methods and procedures actually applied :	As per the *"Tool to determine methane emissions avoided from dumping waste at a solid waste disposal site"*
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	Value applied as the Gramacho Landfill is not a managed solid waste

choice of data or description of measurement methods and procedures actually applied :	disposal site.
Any comment:	

Data / Parameter:	**F**
Data unit:	-
Description:	Fraction of methane in the SWDS gas (volume fraction)
Source of data used:	IPCC 2006 Guidelines for National Greenhouse Gas Inventories
Value applied:	50%
Justification of the choice of data or description of measurement methods and procedures actually applied :	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 50% is recommended by IPCC.
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 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:	0.8
Justification of the choice of data or description of measurement methods and procedures actually applied :	According with the 2006 IPCC Guidelines, the Gramacho Landfill does not meet the criteria of managed SWDS and have depths of greater than or equal to 5 meters (Gramacho Landfill is 50 meters depth) and/or high water table at near ground level.
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:	**DOC_j**
Data unit:	-
Description:	Fraction of degradable organic carbon (by weight) in the waste type *j*
Source of data used:	2006 IPCC Guidelines for National Greenhouse Gas Inventories
Value applied:	see table below
Justification of the choice of data or description of measurement methods and procedures actually applied :	DOC_j selected for each kind of waste type is in a wet basis, according with the waste composition presented by COMLURB.
Any comment:	

DOC_j (% 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

Data / Parameter:	**W_x**
Data unit:	Tons
Description:	Total amount of organic waste prevented from disposal in year *x* (tons)
Source of data used:	COMLURB
Value applied:	see table below

Year	**Waste Disposed**
1993	1,646,374
1994	1,669,443
1995	1,800,209
1996	2,325,161
1997	2,414,508
1998	2,390,021
1999	2,403,311
2000	2,454,563
2001	2,417,409
2002	2,473,918
2003	2,359,715
2004	2,333,759
2005	2,337,625
2006	2,474,464
2007	2,450,064
2008*	2,500,916
2009*	2,500,916

* concerning the expected waste disposed in 2008.

Justification of the choice of data or description of measurement methods and procedures actually applied :	
Any comment:	

Data / Parameter:	$\mathbf{p_{n,j,x}}$
Data unit:	-
Description:	Weight fraction of the waste type *j* in the sample *n* collected during the year *x*
Source of data used:	COMLURB[12]
Value applied:	(see table below)
Justification of the choice of data or description of measurement methods and procedures actually applied :	
Any comment:	

Type of Waste	**% (wet basis)**	**Classification according with the Tool**
Paper/Paperboard	22.39	Pulp, paper and cardboard
Plastics	15.36	Glass, plastic, metal, other inert
Glass	3.10	Glass, plastic, metal, other inert
Organic Matter	49.54	Food, food waste, beverages and tobacco
Metal	2.62	Glass, plastic, metal, other inert
Other Inert	0.92	Glass, plastic, metal, other inert
Leaf	2.48	Garden, yard and park waste
Wood	0.65	Wood and wood products
Rubber	0.26	Wood and wood products
Textiles	2.11	Textiles
Leather	0.25	Wood and wood products
Bone	0.14	Wood and wood products
Cocoanut	0.19	Wood and wood products
Paraffin	0.00	Food, food waste, beverages and tobacco

Data / Parameter:	$\mathbf{k_j}$
Data unit:	-
Description:	Decay rate for the waste type *j*

[12] Caracterização Gravimétrica e Microbiológica dos Resíduos Sólidos Domiciliares do Município do Rio de Janeiro – 2007.

<table>
<tr><td>Source of data used:</td><td>2006 IPCC Guidelines for National Greenhouse Gas Inventories</td></tr>
<tr><td>Value applied:</td><td>
<table>
<tr><th colspan="2">Waste type j</th><th>k_j</th></tr>
<tr><td rowspan="2">Slowly degrading</td><td>Pulp, paper, cardboard (other than sludge), textiles</td><td>0.07</td></tr>
<tr><td>Wood, wood products and straw</td><td>0.035</td></tr>
<tr><td>Moderately degrading</td><td>Other (non-food) organic putrescible garden and park waste</td><td>0.17</td></tr>
<tr><td>Rapidly degrading</td><td>Food, food waste, sewage sludge, beverages and tobacco</td><td>0.4</td></tr>
</table>
</td></tr>
<tr><td>Justification of the choice of data or description of measurement methods and procedures actually applied :</td><td>Those values were adopted considering the climatic area of the Metropolitan Area of Rio de Janeiro:

- MAT_{2006} = 24.78°C (data from SIMERJ –Maracanã Meteorological Station– average of years 2006 and 2007) [13]
- MAP_{2006} = 1,500 mm (data from SIMERJ –Duque de Caxias Meteorological Station– average of years 2006 and 2007) [14]
- PET_{2006} = 103.0 mm (data from EMBRAPA) [15]</td></tr>
<tr><td>Any comment:</td><td></td></tr>
</table>

AM0069 – Biogenic methane use as feedstock and fuel for town gas production

Data / Parameter:	**CEF_{NG}**
Data unit:	tCO_2e/TJ
Description:	Carbon emission factor of the natural gas
Source of data used:	IPCC Guidelines for National Greenhouse Gases Inventories, 2006
Value applied:	56.1
Justification of the choice of data or description of measurement methods and procedures actually applied :	No measurements are necessary.
Any comment:	As the natural gas, which was used in the Town Gas Factory prior to the start of the project activity and would have been used in the absence of project activity, does not contain fractions of methane of biogenic origin, the carbon emission factor does not have to be adjusted. This value was presented as data *non monitored* according with the requirements of AM0069. However, the project also applies the *Tool to calculate project or leakage CO2 emissions from fossil fuel combustion*, which requests the monitoring of $EF_{CO2, NG, y}$, which will be presented

[13] Disponível em < http://www.simerj.com/default_dadosbrutos.php>, accessed on 10 July 2008
[14] Disponível em <http://www.simerj.com/default_reg_cbmerj.php>, accessed on 10 July 2008
[15] Disponível em <http://www.bdclima.cnpm.embrapa.br/resultados/balanco.php?UF=rj&COD=207 >, accessed on 10 July 2008

	ahead.

Data / Parameter:	$Q_{TG, x}$; $Q_{TG, x-1}$; $Q_{TG, x-2}$
Data unit:	Nm^3
Description:	Annual quantity of town gas produced in the three most recent years prior to the start of the project activity *x*, *x-1* and *x-2*
Source of data used:	GPC
Value applied:	<table><tr><th>Year</th><th>Town Gas Produced (Nm³)</th></tr><tr><td>2005</td><td>465,440,268.83</td></tr><tr><td>2006</td><td>475,337,457.14</td></tr><tr><td>2007</td><td>422,798,025.04</td></tr></table>
Justification of the choice of data or description of measurement methods and procedures actually applied :	According with data from GPC
Any comment:	

Data / Parameter:	$NCV_{TG, x}$; $NCV_{TG, x-1}$; $NCV_{TG, x-2}$
Data unit:	TJ/Nm^3
Description:	Average net calorific value of town gas in the most recent three years prior to the start of the project activity *x*, *x-1* and *x-2*
Source of data used:	GPC
Value applied:	<table><tr><th>Year</th><th>Average Net Calorific Value Town Gas (GJ/Nm³)</th></tr><tr><td>2005</td><td>0.01008</td></tr><tr><td>2006</td><td>0.01012</td></tr><tr><td>2007</td><td>0.01014</td></tr></table>
Justification of the choice of data or description of measurement methods and procedures actually applied :	According with data from GPC
Any comment:	NCV was calculated based on the composition of the Town Gas (analysis of the composition of CO, H_2, CH_4 and CO_2 made by GPC), multiplied by the NCV of each gas.

Data / Parameter:	$Q_{NG, x}$; $Q_{NG, x-1}$; $Q_{NG, x-2}$
Data unit:	Nm^3

Description:	Annual quantity of natural gas used as feedstock and fuel for the production of town gas in the three most recent years prior to the start of the project activity *x*, *x-1* and *x-2*
Source of data used:	Invoices from CEG
Value applied:	<table><tr><th>Year</th><th>Natural Gas Consumed (Nm³)</th></tr><tr><td>2005</td><td>151,597,364</td></tr><tr><td>2006</td><td>161,514,095</td></tr><tr><td>2007</td><td>151,165,426</td></tr></table>
Justification of the choice of data or description of measurement methods and procedures actually applied :	CEG emits invoices to GPC every 15 days. The invoices present the amount of gas consumed and the average NCV. As the gas consumed is charged by the amount of energy delivered, the invoices present the gas-flow converted to 9,400 kcal/Nm³.
Any comment:	

Data / Parameter:	$\mathbf{NCV_{NG,x}}$; $\mathbf{NCV_{NG,x-1}}$; $\mathbf{NCV_{NG,x-2}}$
Data unit:	TJ/Nm³
Description:	Average net calorific value of Natural Gas in the most recent three years prior to the start of the project activity *x*, *x-1* and *x-2*
Source of data used:	Invoices from CEG
Value applied:	<table><tr><th>Year</th><th>Average Net Calorific Value Natural Gas (kcal/Nm³)</th></tr><tr><td>2005</td><td>9,400</td></tr><tr><td>2006</td><td>9,400</td></tr><tr><td>2007</td><td>9,400</td></tr></table>
Justification of the choice of data or description of measurement methods and procedures actually applied :	The invoices from CEG present the average NCV and the conversion factor to 9,400 kcal/Nm³. As the amount of gas consumed used to calculate the baseline is the converted one, the NCV adopted to the baseline was 9,400 kcal/Nm³.
Any comment:	

B.6.3 Ex-ante calculation of emission reductions:

The calculations will be divided in four groups:

a) Gramacho Landfill methane emission

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

Table 4. Estimative of methane emissions in the baseline

Year	LFG emissions (Nm3lfg)	Methane Emissions (Nm3CH4)
1993	35,374,760	17,687,380
1994	61,650,806	30,825,403
1995	84,020,247	42,010,124
1996	112,264,414	56,132,207
1997	135,604,996	67,802,498
1998	153,146,761	76,573,380
1999	167,410,030	83,705,015
2000	180,151,274	90,075,637
2001	189,891,169	94,945,584
2002	199,445,448	99,722,724
2003	205,152,610	102,576,305
2004	209,912,132	104,956,066
2005	214,542,510	107,271,255
2006	221,855,978	110,927,989
2007	227,589,346	113,794,673
2008	233,757,356	116,878,678
2009	239,104,421	119,552,211
2010	190,083,115	95,041,558

Year	LFG emissions (Nm3lfg)	Methane Emissions (Nm3CH4)
2011	155,135,768	77,567,884
2012	129,780,247	64,890,124
2013	110,998,636	55,499,318
2014	96,755,862	48,377,931
2015	85,676,867	42,838,433
2016	76,830,060	38,415,030
2017	69,582,052	34,791,026
2018	63,500,168	31,750,084
2019	58,287,012	29,143,506
2020	53,736,526	26,868,263
2021	49,704,464	24,852,232
2022	46,088,540	23,044,270
2023	42,815,069	21,407,534
2024	39,829,960	19,914,980
2025	37,092,647	18,546,323
2026	34,571,973	17,285,986
2027	32,243,405	16,121,703
2028	30,087,139	15,043,569

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 Gramacho Landfill is an unmanaged SWDS, but is more than 50 meters depth; thus, the MCF adopted is equal to **0.8**

W_x *(Total amount of organic waste prevented disposed in year x, in tons):*
The amount of the solid waste entering in the Gramacho Landfill has been monitored by COMLURB (the owner of the landfill) from 1993 on, as presented in item B.6.2 above.

Obs: data of 2008 and 2009 are estimatives

The composition of the solid waste used to calculate *ex-ante* estimatives of methane generation was based in an historical data prepared by COMLURB. The historical average of each type of waste concentration as presented in item B.6.2 above.

b) Gas Sale Calculation
It's estimated that all gas collected will be injected into the dedicated pipeline. Assuming a collection efficiency of 80%, we have:

	Biogas collected and sold to GPC and to the independent power producer	Biogas collected and sold to GPC and to the independent power producer

	(Nm^3)	(Nm^3/h)
2009	191,283,537	21,836
2010	152,066,492	17,359
2011	124,108,614	14,168
2012	103,824,198	11,852
2013	88,798,909	10,137
2014	77,404,690	8,836
2015	68,541,493	7,824
2016	61,464,048	7,016
2017	55,665,642	6,355
2018	50,800,134	5,799
2019	46,629,610	5,323
2020	42,989,221	4,907
2021	39,763,571	4,539
2022	36,870,832	4,209
2023	34,252,055	3,910
2024	31,863,968	3,637
2025	29,674,117	3,387
2026	27,657,578	3,157
2027	25,794,724	2,945
2028	24,069,711	2,748

c) Grid Emission Factor Calculation.
The data used to calculate the grid emission factor was taken from ONS. The final result of the EF calculation was provided by the Brazilian DNA, in their web-site.

d) Town Gas production
According with the project, GPC Town Gas Plant will consume LFG and by doing so will avoid consumption of natural gas. It's estimated that Town Gas will be produced having the following composition:

	NCV (GJ/Nm^3)[16]	Volumetric Composition (%)	Average NCV (GJ/Nm^3)	Average MM (kg/kmol)	Average Density (kg/Nm^3)
CH_4	0.03396	2.49%	0.01002	11.4376	0.5106
CO_2	0	10.77%			
CO	0.01197	17.56%			
H_2	0.01023	69.18%			

According with GPC, each Nm^3 of LFG will produce 2.0951 Nm^3 of Town Gas with the composition above presented. Thus, assuming that 100% of the LFG collected will be sold to GPC, the production of Town Gas will be equal to:

	Town Gas

[16] Source: Gas Engineers Handbook / SINDE, available at < http://www.gasnet.com.br/novo_gasnatural/combust_completo.asp#comb422>, accessed on 23/09/2008

	produced by GPC (Nm^3)
2009	400,752,260
2010	318,589,835
2011	260,016,144
2012	217,518,886
2013	186,039,864
2014	162,168,187
2015	143,599,176
2016	128,771,438
2017	116,623,375
2018	106,429,800
2019	97,692,262
2020	90,065,395
2021	83,307,436
2022	77,246,947
2023	71,760,427
2024	66,757,220
2025	62,169,331
2026	57,944,541
2027	54,041,733
2028	50,427,712

The baseline process efficiency is calculated using the historical production of Town Gas and consumption of Natural Gas prior to the project implementation and the estimative of Town Gas production and LFG consumption:

Table 5. Baseline Process Efficiency Before the Project's Implementation

Year	TG Produced (Nm^3/year)	NCV Town Gas (GJ/Nm^3)	Natural Gas Consumed (Nm^3/year)	NCV Natural Gas (GJ/Nm^3)	η_{BL}
	A	B	C	D	$E = (A . B)/(C . D)$
2005	465,440,269	0.01008	151,597,364	0.03936	1.01166
2006	475,337,457	0.01012	161,514,095	0.03936	0.97819
2007	422,798,025	0.01014	151,165,426	0.03936	0.96660

The Wobbe Index is calculated dividing the NCV of the Town Gas by the square root of the relative density of the Town Gas.

At STP, the density of the gases is calculated as follows:

$$P \times V = n \times R \times T$$

$$P \times V = \frac{m}{MM} \times R \times T \qquad \textbf{(40)}$$

$$\rho = \frac{m}{V} = \frac{P \times MM}{R \times T}$$

Where:

P	Pressure of the gas at STP (101,325 Pa)
V	Volume of the gas at STP (Nm^3)
m	Mass of the gas (kg)
MM	Molar Mass of the gas (kg/kmol)
R	Universal ideal gas constant (8,314 Pa.m^3/K.mol)
T	Temperature of the gas at STP (273 K)

Assuming that the composition of the air is 79% N_2 (MM = 28 kg/kmol) and 21% O_2 (MM = 32 kg/kmol), the above equation is updated to:

$$\rho = \frac{101{,}325 \times (79\% \times 28 + 21\% \times 32)}{8{,}314 \times 273} = 1.2750\ \text{kg/Nm}^3 \qquad \textbf{(41)}$$

Applying the same equation to the Town Gas, assuming an average yearly composition of the Town Gas equal to (according with laboratory analysis from GPC):

YEAR	**TOWN GAS COMPOSITION**				**MM TOWN GAS (kg/kmol)**
	CO	H_2	CH_4	CO_2	
2005	16.31%	71.62%	2.36%	9.54%	10.5744
2006	16.71%	71.09%	2.49%	9.55%	10.7010
2007	16.79%	70.46%	2.73%	9.80%	10.8592
MM (kg/kmol)	28	2	16	32	

$$\rho_{2005} = \frac{101{,}325 \times 10.5744}{8{,}314 \times 273} = 0.4720\ \text{kg/Nm}^3$$

$$\rho_{2006} = \frac{101{,}325 \times 10.7010}{8{,}314 \times 273} = 0.4777\ \text{kg/Nm}^3 \qquad \textbf{(42)}$$

$$\rho_{2007} = \frac{101{,}325 \times 10.8592}{8{,}314 \times 273} = 0.4848\ \text{kg/Nm}^3$$

Applying the Wobbe Index formula, the following results are presented:

$$W_{y,NG} = \frac{NCV}{\sqrt{\frac{\rho_{TG}}{\rho_{air}}}}$$

$$W_{2005} = \frac{0.01008 \times 1{,}000}{\sqrt{\frac{0.4720}{1.2750}}} = 16.6492 \text{ MJ/Nm}^3$$

$$W_{2005} = \frac{0.01012 \times 1{,}000}{\sqrt{\frac{0.4777}{1.2750}}} = 16.6102 \text{ MJ/Nm}^3 \quad \textbf{(43)}$$

$$W_{2005} = \frac{0.01014 \times 1{,}000}{\sqrt{\frac{0.4847}{1.2750}}} = 16.5300 \text{ MJ/Nm}^3$$

Table 6. Baseline Process Efficiency After the Project's Implementation

Year	TG Produced (Nm3/year)	NCV Town Gas (GJ/Nm3)	LFG Consumed (Nm3/year)	NCV LFG (GJ/Nm3)	η_y
	A	B	C	D	*E = (A . B) / (C . D)*
2009	400,752,260	0.01002	191,283,537	0.01698	1.23632
2010	318,589,835		152,066,492		1.23632
2011	260,016,144		124,108,614		1.23632
2012	217,518,886		103,824,198		1.23632
2013	186,039,864		88,798,909		1.23632
2014	162,168,187		77,404,690		1.23632
2015	143,599,176		68,541,493		1.23632
2016	128,771,438		61,464,048		1.23632
2017	116,623,375		55,665,642		1.23632
2018	106,429,800		50,800,134		1.23632
2019	97,692,262		46,629,610		1.23632
2020	90,065,395		42,989,221		1.23632
2021	83,307,436		39,763,571		1.23632
2022	77,246,947		36,870,832		1.23632

2023	71,760,427		34,252,055		1.23632
2024	66,757,220		31,863,968		1.23632
2025	62,169,331		29,674,117		1.23632
2026	57,944,541		27,657,578		1.23632
2027	54,041,733		25,794,724		1.23632
2028	50,427,712		24,069,711		1.23632

For the CERs estimatives, the parameter $\eta_{BL,\,y}$ adopted was 1.23632, the highest value between the expected in the project and the 3-years historical.

The calculation of the Wobbe Index for the Town Gas produced using LFG results in:

$$W_{y,\,LFG} = \frac{NCV}{\sqrt{\frac{\rho_{TG}}{\rho_{air}}}}$$

$$W_{y,\,LFG} = \frac{0.01002 \times 1{,}000}{\sqrt{\frac{0.5106}{1.2750}}} = 15.8412 \text{ MJ/Nm}^3 \quad \textbf{(44)}$$

Comparing the Wobbe Index from the three previous years to the project implementation and the Wobbe Index after the project implementation, the result is:

YEAR	WOBBE INDEX (MJ/Nm^3)	WOBBE INDEX VARIATION
2005	16.6504	**4.86%**
2006	16.6113	**4.64%**
2007	16.5301	**4.17%**
After Project	*15.8412*	

Thus, it's expected that the Wobbe Index won`t vary more than 10%.

Data of TG produced and Natural Gas consumed were supplied by GPC.

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

Year	Estimations of Project Activity Emissions (tCO_2e/year)	Estimations of Baseline Emissions (tCO_2e/year)	Estimation of Leakage (tCO_2e/year)	Estimation of Emission Reductions (tCO_2e/year)
2009	2,920	779,209	0	776,289
2010	5,809	1,232,141	0	1,226,332
2011	5,809	1,005,608	0	999,799
2012	5,809	841,251	0	835,442
2013	5,809	719,506	0	713,697
2014	5,809	627,182	0	621,373
2015	5,809	555,367	0	549,558
2016	2,881	246,963	0	244,083
TOTAL	**40,655**	**6,007,228**	**0**	**5,966,573**

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

B.7.1 Data and parameters monitored:

ACM0001 – Consolidated methodology for landfill gas project activities

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 used:	Project participants.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	Variable
Description of measurement methods and procedures to be applied:	Continuous readings from the flow-meter installed. The equipment is connected to a supervisory computer system, which registers continuously the LFG measured. Data to be aggregated monthly and yearly.
QA/QC procedures to be applied:	Flow meters should be subject to a regular maintenance and testing regime to ensure accuracy.
Any comment:	- Modern flow-meters usually include temperature and pressure readings. Thus, they automatically converts the flow measured to Nm^3; - Calibration of the equipment will be made according with the manufacturers recommendations; - Monitoring under responsibility of the Gramacho Landfill Gas Proiect's operators (the team, the organizational structure and the management structure will be defined after the project's implementation); - All data will be archived electronically and will be kept for 2 years after the end of the last crediting period.

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 used:	Project participants.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	Variable
Description of measurement methods and procedures to be applied:	Continuous readings from the flow-meters installed. The equipment is connected to a supervisory computer system, which registers continuously the LFG measured. Data to be aggregated monthly and yearly for each flare.
QA/QC procedures to be applied:	Flow meters should be subject to a regular maintenance and testing regime to ensure accuracy.
Any comment:	- Modern flow-meters usually include temperature and pressure readings. Thus, they automatically converts the flow measured to Nm^3; - Calibration of the equipment will be made according with the manufacturers recommendations; - Monitoring under responsibility of the Gramacho Landfill Gas Proiect's operators (the team, the organizational structure and the management structure will be defined after the project's implementation). - There will be installed one flow-meter for each flare; - All data will be archived electronically and will be kept for 2 years after the end of the last crediting period.

Data / Parameter:	**3. $LFG_{GPC, y}$**
Data unit:	m^3
Description:	Total amount of landfill gas sent to GPC at Normal Temperature and Pressure
Source of data to be used:	Project participants.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	Variable
Description of measurement methods and procedures to be applied:	Continuous readings from the flow-meter installed. The equipment is connected to a supervisory computer system, which registers continuously the LFG measured. Data to be aggregated monthly and yearly (the flow-meter will be installed as near as possible to the GPC's inlet valve).
QA/QC procedures to be applied:	Flow meters should be subject to a regular maintenance and testing regime to ensure accuracy.
Any comment:	- Modern flow-meters usually include temperature and pressure readings. Thus, they automatically converts the flow measured to Nm^3; - Calibration of the equipment will be made according with the manufacturers recommendations;

	- Monitoring under responsibility of the Gramacho Landfill Gas Proiect's operators (the team, the organizational structure and the management structure will be defined after the project's implementation) ; - All data will be archived electronically and will be kept for 2 years after the end of the last crediting period.

Data / Parameter:	**4. $LFG_{IPP, y}$**
Data unit:	m^3
Description:	Total amount of landfill gas sent the end-user IPP at Normal Temperature and Pressure
Source of data to be used:	Project Participants.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	Variable
Description of measurement methods and procedures to be applied:	Continuous readings from the flow-meter installed. The equipment is connected to a supervisory computer system, which registers continuously the LFG measured. Data to be aggregated monthly and yearly (the flow-meter will be installed as near as possible to the IPP's inlet valve).
QA/QC procedures to be applied:	Flow meters should be subject to a regular maintenance and testing regime to ensure accuracy.
Any comment:	- Modern flow-meters usually include temperature and pressure readings. Thus, they automatically converts the flow measured to Nm^3; - Calibration of the equipment will be made according with the manufacturers recommendations; - Monitoring under responsibility of the Gramacho Landfill Gas Proiect's operators (the team, the organizational structure and the management structure will be defined after the project's implementation) ; - All data will be archived electronically and will be kept for 2 years after the end of the last crediting period.

Data / Parameter:	**5. w_{CH4}**
Data unit:	m^3CH_4/m^3LFG
Description:	Methane fraction in the landfill gas
Source of data to be used:	Continuous measurement using a certified gas analyzer. The analyzer will measure the methane content directly.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	50%
Description of measurement methods and procedures to be applied:	The gas samples are taken using a stream system. The analysis is made on the main line continuously.
QA/QC procedures to	The gas analyser should be subject to a regular maintenance and testing

be applied:	regime to ensure accuracy
Any comment:	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:	**25. EL_{LFG}**
Data unit:	MWh
Description:	Net amount of electricity generated using LFG.
Source of data to be used:	Continuous readings from an electricity-meter
Value of data applied for the purpose of calculating expected emission reductions in section B.5	-
Description of measurement methods and procedures to be applied:	-
QA/QC procedures to be applied:	-
Any comment:	Electricity displacement will not be subject to ERs request. This variable was only included in the project activity's monitoring as the DOE requested the inclusion of the IPP inside the boundaries of the project, according with the methodology ACM0001. Thus, no strength monitoring procedures or QA/QC measurements will be undertaken.

Data / Parameter:	**$PE_{Flare, y}$**
Data unit:	tCO_2e
Description:	Project emissions from flaring of the residual gas stream in year y
Source of data to be used:	Calculated as per the *Tool to determine project emissions from flaring gases containing methane*
Value of data applied for the purpose of calculating expected emission reductions in section B.5	As per the *Tool to determine project emissions from flaring gases containing methane*
Description of measurement methods and procedures to be applied:	As per the *Tool to determine project emissions from flaring gases containing methane*
QA/QC procedures to be applied:	As per the *Tool to determine project emissions from flaring gases containing methane*
Any comment:	Please, see the monitoring below – no number was indexed to this variable as all parameters to monitor the flare efficiency are presented below.

Tool to determine project emissions from flaring gases containing methane

Data / Parameter:	**6. $fv_{i,h}$**
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 used:	Measurements by project participants using a continuous gas analyser
Value of data applied for the purpose of calculating expected emission reductions in section B.5	-
Description of measurement methods and procedures to be applied:	Ensure that the same basis (dry or wet) is considered for this measurement and the measurement of the volumetric flow rate of the residual gas ($FV_{RG,h}$) when the residual gas temperature exceeds 60 ºC
QA/QC procedures to be applied:	Analysers will be periodically calibrated according to the manufacturer's 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 **5. 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:	**7. $FV_{RG,h}$**
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 used:	Measurements by project participants using a flow meter
Value of data applied for the purpose of calculating expected emission reductions in section B.5	
Description of measurement methods and procedures to be applied:	Ensure that the same basis (dry or wet) is considered for this measurement and the measurement of volumetric fraction of all components in the residual gas ($fv_{i,h}$) when the residual gas temperature exceeds 60 ºC
QA/QC procedures to be applied:	Flow meters are to be periodically calibrated according to the manufacturer's recommendation.
Any comment:	Please, refer to the measurements of **2. LFG_{flare}** above.

Data / Parameter:	**8. $t_{O2,h}$**
Data unit:	-
Description:	Volumetric fraction of O_2 in the exhaust gas of the flare in the hour *h*
Source of data to be used:	Measurements using a continuous gas analyser

Value of data applied for the purpose of calculating expected emission reductions in section B.5	N/A, as the efficiency adopted to calculate ERs was considered as 99.94%[17]
Description of measurement methods and procedures to be applied:	The gas samples are taken using a stream system. The analysis will be made individually for each flare.
QA/QC procedures to be applied:	The analyzer will calibrated regularly, according with the manufacturer's specifications and procedures.
Any comment:	- There will be installed one O_2 analyzer for each flare; - All data will be archived electronically and will be kept for 2 years after the end of the last crediting period.

Data / Parameter:	**9. $fv_{CH4,FG,h}$**
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 used:	Measurements using a continuous gas analyser
Value of data applied for the purpose of calculating expected emission reductions in section B.5	N/A, as the efficiency adopted to calculate ERs was considered as 99.94%[17]
Description of measurement methods and procedures to be applied:	The gas samples are taken using a stream system. The analysis will be made individually for each flare.
QA/QC procedures to be applied:	The analyzer will calibrated regularly, according with the manufacturer's specifications and procedures
Any comment:	- There will be installed one CH4 analyzer for each flare; - All data will be archived electronically and will be kept for 2 years after the end of the last crediting period.

Data / Parameter:	**10. T_{flare}**
Data unit:	^oC
Description:	Temperature in the exhaust gas of the flare
Source of data to be used:	Measurements by project participants, using thermocouples
Value of data applied for the purpose of calculating expected emission reductions in section B.5	N/A, as the efficiency adopted to calculate ERs was considered as 99.94%[17]

[17] Efficiency based on Hofstetter's estimatives, the flare Novo Gramacho intends to acquire.

Description of measurement methods and procedures to be applied:	Measure the temperature of the exhaust gas stream in the flare by a Type N thermocouple. A temperature above 500 ºC indicates that a significant amount of gases are still being burnt and that the flare is operating.
QA/QC procedures to be applied:	Thermocouples will be replaced or calibrated every year.
Any comment:	All data will be archived electronically and will be kept for 2 years after the end of the last crediting period. An excessively high temperature at the sampling point (above 700 ºC) may be an indication that the flare is not being adequately operated or that its capacity is not adequate to the actual flow.

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

Data / Parameter:	**11. $EC_{PJ, y}$**
Data unit:	MWh
Description:	Amount of electricity consumed from to the Brazilian Electric Grid
Source of data to be used:	Measurements of the electricity meter installed in compression system.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	26,280 MWh/year
Description of measurement methods and procedures to be applied:	The electricity meter will make instantly readings and data will be stored in the supervisory computer system connected. Data will be aggregated every hour.
QA/QC procedures to be applied:	Electricity meters will be subject to regular calibrations, according with the manufacturer's recommendation.
Any comment:	- Monitoring under responsibility of the project operators (the team, the organizational structure and the management structure will be defined after the project's implementation); - All data will be archived electronically and will be kept for 2 years after the end of the last crediting period.

Data / Parameter:	**12. $TLD_{project, y}$**
Data unit:	%
Description:	Average technical transmission and distribution losses for providing electricity to the project in year *y*
Source of data to be used:	*Tool to calculate baseline, project and/or leakage emissions from electricity consumption*
Value of data applied for the purpose of calculating expected emission reductions in section B.5	20%, as electricity is a source of project emissions, according with the Tool.

Description of measurement methods and procedures to be applied:	Annually. In the absence of data from the relevant year, most recent figures should be used, but not older than 5 years.
QA/QC procedures to be applied:	N/A
Any comment:	- All data will be archived electronically and will be kept for 2 years after the end of the last crediting period.

Tool for calculation of emission factor for electricity systems

Data / Parameter:	**13. $EF_{OM, 2007}$**
Data unit:	tCO_2e/MWh
Description:	Emission Factor of the Operating Marging during 2006
Source of data to be used:	ONS – National Operator System
Value of data applied for the purpose of calculating expected emission reductions in section B.5	0.2909
Description of measurement methods and procedures to be applied:	The monitoring of EF_{OM} will be made by the Brazilian DNA and will be annually updated for *ex-post* calculation.
QA/QC procedures to be applied:	
Any comment:	- $EF_{OM, 2007}$ calculated by the Brazilian DNA; - All data will be archived electronically and will be kept for 2 years after the end of the last crediting period.

Data / Parameter:	**14. $EF_{BM, 2006}$**
Data unit:	tCO_2e/MWh
Description:	Emission Factor of the Built Marging of 2006
Source of data to be used:	ONS – National Operator System
Value of data applied for the purpose of calculating expected emission reductions in section B.5	0.0775
Description of measurement methods and procedures to be applied:	The monitoring of EF_{BM} will be made by the Brazilian DNA and will be updated for *ex-post* calculation.
QA/QC procedures to be applied:	
Any comment:	- $EF_{BM, 2007}$ calculated by the Brazilian DNA; - All data will be archived electronically and will be kept for 2 years after the end of the last crediting period.

Data / Parameter:	**15. $EF_{CM, 2007}$**
Data unit:	tCO_2e/MWh
Description:	Electricity Baseline Emission Factor for 2006
Source of data to be used:	ONS – National Operator System
Value of data applied for the purpose of calculating expected emission reductions in section B.5	0,1842 (average of the monthly OM emission factor).
Description of measurement methods and procedures to be applied:	The monitoring of $EF_{CM, y}$ will be made using information from the Brazilian DNA.
QA/QC procedures to be applied:	
Any comment:	- $EF_{CM, 2007}$ calculated by the Brazilian DNA; - All data will be archived electronically and will be kept for 2 years after the end of the last crediting period.

AM0069 – Biogenic methane use as feedstock and fuel for town gas production

Data / Parameter:	**16. $Q_{TG, y}$**
Data unit:	kg or m^3
Description:	Measured quantity of town gas produced in year *y*
Source of data to be used:	GPC
Value of data applied for the purpose of calculating expected emission reductions in section B.5	Variable
Description of measurement methods and procedures to be applied:	Continuous measurements performed using certified flow meters.
QA/QC procedures to be applied:	Zero checks and calibration procedures as recommended by equipment manufacturers
Any comment:	All data will be archived electronically and will be kept for 2 years after the end of the last crediting period.

Data / Parameter:	**17. $NCV_{TG, y}$**
Data unit:	TJ/kg or TJ/m^3
Description:	Average net calorific value of the Town Gas in year *y*
Source of data to be used:	To be measured continuously using certified equipment.
Value of data applied	Variable

for the purpose of calculating expected emission reductions in section B.5	
Description of measurement methods and procedures to be applied:	Online Heating Value Meter to measure the NCV directly from the gas stream. The measurement will be in mass or volume basis.
QA/QC procedures to be applied:	Zero checks and calibration procedures as recommended by equipment manufacturers
Any comment:	All data will be archived electronically and will be kept for 2 years after the end of the last crediting period.

Data / Parameter:	**18. $Q_{BG, y}$**
Data unit:	kg or m^3
Description:	Annual quantity of biogas used as feedstock and fuel for the production of town gas in year *y*
Source of data to be used:	Novo Gramacho Energia Ambiental (please, refer to **3. $LFG_{GPC, y}$**)
Value of data applied for the purpose of calculating expected emission reductions in section B.5	Variable
Description of measurement methods and procedures to be applied:	Continuous measurements performed using certified flow meters (please, refer to **3. $LFG_{GPC, y}$**)
QA/QC procedures to be applied:	Zero checks and calibration procedures as recommended by equipment manufacturers (please, refer to **3. $LFG_{GPC, y}$**)
Any comment:	Please, refer to **3. $LFG_{GPC, y}$**

Data / Parameter:	**19. $NCV_{BG, y}$**
Data unit:	TJ/kg or TJ/m^3
Description:	Average net calorific value of biogas used as feedstock and fuel for the production of town gas in year *y*
Source of data to be used:	Novo Gramacho Energia Ambiental
Value of data applied for the purpose of calculating expected emission reductions in section B.5	Variable
Description of measurement methods and procedures to be applied:	Continuous measurements performed using certified flow meters.
QA/QC procedures to be applied:	Zero checks and calibration procedures as recommended by equipment manufacturers.

Any comment:	All data will be archived electronically and will be kept for 2 years after the end of the last crediting period.

Data / Parameter:	**20. $Q_{NG,y}$**
Data unit:	kg or m^3
Description:	Annual quantity of Natural Gas used as feedstock and fuel for the production of town gas in year *y*.
Source of data to be used:	Invoices from CEG.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	0
Description of measurement methods and procedures to be applied:	Continuous measurements performed using certified flow meters.
QA/QC procedures to be applied:	Zero checks and calibration procedures as recommended by equipment manufacturers.
Any comment:	The methodology requests the monitoring of the "Annual quantity of fossil fuel type *i* used as feedstock and fuel for the production of town gas in year *y*". As the project will only consume Natural Gas, the index *i* was replaced by NG (Natural Gas). All data will be archived electronically and will be kept for 2 years after the end of the last crediting period.

Data / Parameter:	**21. $NCV_{NG,y}$**
Data unit:	TJ/kg or TJ/m^3
Description:	Average net calorific value of the Natural Gas used as feedstock and fuel for the production of town gas in year *y*
Source of data to be used:	Invoices from CEG presents the average calorific value of the Natural Gas.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	0
Description of measurement methods and procedures to be applied:	Continuous measurements performed using certified flow meters.
QA/QC procedures to be applied:	Zero checks and calibration procedures as recommended by equipment manufacturers.
Any comment:	The methodology requests the monitoring of the "Average net calorific value of fossil fuel type *i* used as feedstock and fuel for the production of town gas in year *y*". As the project will only consume Natural Gas, the index *i* was replaced by NG (Natural Gas).

	All data will be archived electronically and will be kept for 2 years after the end of the last crediting period.

Tool to calculate project or leakage CO2 emissions from fossil fuel combustion

Data / Parameter:	**22.** $FC_{NG, TGP, y}$
Data unit:	
Description:	
Source of data to be used:	
Value of data applied for the purpose of calculating expected emission reductions in section B.5	
Description of measurement methods and procedures to be applied:	
QA/QC procedures to be applied:	
Any comment:	Please, refer to the measurements of **20.** $Q_{NG, y}$ above.

Data / Parameter:	**23.** $NCV_{NG, y}$
Data unit:	
Description:	
Source of data to be used:	
Value of data applied for the purpose of calculating expected emission reductions in section B.5	
Description of measurement methods and procedures to be applied:	
QA/QC procedures to be applied:	
Any comment:	Please, refer to the measurements of **21.** $NCV_{NG, y}$ above.

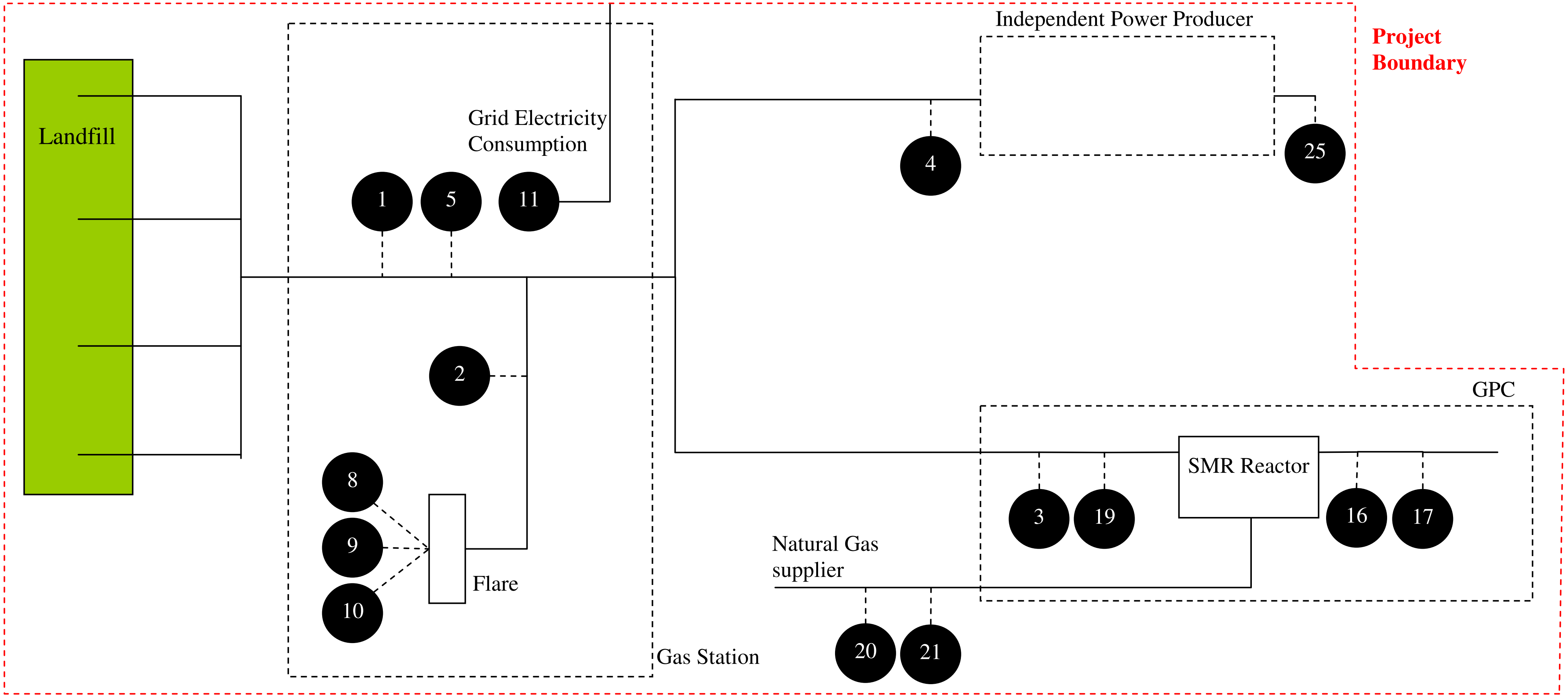
Data / Parameter:	**24.** $EF_{i, CO2, y}$
Data unit:	tCO_2/GJ
Description:	Weighted average CO_2 emission factor of fuel type *i* in year *y*
Source of data to be used:	IPCC default values at the upper limit of the uncertainty at a 95% confidence interval as provided in table 1.4 of Chapter1 of Vol. 2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories

Value of data applied for the purpose of calculating expected emission reductions in section B.5	56.1
Description of measurement methods and procedures to be applied:	Any future revision of the IPCC Guidelines will be taken into account to update the parameter.
QA/QC procedures to be applied:	
Any comment:	As the Natural Gas supplier does not inform the values in the invoices, option *d)* was selected.

B.7.2 Description of the monitoring plan:

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

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



OBS 1: There will be one flow-meter and one O_2 and CH_4 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 completed on 06/01/2009 by ARCADIS Tetraplan, contact information:

ARCADIS Tetraplan
Avenida Nove de Julho, 5966 – Itaim
São Paulo – SP – Brazil
CEP: 01406-200
C/O: Eduardo Cardoso Filho
eduardo@tetraplan.com.br
Tel./Fax.: + 55 11 3060-8457

SECTION C. Duration of the project activity / crediting period

C.1 Duration of the project activity:

C.1.1. Starting date of the project activity:

20/10/2008

This is the date expected to the beginning of the landfill's perforation.

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

15 years after the emission of the landfill closure term (according with the contract).

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

C.2.1. Renewable crediting period

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

01/07/2009

C.2.1.2. Length of the first crediting period:

7 years

C.2.2. Fixed crediting period:

C.2.2.1. Starting date:

N/A

C.2.2.2. Length:

N/A

SECTION D. Environmental impacts

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

All environmental impacts were raised at the Environmental Study submitted to FEEMA – Fundação Estadual de Engenharia e Meio-Ambiente (Rio de Janeiro State's environmental authority). According with the study, no transboundary impacts are expected and the impacts raised are positive, once the project involves civil works to improve the environmental quality of the Gramacho Landfill, including the LFG collection system, leachate treatment improvement, final closure and capping of the landfill and monitoring of environmental parameters (ground-water quality leachate treatment facility monitoring).

FEEMA issued, in 02/06/2008 the Installation Licence # FE014252.

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

As previously explained, the environmental negative impacts of the project's implementation are not considered significant and all impacts raised were properly described in the Environmental Study and analyzed by FEEMA.

SECTION E. Stakeholders' comments

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

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

In 12/08/2008 and 13/08/2008, a letter containing a copy of the PDD translated to Portuguese and an explanation on how the project will contribute to the promotion of sustainable development was sent to each of the following stakeholders:

Resolução nº7	Stakeholder invited
Prefeitura do município envolvido	Prefeitura de Duque de Caxias *(City Hall of Duque de Caxias)*
Câmara dos vereadores do município envolvido	Câmara dos Vereadores de Duque de Caxias *(Legislative Chamber of Duque de Caxias)*
Órgão Ambiental Estadual	FEEMA – Fundação Estadual de Engenharia e Meio Ambiente *(State Environmental Agency)*
Órgão Ambiental Municipal	Secretaria Municipal do Meio Ambiente *(Municipal Environmental Secretariat)*
Fórum Brasileiro de ONG's e Movimentos	Fórum Brasileiro de ONG's e Movimentos Sociais

Sociais para o Meio Ambiente e Desenvolvimento	para o Meio Ambiente e Desenvolvimento *(Brazilian NGO Forum)*
Ministério Público estadual	Ministério Público do Rio de Janeiro (*State Public Attorney*)
Ministério Público Federal	Ministério Público Federal *(Federal Public Attorney)*
Entidade de classe	ACAMJG – Associaçã dos Catadores de Materiais Recicláveis de Jardim Gramacho
Outras Entidades	Prefeitura da Cidade do Rio de Janeiro *(Municipality of Rio de Janeiro)*

Evidence of delivery was sent with the letters.

E.2. Summary of the comments received:

No comments were received.

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

As no comments were received Novo Gramacho Energia Ambiental kept with the development of the Gramacho Landfill Gas Project.

Annex 1
CONTACT INFORMATION ON PARTICIPANTS IN THE PROJECT ACTIVITY

Organization:	Novo Gramacho Energia Ambiental S.A.
Street/P.O.Box:	Rua da Assembléia, 10 – 15º andar, sala 1504
Building:	
City:	Rio de Janeiro
State/Region:	Rio de Janeiro
Postfix/ZIP:	20011-901
Country:	Brazil
Telephone:	+ 55 (21) 2222-0430
FAX:	+ 55 (21) 2222-0430
E-Mail:	
URL:	
Represented by:	Mr. Eduardo Levenhagen
Title:	Director
Salutation:	Mr.
Last Name:	Levenhagen
Middle Name:	
First Name:	Eduardo
Department:	
Mobile:	
Direct FAX:	
Direct tel:	
Personal E-Mail:	eduardo@novogramacho.com.br

Organization:	Companhia Municipal de Limpeza Urbana – COMLURB
Street/P.O.Box:	Rua Major Ávila, 358 – 2nd floor
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City:	Rio de Janeiro
State/Region:	Rio de Janeiro
Postfix/ZIP:	20511-900
Country:	Brazil
Telephone:	+ 55 21 2204-9999
FAX:	+ 55 21 2214-7272
E-Mail:	comlurb_pce@rio.rj.gov.br
URL:	http://www.rio.rj.gov.br/comlurb
Represented by:	Mr. José Henrique Rabello Penido Monteiro
Title:	Chief Assessor
Salutation:	Mr.
Last Name:	Penido Monteiro
Middle Name:	Rabelo
First Name:	José Henrique
Department:	Technical and Industrial Directory
Mobile:	
Direct FAX:	
Direct tel:	
Personal E-Mail:	comlurb_igd@rio.rj.gov.br

Annex 2

INFORMATION REGARDING PUBLIC FUNDING

There are no public funding involved in the Gramacho Landfill Gas Project.

Annex 3

BASELINE INFORMATION

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 to calculate the emission factor for an electricity system* 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 Mid-West (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). Moreover, the transmissions limits between the subsystems were analyzed and the results were that during 70% of the hours in one year, the transmission in full capacity happened in 70% or more hours during one year, concluding that there are no significant transmission looses.

The unique subsystem is presented in Figure 12.

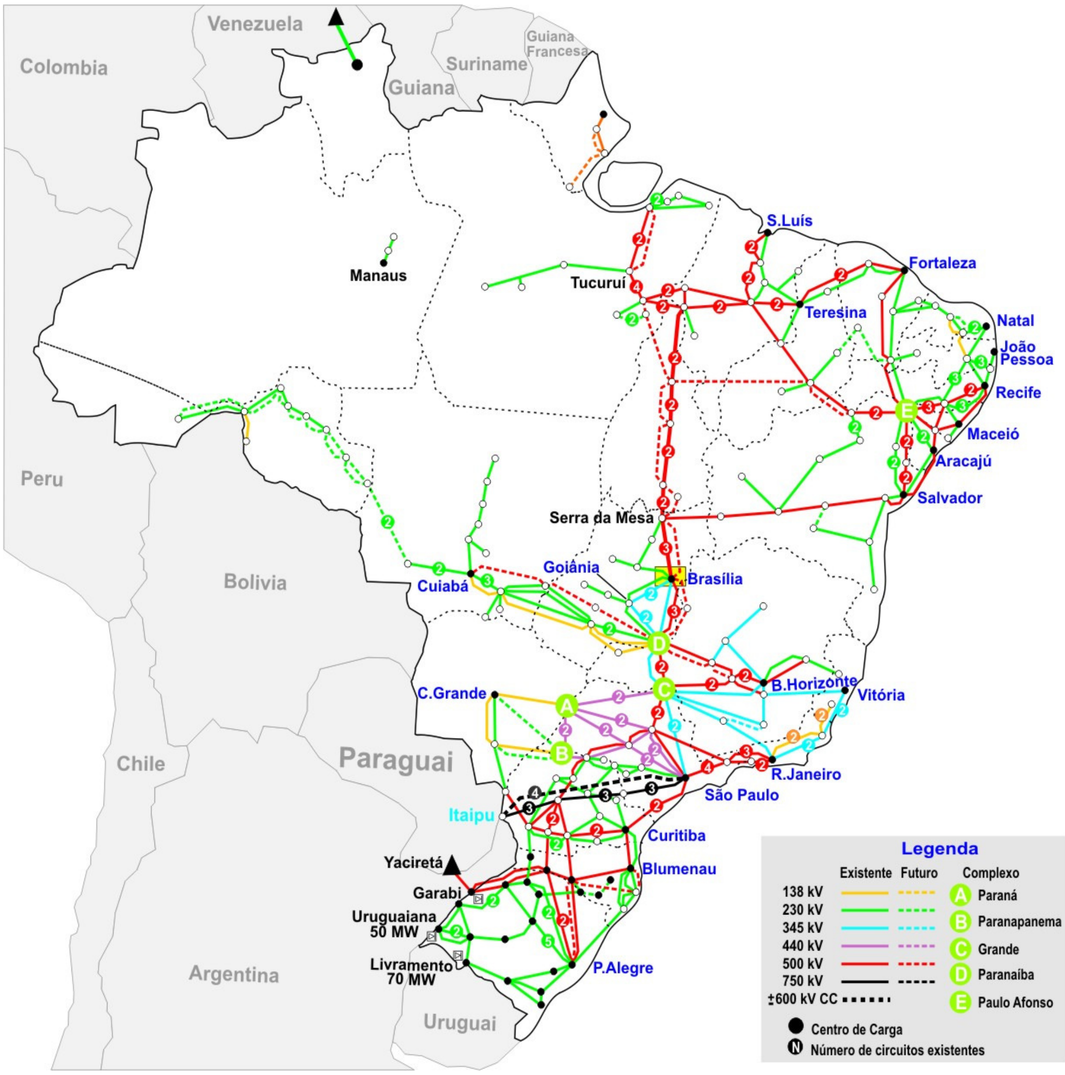

Figure 12. Brazilian Interconnected National System (Source: ONS)

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

Table 7. Thermoelectric Power Plants dispatched by ONS (source: ONS)

	Name	Fuel Used Actually	State
Northeast Sub-market	FAFEN	Natural Gas	Bahia
	S.C.JEREISATI	Natural Gas	Ceará
	TERMOBAHIA	Natural Gas	Bahia
	US.CAMACARI	Natural Gas	Bahia
	UT PERNAMBUCO	Natural Gas	Pernambuco
	UT. FORTALEZA	Natural Gas	Ceará
South Sub-market	P.MEDICI	Coal	Rio Grande do Sul
	PORTO ALEGRE	Fuel Oil	Rio Grande do Sul
	SAO JERONIMO	Coal	Rio Grande do Sul
	U. ALEGRETE	Fuel Oil	Rio Grande do Sul
	U. CANOAS	Natural Gas	Rio Grande do Sul
	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
Southeast-Midwest Sub-market	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
	JUIZ DE FORA	Natural Gas	Minas Gerais IS
	MACAE MERCHAN	Natural Gas	Rio de Janreiro
	NO.FLUMINENSE	Natural Gas	Rio de Janreiro
	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

Annex 4

MONITORING INFORMATION

As the project was not implemented by the time of the validation, what will be presented below is an ***idea*** of the main measures to be implemented – it does not mean that all measured will be indeed implemented. The measurements presented are based on Biogás Energia Ambiental – one of Novo Gramacho Energia Ambiental's shareholders:

a) Team
A team of well trained operators will be responsible for the correct monitoring and maintenance of the project. Proper training will be provided to all operators, which will receive training certificates. All operators will respond to a supervisor, inside a managing structure. Internal procedures might be developed to standardize actions.

b) Monitoring of data
The project will count with a computer-based system, which will be responsible for the continuous monitoring of all parameters necessary to calculate ERs.

All information will be recorded at the computer's hard disk and proper backups will be undertaken in order to avoid data looses. Moreover, the operators might be requested to take manual notes of the main variables (gas-flows) every day – the precise routine will be presented in internal procedures.

c) Maintenance and calibration
Maintenance and calibration procedures might be developed according with the recommendations from the manufacturers in order to assure the equipment's lifetime and data credibility.

d) Internal audits
Following the example of the Bandeirantes and São João landfill's projects, all data might be checked by the supervisors and by external consultants before the development of the Monitoring Reports. Proper procedures and measurements will be presented by the time of the 1st periodic verification as the project was not implemented by the time of the validation.

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