PROJECT DESIGN DOCUMENT FORM
FOR CDM PROJECT ACTIVITIES (F-CDM-PDD)
Version 04.1

PROJECT DESIGN DOCUMENT (PDD)

Title of the project activity	Gramacho Landfill Gas Project
Version number of the PDD	02.1
Completion date of the PDD	13/12/2012
Project participant(s)	*Companhia Municipal de Limpeza Urbana – COMLURB* and *Novo Gramacho Energia Ambiental S.A.*
Host Party(ies)	Brazil
Sectoral scope and selected methodology(ies)	13 - Waste handling and disposal ACM0001 – "Flaring or use of landfill gas" (version 13.0.0)
Estimated amount of annual average GHG emission reductions	313,751tCO_2e/year

SECTION A. Description of project activity

A.1. Purpose and general description of project activity

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The primary objective of the Gramacho Landfill Gas Project Activity is to avoid greenhouse gases emission by the Gramacho Landfill through landfill gas capture, purification and injection in a distribution grid, while contributing to the environmental, social and economic sustainability by minimizing global climate changes and local air pollution.

The Gramacho landfill is located in Duque de Caxias, Rio de Janeiro State in the southern region of Brazil and is considered the biggest solid waste disposal site in the Latin American region and is operational since 1978. At first, the waste deposition was conducted in an uncontrolled manner (open dump). From 1993 on, the landfill operations were reformulated. Since then the SWDS has been functioning as a controlled landfill. The average daily amount of waste deposited in the site since its opening in 1978 up to 2011 is 5,100tons. The landfill was closed at the end of the first half of 2012. As of today, the LFG capture system is already operational and the LFG upgrading facility is under implementation. It is forecasted that by the end of 2012, the proposed CDM Project Activity is fully operational.

Previously to the implementation of the proposed CDM Project Activity no active collection of LFG took place in the project site. On the contrary, only a small portion of the gas was destructed using a passive venting system. 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. The wells that were used in the passive venting system were shallow and very inefficient even for just venting. Therefore LFG flow could not be controlled to avoid free emission to the atmosphere.

The proposed CDM Project Activity consists of capturing the landfill gas (LFG) generated by the landfill using an active LFG capture system and injecting it into a natural gas distribution network (after a purification process), displacing the use of natural gas. Any LFG excess will be flared. Novo Gramacho understands that flaring shall be always the very last option of any CDM project related to LFG destruction.

Applying the state-of-the-art on LFG capture technology, a collecting system that will cover most of surface of the Gramacho Landfill (148 hectares) will be installed, as part of its effort to avoid the free emission of methane to the atmosphere. The LFG captured will be sent to the upgrading facility before being injected to the natural gas distribution grid of Petrobras (REDUC refinery, as upgraded gas with natural gas specifications).

Petrobras has been using natural gas as feedstock since 1982 (from Macaé). Petrobras will receive the upgraded gas from Gramacho Landfill Gas Project (GLFGP) through a natural gas distribution grid, therefore mixing with natural gas. This type of project, *i.e.*, upgrading of landfill gas to natural gas and injection into a natural gas distribution grid is the first of its kind in Brazil.

The project activity expects to inject an average of 8,900 Nm^3/h of upgraded biogas to the distribution grid. The estimated annual average GHG emission reductions, after the implementation of the proposed CDM Project Activity, are 313,751tCO_2e. By the end of the first crediting period, the project is expected to reduce on total 2,196,254tCO_2e.

The Novo Gramacho Project will have a substantial positive impact in terms of sustainable development as it will be the first LFG project in Brazil directly displacing natural gas consumption.

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 (after its upgrading) into the natural gas distribution grid, therefore avoiding the consumption of natural gas.

Besides its direct global environmental benefits related to the avoidance of emission of LFG to the atmosphere and avoiding natural gas consumption, 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 meet the requirements of the local legislation for discharge in the Baía de Guanabara;
- Design and execution of the landfill closure after the Rio de Janeiro Municipal Waste Agency (COMLURB) decided 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 at training people who used to live from picking the waste during its disposal in the landfill.

c) Contribution to labour capacitating

The Gramacho Landfill Gas Project is the first of its kind in Brazil. Hence, there are not qualified people in the market, principally related to the LFG upgrading plant. 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.2. Location of project activity

A.2.1. Host Party(ies)

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Brazil

A.2.2. Region/State/Province etc.

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Rio de Janeiro

A.2.3. City/Town/Community etc.

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Duque de Caxias

A.2.4. Physical/Geographical location

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The Gramacho Landfill is located is located in the municipality of Duque de Caxias, Rio de Janeiro state, south-eastern region of Brazil (Figure 1). The geographic coordinates of the site where the project is to be implemented are:

Latitude: 22º44’46” South

Longitude: 43º15’37” West

Figure 1 – Duque de Caxias location (Source: http://pt.wikipedia.org)

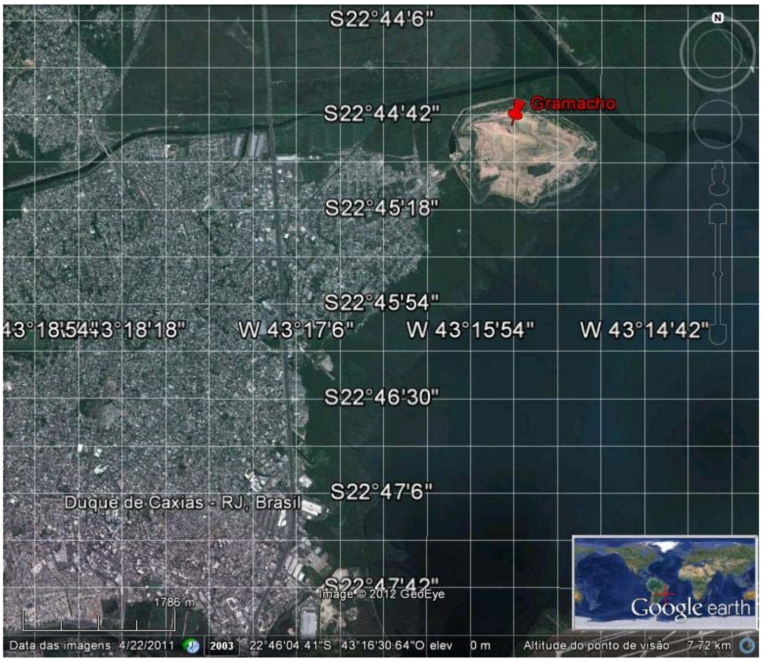

Figure 2 - Gramacho Landfill location (Source: adapted from Google Earth)

A.3. Technologies and/or measures

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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:

- Gas extraction wells with wellhead flow control and monitoring;
- A wellfield gas conveyance system (“laterals” and “header”);

- A Gas Station and an upgrading gas facility;
- A flaring system; and,
- A pipeline to inject the upgraded gas into the natural gas distribution grid.

1. Collecting System

Following well known technologies applied global wide, the Gramacho Landfill Gas Projectwill involve the perforation of about 300 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.

Figure 3 - Example of wellhead, Novo Gramacho Landfill

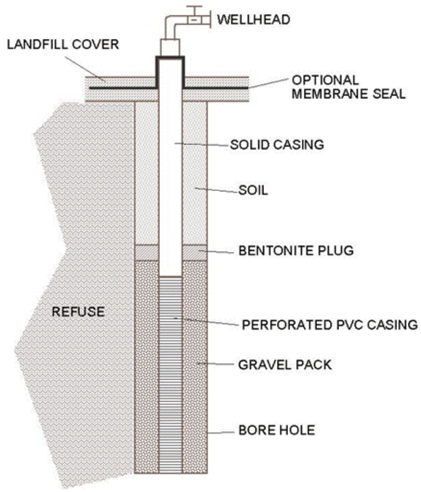

Figure 4. Internal detail of a well and wellhead (source: USEPA, 1996[1])

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 and incur in extra operational costs.

The landfill gas extraction well casings and screens are typically constructed with HDPE or PVC due to their characteristics in terms of flexibility and corrosion resistance. Novo Gramacho Energia Ambiental foresees the installation of at least 300 wells all over the landfill's area (the exact number of wells will be determined in the Executive Project and will be subject to adjustment based on conditions at the landfill observed during well installation and preliminary operation). Preliminarily, it is anticipated that the gas extraction wells will be spaced at regular intervals of approximately 30-60 meters.

Flow-control and monitoring wellheads will be employed at every gas extraction well, to allow precise regulation/adjustment of the gas flow at each well. Gas quality monitoring and flow adjustment is important to ensure that the system is "balanced" (i.e. gas extraction is matched to gas production so that atmospheric air is not introduced into the landfill). The wellheads are connected to conveyance pipelines, first to "laterals"

1 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

using flexible piping to accommodate landfill settling and pipe expansion and contraction. The laterals are in turn connected perpendicularly to a "header" which encircles the landfill and then brings the gas to the Gas Station. Isolation valves are located periodically along the header to allow repair work if necessary without shutting off the entire system. Approximately 50 laterals, each connecting between 1-12 wells (with the diameter of the lateral being selected based on the number of wells connected to each) are planned for the Gramacho gas collection system. Each lateral can be turned on or off with a valve at the point the lateral connects to the header, to allow maintenance to wellheads or attachment of new wells without the need to turn off the entire system.

An important feature of the lateral collector design is that a downward slope is maintained on every lateral pipe away from every gas extraction well, ensuring that any liquids (condensate, or leachate entrained in the gas flow) is conveyed by gravity to the perimeter header where is it removed from the system (using liquid vacuum traps) instead of being allowed to drain back into the landfill. This feature will ensure that the collection pipes are not blocked by liquid, and that the wells themselves do not get "flooded" by returning liquids.

As it is, liquid management is expected to very important at Gramacho. The lack of any formal leachate collection system means that the gas extraction wells will likely encounter leachate, which if allowed to accumulate to high levels, will reduce the amount of gas that can be pumped from each well. Therefore, it is anticipated that perhaps between 25-100 in-well leachate pumps, specifically designed for removing liquids from landfill gas wells, will be deployed to gather leachate from the wells and send it to the on-site leachate.

Figure 5. Example of Flow Control Wellhead connected to Lateral Conveyance Lines, Novo Gramacho Landfill

2. Transmission Pipeline (Header)

The "header" encircles the entire landfill and brings gas to the Gas Station. The header design will be completed with liquid evacuation in mind. At parts of the header where gas will be flowing in the opposite direction of the condensate flow direction (i.e. the gas will be flowing "up slope") the flow velocity will be slowed down by increasing the effective pipe diameter in order to prevent the flowing gas from impeding the flow of liquid. Instead of a single pipe however, the effective pipe diameter of the header will be adjusted using several pipes connected using "plenums." These plenums will also serve as liquid drainage points, and provide a convenient means to expand the effective diameter without replacing the entire header if additional flow conveyance capacity is needed.

Figure 6. Example of a transmission pipeline showing a plenum allowing the effective pipe diameter to be doubled (Source: Jardim Gramacho Landfill)

3. Gas Station and Upgrading gas facility

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 and condensate knock-outs. There will be installed 4 blowers, each with a maximum capacity of 6,333 Nm^3/hour and a minimum capacity of 1,500 Nm^3/hour.

As a source of methane, LFG can be used to replace the consumption of Natural Gas. However, in order to accomplish with the requirements from ANP – Agência Nacional do Petróleo (*National Petroleum Agency*) to be considered as natural gas, the concentration of methane must be higher than 86%[2]. Prior to the introduction of the biogas to the natural gas distribution grid, it will be treated in an upgrading facility, where most of the non-methane gases will be removed from the stream using different technologies such as the Pressure Swing Adsorption (PSA) and membranes. There is no use of water in this process and no wastewater is generated.

The use of this technique will deliver an upgraded gas (BTU- Gas Verde) with at least 92.5% of methane[3], therefore meeting the national standards for natural gas.

The LFG is firstly compressed to 7 bar and then directed to the H_2S removal system, where H_2S is removed through its reduction with a bed of non-degradable media. Then the biogas is directed to a 2 bed adsorber with a maximum inlet flow of 20,000 Nm^3/hr, where the water vapor from the gas feed stream is adsorbed while the dry gas passes through a bed of adsorbent. At any point in time, one of the two beds is on the adsorption phase while heating and cooling are regenerating the second bed. When the second bed is regenerated, it is switched into the adsorption mode and the position of the two beds is reversed. The dry biogas is now compressed from approximately 6.5 bar to 24 bar and directed to the VOC´s removal system. The VOC´s are eliminated through thermal destruction (Thermal Oxidizer). The biogas, now free from H_2S and VOC´s is sent to a series of membranes where the CO_2 is removed. Then, the N_2 is removed through a pressure swing adsorption system (PSA). Finally, the upgraded gas, with 92.5% of methane content, is compressed in order to maintain the required pressure at the injection point in the natural gas grid.

2 Resolução ANP nº 16, from 17/06/2008.

3 In accordance with the LFG Upgrading Facility Process Diagram.

Figure 7. Example of Blowers installed at Novo Gramacho Ambiental.

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 1,000ºC and retention time > 0.3 seconds. Nevertheless, in accordance with options provided by the ACM0001 methodology, the default value for monitoring the flare efficiency is to be adopted. Please refer to details, below in Section B.6.1.

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

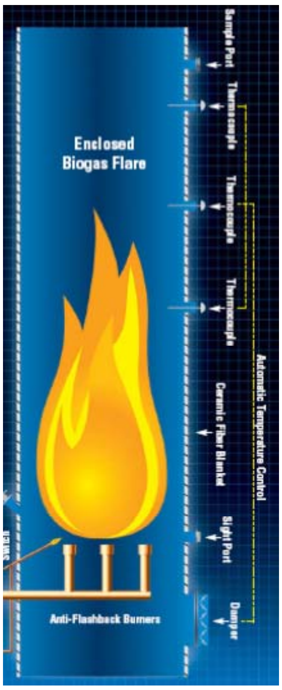

Figure 8. Detail of an Enclosed Flare (Source: John Zink, accessed on January 31st, 2006)

Figure 9. Enclosed Flares, Novo Gramacho Ambiental

There will be installed 3 flares, each with a maximum capacity of 5,000 Nm³/hour and a minimum capacity of 500 Nm³/hour.

5. Upgraded gas pipeline

The upgraded gas will be transported to the injection point through a 6 km pipeline. Within the landfill area the gas will be collected using a *Flex Steel* pipeline. From the landfill border until Petrobras (consumer), a *Carbon Steel* pipeline is to be used. This technology will reduce the environmental impacts produced in a conventional mechanical construction, as it requires the use of fewer machines during its construction.

Despite the fact that LFG projects can be of great potential in Brazil, the local market does not have yet technology for LFG flaring and upgrading. 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. Parties and project participants

Party involved (host) indicates a host Party	Private and/or public entity(ies) project participants (as applicable)	Indicate if the Party involved wishes to be considered as project participant (Yes/No)
Brazil(host)	Public entity - Companhia Municipal de Limpeza Urbana – COMLURB	No
Brazil (host)	Private entity - Novo Gramacho Energia Ambiental S.A.	No

A.5. Public funding of project activity
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There is no public funding from Parties included in Annex I involved in this project activity.

SECTION B. Application of selected approved baseline and monitoring methodology
B.1. Reference of methodology
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Gramacho Landfill Gas Project applies the ACM0001 methodology – "*Flaring or use of landfill gas*" (version 13.0.0) and the following methodological tools:

- "*Project emissions from flaring"* (version 02.0.0)
- "*Tool to calculate baseline, project and/or leakage emissions from electricity consumption"* (version 01)
- *"Tool to calculate the emission factor for an electricity system"* (version 2.2.1).
- "*Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion"* (version 02).
- "*Emissions from solid waste disposal sites"* (version 06.0.1)
- "*Combined tool to identify the baseline scenario and demonstrate additionality"* (version 04.0.0)
- *"Tool to determine the mass flow of a greenhouse gas in a gaseous stream"* (version 02.0.0)
- *"Tool to determine the baseline efficiency of thermal or electric energy generation systems"* (version 01)
- *"Tool to determine the remaining lifetime of equipment"* (version 01)

Please note that *"Tool to determine the baseline efficiency of thermal or electric energy generation* *systems"* and the *"Tool to determine the remaining lifetime of equipment"* are not applicable to the project activity, and therefore are not used.

B.2. Applicability of methodology

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The project complies with the applicability conditions described in the methodology ACM0001 as further detailed below.

This methodology is applicable to project activities which:

- *(a) Install a new LFG capture system in a new or existing SWDS; or*
- *(b) Make an investment into an existing LFG capture system to increase the recovery rate or change the use of the captured LFG, provided that:*
  - *(i) The captured LFG was vented or flared and not used prior to the implementation of the project activity; and*
  - *(ii) In the case of an existing active LFG capture system for which the amount of LFG can not be collected separately from the project system after the implementation of the project activity and its efficiency is not impacted on by the project system: historical data on the amount of LFG capture and flared is available.*
- *(c) Flare the LFG and/or use the captured LFG in any (combination) of the following ways:*
  - *(i) Generating electricity;*
  - *(ii) Generating heat in a boiler, air heater or kiln (brick firing only) or glass melting furnace; and/or*
  - *(iii) Supplying the LFG to consumers through a natural gas distribution network.*
- *(d) Do not reduce the amount of organic waste that would be recycled in the absence of the project activity.*

The project activity will capture the landfill gas which was previously vented prior to the implementation of the project activity in an existing SDWS. LFG flow cannot be currently controlled to avoid free emission to the atmosphere as the existent wells are shallow with less than 4 meters depth and very inefficient even for just venting[4].

The project activity consists of using the captured gas for flaring (as emergency) and upgrading for injection in a natural gas distribution grid. The proposed project activity will process and upgrade biogas from the Gramacho landfill to the quality of natural gas, which will be distributed through the natural gas distribution grid of Petrobras SA (i.e., consumer). The project activity will install the flare system for emergency purposes.

Further, the implementation of the proposed CDM project activity does not reduce the amount of organic waste that would be recycled in the absence of the project activity. There is no recycling system in the region. All the solid waste is disposed in the Gramacho landfill.

The methodology is only applicable if the application of the procedure to identify the baseline scenario confirms that the most plausible baseline scenario is

- *(a) Release of the LFG from the SWDS; and*

[4] For documented evidence please refer to the drawing "*Planta As-Built: Poços de Gás*", made by Novo Gramacho Energia Ambiental on 30/05/2008. Annex 5.

(b) *In the case that the LFG is used in the project activity for generating electricity and/or generating heat in a boiler, air heater, glass melting furnace or kiln;*

(i) *For electricity generation: that electricity would be generated in the grid or in captive fossil fuel fired power plants; and/or*

(ii) *For heat generation: that heat would be generated using fossil fuels in on-site equipment.*

The baseline scenario is the partial or total atmospheric release of the gas (usual practice of the Gramacho Landfill management). Please refer to Section B.4 for details.

This methodology is not applicable:

(a) *In combination with other approved methodologies. For instance, ACM0001 cannot be used to claim emission reductions for the displacement of fossil fuels in a kiln or glass melting furnace, where the purpose of the CDM project activity is to implement energy efficiency measures at a the kiln or glass melting furnace;*

(b) *If the management of the SWDS in the project activity is deliberately changed during the crediting in order to increase methane generation compared to the situation prior to the implementation of the project activity.*

The ACM0001 is applicable to the proposed CDM Project Activity since the Gramacho Landfill Gas Project does not use other CDM approved methodology. In addition, the management of the Gramacho landfill in the project activity is not changed in order to increase methane generation compared to the situation prior to the implementation of the project activity (e.g. other to meet a technical or regulatory requirement). There is neither the addition of liquids to the SWDS and pre-treating waste to seed it with bacteria for the purpose of increasing the anaerobic degradation environment of the SWDS nor changing the shape of the SWDS to increase the Methane Correction Factor.

Besides the ACM0001 methodology applicability conditions, the ones listed in the tools applied must also be assessed. Regarding the *"Tool to determine the mass flow of a greenhouse gas in a gaseous stream"*, the flow and composition of residual or flared gases or exhaust gases are measured for the determination of baseline or project emissions. Therefore, this tool is applicable.

The methodological tool *¨Emissions from solid waste disposal sites"* is applicable as it is used under Application A: *¨The CDM project activity mitigates methane emissions from a specific existing SWDS. Methane emissions are mitigated by capturing and flaring or combusting the methane. The methane is generated from waste disposed in the past, including prior to the start of the CDM project activity. In these cases, the tool is only applied for an ex- ante estimation of emissions in the CDM-PDD. The emissions will then be monitored during the crediting period (e.g. measuring the amount of methane captured from the SWDS).*

The *"Tool to calculate baseline, project and/or leakage emissions from electricity consumption"* is applicable since the project activity consumes electricity from the grid (a source of project emissions). Further, the *"Tool to calculate the emission factor for an electricity system"* is applicable since, as further described below in section B.6.1., off-grid power plants are not considered. Hence, the requirements of Annex 2 of the tool, referring to the applicability conditions that shall be met when this kind of plants are considered, are not applicable. Besides, the Brazilian Electric System is neither partially nor totally located in any Annex-I country.

The methodological tool *"Project emissions from flaring"* is applicable to the flaring of flammable greenhouse gases where:

- *Methane is the component with the highest concentration in the flammable residual gas;*
- *The source of the residual gas is coal mine or gas from biogenic source (e.g. biogas, landfill gas or wastewater treatment gas).*

The flammable residual gas is LFG (gas from biogenic source), which is composed by CH_4, H_2S, CO_2 and N_2, among other components. By default, the methodology adopts that the default fraction of methane in the LFG is 50%. Therefore, it can be assumed that methane is the component with the highest concentration in the LFG. In this sense, both applicability conditions of the tool are met.

The *"Tool to calculate project or leakage CO_2 emissions from fossil fuel"* combustion is applicable for calculating the project CO_2 emissions from the combustion of fossil fuels - *i.e.* diesel generator used for emergency purposes - which are determined based on the quantity of fuel used.

In addition to the tools mentioned above, as required by the methodology ACM0001, the "*Combined tool to identify the baseline scenario and demonstrate additionality"* is used.

B.3. Project boundary

	Source	GHGs	Included?	Justification/Explanation
Baseline scenario	Emissions from decomposition of waste at the SWDS site	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 SWDS. This is conservative
		CO_2	No	CO_2 emissions from decomposition of organic waste are not accounted since the CO_2 is also released under the project activity
	Emissions from electricity generation	CO_2	No	Excluded. Power generation is not included in the project activity
		CH_4	No	Excluded for simplification. This is conservative
		N_2O	No	Excluded for simplification. This is conservative
	Emissions from heat generation	CO_2	No	Excluded. Heat generation is not included in the project activity
		CH_4	No	Excluded for simplification. This is conservative
		N_2O	No	Excluded for simplification. This is conservative
	Emissions from the use of natural gas	CO_2	No	Excluded for simplification. This is conservative
		CH_4	Yes	Major emission source if supply of LFG through a natural gas distribution network is included in the project activity
		N_2O	No	Excluded for simplification. This is conservative
Project scenario	Emissions from fossil fuel consumption for purposes other than electricity generation or transportation due to the project activity	CO_2	Yes	May be an important emission source
		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
	Emissions from electricity consumption due to the project activity	CO_2	Yes	May be an important emission source
		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

According to the ACM0001 methodology the project boundary includes *the site where the LFG is captured* (Gramacho Landfill) *and*:

- *Sites where the LFG is flared or used (e.g. flare, power plant, boiler, air heater, glass melting furnace, kiln or natural gas distribution network);*

In the case of the proposed CDM Project Activity, the sites where the LFG is flared/used consists of the collection system, biogas upgrading facility, pipeline, gas station facilities (including flaring);

- *Captive power plant(s) (including emergency diesel generators) or power generation sources connected to the grid, which are supplying electricity to the project activity;*

All the power generation sources connected to the Brazilian National Grid, once electricity will also be consumed from the grid. On May 26th, 2008, the Brazilian Designated Authority published Resolution #8[5] defining the Brazilian Interconnected Grid as a single system covering all five geographical regions of the country (North, Northeast, South, Southeast and Midwest). Hence, this is the configuration of the national grid that is to be considered.

The figure below is a representation of the project boundary.

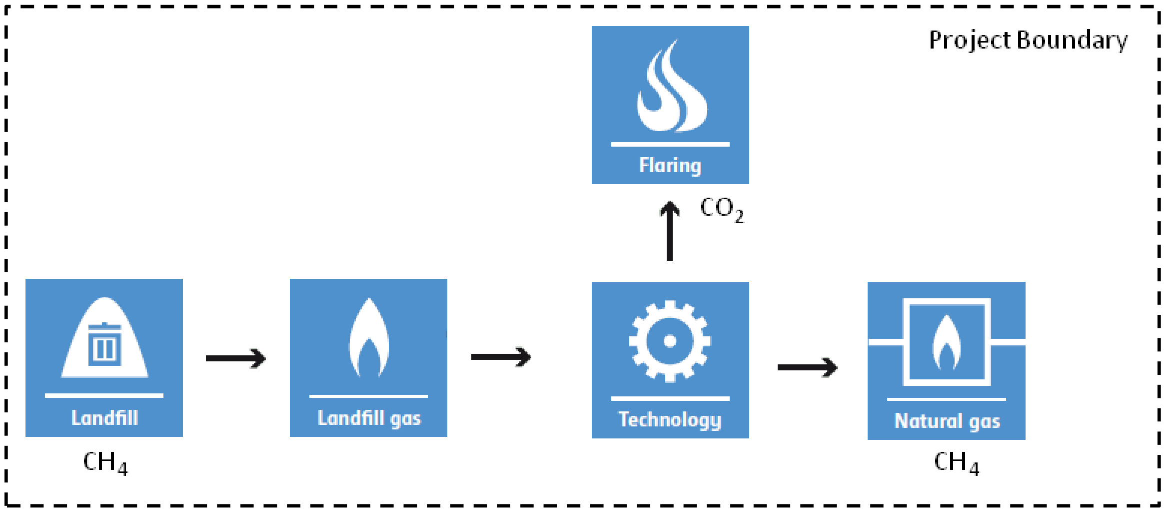

Figure 10 – Simplified diagram of the Project Boundary[6]

B.4. Establishment and description of baseline scenario

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According with ACM0001 the procedures of the latest version of the "*Combined tool to identify the baseline scenario and demonstrate additionality"* is to be applied when selecting the most plausible baseline scenario.

STEP 0: Demonstration that the proposed project activity is the First-of-its-kind

Though the proposed CDM Project Activity is the first of its kind in Brazil applying a different technology to deliver natural gas (i.e., by upgrading the LFG), the "*Guidelines on additionality of first-of-its-kind project activities*" is not used since project participants selected a renewable crediting period.

STEP 1: Identification of alternative scenarios.

The realistic and credible alternatives scenarios to the proposed CDM Project Activity were identified following the recommendations of the "*Combined Tool for the demonstration and assessment of additionality"* and ACM0001 methodology.

[5] Comissão Interministerial de Mudança Global do Clima (CIMGC). Available at: <http://www.mct.gov.br/upd_blob/0024/24719.pdf>.

[6] Some of the icons used to illustrate the project boundary were adapted from the CDM Methodology Booklet available at http://cdm.unfccc.int/methodologies/documentation/meth_booklet.pdf

Step 1a: Define alternative scenarios to the proposed CDM 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 consists of capture the LFG and supplying it to consumers, the following alternatives are identified for the destruction of the LFG in the absence of the project activity:

- *LFG1*: Project Activity undertaken without being registered as a CDM Project Activity (capture, flare and use of LFG),
- *LFG2*: Continuation of the landfill operation, continuation of atmospheric release of the landfill gas (Business as Usual – BAU scenario) or partial capture of landfill gas and destruction trough flaring to comply with regulations or contractual requirements, or to address safety and odour concerns;
- *LFG3*: LFG is partially not generated because part of the organic fraction of the solid waste is recycled and not disposed in the SWDS;
- *LFG4*: LFG is partially not generated because part of the organic fraction of the solid waste is treated aerobically and not disposed in the SWDS;
- *LFG5*: LFG is partially not generated because part of the organic fraction of the solid waste is incinerated and not disposed in the SWDS.

In addition to the scenarios presented above, for the supply of LFG to a natural gas distribution network, the baseline is assumed to be the supply with natural gas, as indicated in the methodology.

Once the proposed CDM Project Activity does not foresee either the production of heat or electricity, no Scenarios for those components are applicable.

Step 1b: Consistency with mandatory laws and regulations

In Brazil, there are no policies regarding mandatory LFG capture or destruction requirements neither local environmental regulations nor policies which promote the productive use of LFG such as those for the production of renewable energy and processing of organic waste.

In the beginning of 2010, the *Política Nacional de Resíduos Sólidos* (National Solid Waste Policy), under discussion since 2000, was approved. One of the scopes of this policy is to enforce the adequate environmental final destination of the solid waste. However, the Policy does not foreseen either the obligation of landfill gas destruction or the promotion of the landfill gas use such as those for the production of renewable energy and processing of organic waste[7].

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. The calls for PROINFA were closed in 2003, before the beginning of the Gramacho Landfill Gas Project's operation and investment decision.

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

7 PROJETO DE LEI - Institui a Política Nacional de Resíduos Sólidos e dá outras providências; Available at http://www.camara.gov.br/sileg/integras/501911.pdf, accessed on 10/04/2010.

Alternative	Compliance with Local / National Policies	Observations
LFG1: Project Activity undertaken without being registered as a CDM Project Activity	Yes	---
LFG2: Continuation of the landfill operation, continuation of atmospheric release of the landfill gas (Business as Usual – BAU scenario) or partial capture of landfill gas and destruction trough flaring to comply with regulations or contractual requirements, or to address safety and odour concerns;	Yes	▪ 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. As stated before, there is no current law or contractual requirements to capture/destroy/use the LFG.
LFG3: LFG is partially not generated because part of the organic fraction of the solid waste is recycled and not disposed in the SWDS	Yes	▪ There is no law which restricts the use of the organic fraction of the waste to be recycled and not disposed in the SWDS
LFG4: LFG is partially not generated because part of the organic fraction of the solid waste is treated aerobically and not disposed in the SWDS;	Yes	▪ There is no law which restricts the use of the organic fraction of the waste to be treated aerobically and not disposed in the SWDS
LFG5: LFG is partially not generated because part of the organic fraction of the solid waste is incinerated and not disposed in the SWDS.	Yes	▪ There is no law which restricts the incineration of organic wastes in Brazil

Concerning the supply of LFG to a natural gas distribution network, as explained above, the baseline scenario is assumed to be the supply of natural gas. In the same as mentioned above for the LFG related scenarios, there are no mandatory policies and/or regulations in the country enforcing the supply of natural gas.

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

STEP 2: Barrier analysis

Step 2a. Identify barriers that would prevent the implementation of alternative scenarios

The proposed use of LFG from the Gramacho Landfill Gas Project will be the first of its 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 the upgrading of the LFG and its injection into a natural gas distribution grid.

- *Barriers due to prevailing practice:*

According to the latest official statistics on urban solid waste in Brazil – *Pesquisa Nacional de Saneamento Básico 2008* (PNSB 2008) – the country produces 259,547 tons of waste per 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 or controlled landfills 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 2008.

Table 1 - Daily amount of urban solid waste collected/received, by final destination unit and according with the size and population of the Districts - 2008

Districts according to size (population)	Daily amount of urban solid waste collected/received in t/day								
	Total	Units of collected waste final destination							
		Open Dump	Open dumps in Flooded Areas	Controlled Landfill	Sanitary Landfill	Composting	Recycling	Incineration	Other
Brazil	*259,547*	*45,710 (17.6%)*	*46 (0.02%)*	*40,695 (15.7%)*	*167,636 (64.6%)*	*1,635 (0.62%)*	*3,122 (1.2%)*	*67 (0.02%)*	*636*
<50,000 inhabitatns	*65,762*	*32,247*	*39*	*10,354*	*20,995*	*468*	*1,179*	*29*	*451*
50,000-100,000 inhabitants	*31,181*	*8,264*	*4*	*4,251*	*18,078*	*115*	*419*	*10*	*40*
100,000-300,000	*55,946*	*3,207*	*3*	*6,886*	*44,851*	*268*	*962*	*3*	*36*
300,000-500,000	*35,609*	*780*	*-*	*6,667*	*27,754*	*253*	*135*	*5*	*15*
500,000-1,000,000	*21,577*	*1,200*	*-*	*4,636*	*15,443*	*-*	*291*	*3*	*4*
>1,000,000	*49,472*	*12*	*-*	*7,901*	*40,515*	*531*	*406*	*17*	*90*

Source: IBGE, Diretoria de Pesquisas, Departamento de População e Indicadores Sociais, Pesquisa Nacional de Saneamento Básico 2008.
Note: This table was adapted from the original table from PNSB2008

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 Brazil Low Carbon Study, published by the World Bank in 2010[8], evaluated the actual practices of the waste sector in Brazil. This report confirms the information presented above since it states that "*Brazil possesses only two sanitary landfills which use biogas CH4 for burning and energy generation. The most common practice at present is to allow the gas to escape directly into the atmosphere through collector drains*".

The landfills which have implemented a system for gas collection and flaring were undertaken only under the CDM and none of them have been implemented concerning the injection of upgraded biogas in a natural gas distribution grid. Moreover, the current practice is the injection of natural gas in natural gas

[8] THE WORLD BANK. ***Brazil Low Carbon Study: Technical Synthesis Report – Waste***. 2010. Document available at http://www.cetesb.sp.gov.br/proclima/eventos-proclima/269-

grids. Detailed information regarding operational landfills in the country with a forced LFG collection system is presented below in the Common Practice analysis section.

The existing landfills operate with passive emission of methane to the atmosphere, as controlled landfill gas collection and destruction is neither mandated by laws/regulations nor by local environmental regulations and GHG emission reduction policies. The most relevant law of the sector is Brazil's new National Solid Waste Policy (http://www.planalto.gov.br/ccivil_03/_ato2007-2010/2010/lei/l12305.htm), ratified by the President on 02/08/2010 after 19 years under discussion, which does not requires the LFG to be captured and/or flared.

Step 2 b. Eliminate alternative scenarios which are prevented by the identified barriers

Alternative	Barriers due to prevailing practice
LFG1: 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.
LFG2: Continuation of the landfill operation, continuation of atmospheric release of the landfill gas or partial capture of landfill gas and destruction trough flaring to comply with regulations or contractual requirements, or to address safety and odour concerns;	This barrier does not prevent the implementation of this alternative, as it is the business as usual scenario (please refer to Sub-Step 2 a).
LFG3 is partially not generated because part of the organic fraction of the solid waste is recycled and not disposed in the SWDS	Considering the actual situation of waste disposal in Brazil this barrier prevents the implementation of this alternative; only 1.2% of the waste generated in Brazil is recycled. Thus, this alternative would face a prevailing practice barrier.
LFG4 LFG is partially not generated because part of the organic fraction of the solid waste is treated aerobically and not disposed in the SWDS	Considering the actual situation of waste disposal in Brazil this barrier prevents the implementation of this alternative; only 0.62% of the waste generated in Brazil is sent to composting. Thus, this alternative would face a prevailing practice barrier.
LFG5 LFG is partially not generated because part of the organic fraction of the solid waste is incinerated and not disposed in the SWDS.	Considering the actual situation of waste disposal in Brazil this barrier prevents the implementation of this alternative; only 0.02% of the waste generated in Brazil is incinerated. Thus, this alternative would face a prevailing practice barrier.

As presented in the table above, the prevailing practice barrier would prevent the implementation of all alternatives, except for the release of the methane generated to the atmosphere, BAU scenario. Therefore LFG2 is considered as the baseline scenario.

CDM incentives will help alleviate the barriers identified for the proposed project above and also the investment barrier (Please refer to Step 3 below).

STEP 3: Investment analysis

In July, 2007, Novo Gramacho Ambiental S.A. and COMLURB agreed on the concession Contract which granted Novo Gramacho Ambiental S.A. the rights to implement the proposed CDM Project Activity. Although the contract clearly described that the company could sell CERs and supply LFG for final consumers, it did not obliged the implementation of the project as described in this PDD.

Since then the project is being developed to consider both the CDM revenues and the supply of LFG. Please refer to the project's timeline presented below in section C.1.1. for details. The first significant commitment towards the implementation of the project was made on 12/12/2008 (first start date). Nevertheless, the first design of the project was changed in 30/12/2009 (second start date) resulting in the final configuration as presented throughout this document. Therefore, both investment analyses will be taken into consideration while assessing the additionality of the project.

The financial indicator identified for the project activity is the Project's Internal Rate of Return (IRR). The IRR of the project without CDM revenues has been compared to the appropriate benchmark of the sector, which is the Weighted Average Cost of Capital (WACC).

Weighted Average Cost of Capital (WACC)

The weighted-average cost of capital (WACC) is a rate used to discount business cash flows and takes into consideration the cost of debt and the cost of equity of a typical investor in the sector of the project activity. The benchmark can be applied to the cash flow of the project as a discount rate when calculating the net present value (NPV) of the same, or simply by comparing its value to the internal rate of return (IRR) of the project (in accordance with paragraph 12, Annex 5, EB 62). The WACC considers that shareholders expect compensation towards the projected risk of investing resources in a specific sector or industry in a particular country.

The WACC calculation is based on parameters that are standard in the market, considers the specific characteristics of the project type, and is not linked to the subjective profitability expectation or risk profile of this particular project developer. This is due the fact that any corporate entity would be able to obtain the public concession to implement that project. Therefore, the use a sectoral benchmark is applicable as per the guidance provided in paragraph 13, Annex 5, EB62.

The WACC of the sector considered are the ones calculated for 2008 and 2009 – *i.e.* first and second investment decision dates – and are equal to 18.97% and 15.80%, respectively. These values were calculated through the formula below:

$$WACC = Wd \times Kd + We \times Ke$$

We and **Wd** are, respectively, the weights of equity and debt typically observed at the sector. Nevertheless, this information is not readily available for similar project being developed in Brazil. Then, in accordance with the "*Guidelines on the assessment of investment analysis*" (paragraph 18, Annex 5, EB62), 50% debt (**Wd**) and 50% (**We**) equity are assumed as a default value.

Kd is the cost of debt, which is observed in the market related to the project activity, and which already accounts for the tax benefits of contracting debts. In the **Kd** calculation, the marginal tax rate (**t**) is multiplied by the Cost of debt and then by the debt to total cost of capital ratio to ascertain the debt portion of the WACC formula. In the case of Brazil, this tax factor could either be 34% (actual profit) or 0% (presumed profit). This is decided by the specific type of project and tax regime under which it sits. For the Presumed Profit eligibility, corporate entities revenues must be under Forty eight million Reais per year (Article #13, Law #9.718/1998)[9]. In the case of the proposed project activity, the 0% tax factor applies for the first investment decision and the 34% tax factor applies for the second investment decision.

The nominal rate achieved for debt is used to calculate nominal WACC, which is used to discount nominal cash flow projections. In order to achieve the nominal cash flow rate in *Reais* (BRL), the inflation targeting figure (d) for Brazil is reduced from the nominal figure achieved. The (d) is obtained from the Brazilian Central Bank (www.bcb.gov.br) and has experienced very little variance in the past 5 years.

Kd is calculated through the following equation:

$$Kd = [1 + (a+b+c) \times (1-t)]/(1+d) - 1$$

Values used in the cost of debt calculation are presented in Table 2 below.

Table 2 – Cost of debt (Kd) calculation

Cost of Debt (Kd)	**2008**	**2009**
(a) Financial cost[10]	8.54%	8.01%
(b) BNDES Spread[11]	0.90%	0.90%
(c) Credit Risk Rate[12]	3.57%	3.57%
(a+b+c) Pre-Cost of Debt	13.01%	12.48%
(t) Marginal tax rate[13]	0%	34.00%
(d) Inflation forecast[14]	4.50%	4.50%
After tax Cost of Debt	13.01%p.a.	8.24%p.a.

According to the table above, **Kd** is of 13.01% for 2008 and 8.24% for 2009.

Ke is the cost of equity. As per option b) provided in the paragraph 15 of Annex5, EB62, it was estimated using the best financial practices through the Capital Asset Pricing Model - CAPM (mentioned as an appropriate method to determine benchmarks in guidance 14, Annex 5, EB62). This method considers the risk associated in investing in the Brazil.

The following equation is used to calculate the **Ke**:

$$Ke = [(1+Rf)/(1+\pi')-1] + \beta \times (Rm-Rf) + Rc$$

Rf stands for the risk free rate. The risk-free rate used for **Ke** calculation was a long term bond rate. This bond was issued by the US government. In order to adjust the risk-free rate (**Rf**) to the inflation adjusted rate, the expected inflation rate (for the United States) (**π'**) is reduced. The inflation is calculated based on the treasury through spot TIPS (Treasury Inflation Protected Securities) which are readily quoted in the market.

Beta, or **β,** stands for the average sensitivity of comparable companies in that industry to movements in the underlying market. **β** derives from the correlation between returns of US companies from the sector and

[9] Publicly available in Portuguese at http://www.receita.fazenda.gov.br/legislacao/leis/Ant2001/lei971898.htm.

[10] http://www.bndes.gov.br/SiteBNDES/bndes/bndes_pt/Institucional/Apoio_Financeiro/Custos_Financeiros/Taxa_de_Juros_de_Longo_Prazo_TJLP/index.html

[11] http://www.bndes.gov.br/SiteBNDES/export/sites/default/bndes_pt/Galerias/Arquivos/conhecimento/bnset/Set2901.pdf

[12] http://www.bndes.gov.br/SiteBNDES/export/sites/default/bndes_pt/Galerias/Arquivos/conhecimento/bnset/Set2901.pdf

[13] http://www.receita.fazenda.gov.br/Aliquotas/ContribCsll/Aliquotas.htm http://www.receita.fazenda.gov.br/Aliquotas/ContribPj.htm

[14] http://www.bcb.gov.br/pec/metas/InflationTargetingTable.pdf

the performance of the returns of the US market. **β** has been adjusted to the leverage of Brazilian companies in the sector, reflecting both structural and financial risks. **β** adjusts the market premium to the sector.

(Rm–Rf) represents the market premium, or higher return, expected by market participants in light of historical spreads attained from investing in equities versus risk free assets such as government bond rates, investors require a higher return when investing in private companies. The market premium is estimated based on the historical difference between the S&P 500 returns and the long term US bonds returns. The spread over the risk-free rate is the average of the difference between those returns.

Note that in the formula above there is the factor EMBI+ (Emerging Markets Bond Index Plus), considers as the country risk premium, **Rc**. This factor accounts for the country or sovereign risk embedded in the debt of a country. Assuming that relative to the US risk-free debt market EMBI+ is 0, then Brazil's EMBI+ would calculate for the added or reduced risk relative of Brazils debt markets to the US.

Justification for the EMBI+ addition to the risk-free rate lies in the vast differences between the United States in such factors as credit risk, inflation history, politics, debt markets, and more. Ignoring these differences would result in the incorrect application of relevant environmental factors in the decision-making process of an investor in Brazil.

Values used in the cost of equity calculation are presented in Table 3 below.

Table 3 – Cost of equity (Ke) calculation

Cost of Equity (Ke) – CAPM	2008	2009
(Rf) Risk-free rate[15]	4.64%	4.28%
(Rm) Equity risk premium[16]	6.20%	6.20%
(Rc) Estimated country risk premium[17]	3.62%	3.33%
(β) Adjusted industry beta[18]	2.26%	1.87%
(π') US expected inflation[19]	2.26%	0.99%
Cost of Equity with Brazilian Country Risk (p.a.)	24.92%p.a.	23.35%

According to the table above, Ke is of 24.92% for 2008 and 23.35% for 2009. Plugging these numbers into WACC formulae we obtain:

For 2008:

$$WACC_{2008} = 50\% \times 13.01\% + 50\% \times 24.92\% = 18.97\%$$

For 2009:

$$WACC_{2009} = 50\% \times 8.24\% + 50\% \times 23.35\% = 15.80\%$$

Each assumption made and all data used to estimate the benchmark has been presented to the DOE. The spreadsheet used for calculation of the WACC is available with the Project Participants and has also been

[15] http://pages.stern.nyu.edu/~adamodar/
[16] http://pages.stern.nyu.edu/~adamodar/
[17] http://www.cbonds.info/all/eng/index/index_detail/group_id/1/
[18] http://pages.stern.nyu.edu/~adamodar/
[19] http://www.federalreserve.gov/econresdata/researchdata.htm

provided to the DOE. For complete reference of the data used to estimate the benchmark please refer to this spreadsheet, which is also attached to this PDD.

Financial Indicator, Internal rate of return (IRR)

As mentioned above, there are two different investment decision dates for the proposed project activity. Both IRR calculations, referring to 2008 and 2009, were made considering a 15-years period (as per the contract signed between COMLURB and Novo Gramacho Energia Ambiental S.A.) from the point of emission of the "*Termo de Encerramento da Etapa de Operação do Aterro*" (term of landfill's closure). The analysis related to the reformulated project design (2009) also considers five years of construction. This term is in line with the guidance of paragraph 3, Annex 5, EB62.

Additionally, both investment analyses considered revenues and costs foreseen in the concession contract agreed between Novo Gramacho and COMLURB in 2007, such as fixed concession expenses, "catadores" fund costs, landfill operational costs and income from landfill operation.

The main subject of the concession contract is to grant to a private entity the rights to explore the LFG of Gramacho Landfill, or rather, to implement the CDM project (Second clause of the concession contract). The conditions set out in the contract are the same that were made publicly available in the public announcement related to the concession.

Therefore, all of the companies that participated on the tender aiming at getting the authorization to implement the CDM project were aware of all of the possible revenues, even if they were not directly connected to the implementation of the CDM Project. In other words, it was not possible to implement the CDM Project without assuming all the costs transferred by the public entity (the municipality) to the CDM project developer and explicitly disclosed in the concession contract.

The concession contract explicitly states that COMLURB will reimburse Novo Gramacho for those expenses related to the operation of the landfill, thus representing a revenue (Clause 6.2 of the concession contract). In the same way, with regards to the mentioned costs, the concession contract explicitly states private entity wining the concession will be responsible for the following costs: SWDS operational costs, before and after its closure (Clause 2.1 of the concession contract), fixed concession costs which are due to the concession (Clause 7.1 of the concession contract) and "Catadores" fund costs (Clause 7.2 of the concession contract).

On the starting date of the proposed project activity the project sponsors were aware of all of these costs and revenues and thus, their consideration in the investment analyses are reasonable and are in accordance with Guidance 6 from Annex 5, EB62 where it is recommended that "*input values used in all investment analysis should be valid and applicable at the time of the investment decision taken by the project participant*".

The investment analysis related to the first investment decision was presented in the first submission for registration of the proposed as a CDM Project Activity. At that time, the calculated Project IRR was of 11.89% (in nominal terms). In line with paragraph 4, Annex 5, EB62, the fair value, which had not been considered during the first validation of the proposed project activity, was included in the calculation of the Project IRR. The result is that the IRR of the project at the first investment decision was of 11.97%. A copy of the IRR calculation spreadsheet presented in the first submission is below. This result is below the 2008 benchmark calculated above.

	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
DEPRECIATION																
Depreciation		-2.1678	-4.3123	-5.1966	-5.1966	-5.1966	-5.1966	-5.1966	-5.1966	-5.1966	-5.1966	-5.1966	-5.1966	-5.1966	-5.1966	-5.1966
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	-0.4526	-0.4378	-0.4251	-0.4140	-0.4042	-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	2.8582	2.1975	1.5745	0.9711	0.3746	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
Fair Value																3.9131
Activity's Cash-Flow	0.0000	22.7908	17.4071	14.3850	12.2646	10.5303	7.6919	5.5938	4.5952	3.7732	2.9301	2.2538	1.6275	1.0223	0.4251	8.2943
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	2.9301	2.2538	1.6275	1.0223	0.4251	8.2943
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	1.8045	1.3282	0.9178	0.5517	0.2195	4.0988
PROJECT IRR - Nom	11.97%															

Nevertheless, the project was reformulated (change in the consumer of the biogas and inclusion of the LFG upgrading facility). In this sense, the project IRR of the second investment decision (2009) has been calculated as a ¨consolidated IRR¨, considering the investment analyses of the two companies: ¨Gas Verde S.A.¨ and Novo Gramacho Energia Ambiental S.A.¨.

Gas Verde is the company which upgrades the LFG, sells the upgraded gas to Petrobras and purchases the LFG from Novo Gramacho, while Novo Gramacho Energia Ambiental is in charge of the collection of the LFG and sells the LFG to Gas Verde.

At the beginning of the project only one company would perform both activities, however, the management decided to divide the activities into two companies one of them aiming at managing the concession contract signed with COMLURB (Novo Gramacho) and the other to deal with the contract agreed with the upgraded biogas consumer (Petrobras).

Novo Gramacho and Gas Verde are sister companies (same shareholders and same % of the capital stock).

Based on their corporate strategy, the three shareholders (Biogas/JMalucelli/Synthesis) decided to create in September 2009 a separate company named Gas Verde S.A for the specific purpose of investing in and operating the LFG Purification Plant. Gas Verde was thereafter entitled to sign in January 2010 the gas supply contract with Petrobras.

The business structure can be summarized therefore as follows:

- Novo Gramacho - responsible for operation of the landfill and exploitation of the LFG produced by the waste biodegradation. The company is also responsible for investments in gas wells, pipeline and gas plant, including flares. The company's revenue derives from the temporary waste disposal operation, sale of CERs and sale of raw LFG to Gas Verde.
- Gas Verde – responsible for processing the gas purification and its delivery to Petrobras site (REDUC) by a dedicate pipeline. The company is responsible for all investments related to the purification plant, including electrical system, infrastructure, support facilities and the dedicated pipeline. The company’s revenue will derive from the signed Petrobras sale contract, sale of CERs and future sale of CO_2 liquid.

The following input values have been considered in the second investment analysis:

Table 4 – Investment analysis main input parameters.

Novo Gramacho Energia Ambiental S.A.		
PARAMETER	VALUE (1,000,000R$)	SOURCE
CAPEX	131.83R$	Based on audited financial statements and estimative from the amount of waste as informed by a third company (FRAL) and the expenses of the previous years.
Operational costs:		
-O&M gas extraction	1.74R$/MBTU	Estimated based on previous shareholders experience in LFG recovery projects (São João landfill project)
-Fixed concession costs	0.60R$/year	Clause 7.1 of the Concession Contract between Novo Gramacho and COMLURB dated 05/07/07
-¨Catadores¨ fund costs	1.20R$/year	Clause 7.2 of the Concession Contract between Novo Gramacho and COMLURB dated 05/07/07
-Landfill operational costs (average until 2012)	12.70R$/year	From the audited financial statements of the company.
-Landfill operational costs (from 2012)	3.99 R$/year	Estimated based on previous shareholders experience in LFG recovery projects
Administrative Expenses	1.02R$/year	Administrative expenses as of November, 2009. Cross checked using the audited financial statements
Revenues:		
-sale of LFG to Gas Verde	9.28R$/MBTU	Contract between Gas Verde and Novo Gramacho.
-landfill operation	12.99R$/year	Clause 6.2 of the Concession Contract between Novo Gramacho and COMLURB dated 05/07/07
Depreciation	6.67%	From the audited financial statements of the company.
Taxes:		
-ICMS	12% (over gas sales	ICMS Accord nº 112/1989 and Art. 27 from Book IV of RICMS-RJ/2000, available at http://www.idealsoftwares.com.br/tabelas/aliquotas_rj.html

	revenues)	
-PIS	1.65% (over total revenues)	Law nº 10.637/2002, available at http://www.portaltributario.com.br/tributos/pis.htm)
-Cofins	7.60% (over total revenues)	Law nº 10.833/03, available at http://www.receita.fazenda.gov.br/legislacao/leis/2003/lei10833.htm
-ISS	5% (over revenues from landfill operation)	Complementary Law nº 116, dated July 31st, 2003, available at http://www.portaltributario.com.br/legislacao/lc116.htm
-Income and social contribution tax	34%	Law nº. 9 249/95, available at http://www.receita.fazenda.gov.br/legislacao/leis/ant2001/lei924995.htm KPMG. *Investment in Brazil: tax.* São Paulo: Escrituras Editora, 2008. Publicly available in English at http://www.kpmg.com.br/publicacoes/livros_tecnicos/Investment_in_Brazil10_out08.pdf)

Gas Verde S.A.		
PARAMETER	VALUE	SOURCE
CAPEX	98.21 R$	Enerconsult S.A. (third party) budget
Operating costs:		
-O&M and Gas compression	4.79R$/MBTU	Based on the Suppliers information (VAN DER WIEL) on similar projects.
-LFG purchase (from Novo Gramacho)	9.28R$/MBTU	Contract between Gas Verde and Novo Gramacho.
-CO_2 liquid production	42.10R$/ton	Estimation from GPC Química, a company that have implemented a similar project.
Administrative Expenses	1.96R$/year	Estimated based on previous shareholders experience in LFG recovery projects (São João landfill project)
Revenues:		
-Upgraded gas (as of 2012)	35.18R$/MBTU	Contract with Petrobras signed 30/12/2009
-Liquid CO_2	160.00R$/ton	Quotation from Carbo Gás Ltda dated 18/05/2009
Depreciation	6.67%	From the audited financial statements of similar project owned by the PPs.
Taxes:		
-Income tax	34%	Law nº. 9 249/95, available at http://www.receita.fazenda.gov.br/legislacao/leis/ant2001/lei924995.htm KPMG. *Investment in Brazil: tax.* São Paulo: Escrituras Editora, 2008. Publicly available in English at http://www.kpmg.com.br/publicacoes/livros_tecnicos/Investment_in_Brazil10_out08.pdf
-ICMS	12%	ICMS Accord nº 112/1989 and Art. 27 from Book IV of RICMS-RJ/2000, available at http://www.idealsoftwares.com.br/tabelas/aliquotas_rj.html. The tax was applied to the difference between

		revenues and costs related to the upgraded LFG sales in order to account for the credit already paid by Novo Gramacho. The ICMS related to the liquid $CO_2$is of 19%. Reference to this value are: Decree 27 427/2000 (http://www.legiscenter.com.br/minha_conta/bj_plus/direito_tributario/atos_legais_estaduais/rio_de_janeiro/decretos/2000/22d27427_doerj112000.htm) and Decree 32 646/2003 (http://www.jusbrasil.com.br/legislacao/140756/decreto-32646-03-rio-de-janeiro-rj).
-PIS	1.65%	Law nº 10.637/2002, available at http://www.portaltributario.com.br/tributos/pis.htm). The tax was applied to the difference between revenues and costs related to the upgraded LFG sales in order to account for the credit already paid by Novo Gramacho.
-Cofins	7.60%	Law nº 10.833/03, available at http://www.receita.fazenda.gov.br/legislacao/leis/2003/lei10833.htm. The tax was applied to the difference between revenues and costs related to the upgraded LFG sales in order to account for the credit already paid by Novo Gramacho.
Volume of upgraded LFG	Variable for each year	SCS Engineering Report presenting the expected LFG generation by the project. The mid-range curve is used as per the recommendation of SCS.
Volume of LFG needed to generate 1MBTU	65.82Nm^3	Calculated based on data from Contract with Petrobras and plant specifications

Concerning the first investment decision, the calculated Project IRR is of 12.50%. Regarding the consolidated IRR (considering inflation) for the second investment decision, the result is 10.83%. Both results are lower than their respective benchmarks as presented in the table below, clearly showing that the proposed project have always needed the CDM revenues in order to overcome its financial unattractiveness.

Table 5 – Investment analysis results.

	WACC	*Project IRR*
First investment decision (2008)	18.97%	12.50%
Second investment decision (2009)	15.80%	10.83%

Sensitivity analysis:

A sensitivity analysis was conducted by altering the following parameters:

- Increase in project revenues by altering the following parameter:
  - Volume of LFG, and
  - Price of the biogas sold to Petrobras;
- Reduction in the costs of LFG purchase form Nova Gramacho by Gás Verde;
- Reduction in Novo Gramacho O&M costs: Gas O&M costs and Landfill operational costs
- Reduction in expected investments (CAPEX) both of Novo Gramacho and Gas Verde;

Those parameters were selected as being the most likely to fluctuate over time. In addition, these variables constitute more than 20% of either total project costs or total project revenues (paragraph 20 of Annex 5, EB62). Financial analyses were performed altering each of these parameters by 10%, and assessing what was the impact on project's IRR (paragraph 21 of Annex 5, EB61). The results of the sensitivity analysis, considering a variation of the selected parameters by 10%, are presented in the below table.

Table 6 – Sensitivity analysis results

Parameters		**Variation (%)**	**Consolidated IRR (%)**
Original IRR		**-**	**10.83**
Revenues	*Volume of LFG*	+10	12.71
	Price of biogas sold to Petrobras	+10	12.98
Costs from the purchase of LFG		-10	10.83
O&M costs	*Gas O&M costs*	-10	10.95
	Landfill operational costs	-10	11.45
CAPEX	*Novo Gramacho*	-10	11.73
	Gas Verde	-10	11.44

For all the cases, the consolidated IRR remains below the benchmark, evidencing that project activity is not financially attractive to investor.

Regarding the costs from the purchase of LFG, the price considered in the analysis is taken from the contract agreed between NGEA and GVSA. During the term of the contract, the agreed price is to be adjusted proportionally to the variation observed in the upgraded price sold to Petrobras. Nevertheless, the cash-flow of the proposed project activity has been calculated in nominal terms and the variations in the price of the LFG which is connected to the increase in the upgraded LFG price were already considered in the investment analysis.

Moreover, a consolidated IRR has been calculated, considering the cash flows of the two companies. In this sense, there would not be a significant variation in the IRR of the project since a reduction in the revenues of Novo Gramacho due to the decrease in the price of the LFG purchased by Gas Verde would be compensated by the increase in the Gas Verde profit. In this sense, the IRR is not subjected to variations due to a decrease in the cost from the purchase of LFG, since any variation has a neutral effect in the consolidated Project IRR.

Also, the IRR of the projects is not significantly modified when the O&M costs vary. Even when O&M costs are disregarded, the IRR remains below the benchmark (Table 7).

Table 7 – Project IRR when O&M costs are disregarded.

Parameter		**IRR (%)**
O&M costs	*Gas O&M costs*	12.03
	*Landfill operational costs**	15.04

** 2007, 2008 and 2009 Landfill operational costs were not altered since the values considered consists of the actual expenses, thus, are not subjected to further changes.*

With respect to O&M costs, the following shall also be considered:

– Gas O&M costs: These costs were based on the Project sponsor experience in another landfill located in Brazil (São João landfill). The estimated O&M costs were based in an index calculated from the operational expenses registered in São João landfill. The index remains constant from 2009 up to 2011, showing that no significant variations can be expected. Further, the Gramacho landfill is bigger than São João landfill. The LFG collection system of these two sites is different. Moreover, São João landfill was planned since its beginning to be a SWDS. On the contrary, Gramacho landfill has been reformulated throughout the year to operate as a SWDS. Hence, it is reasonable to assume that the Gramacho landfill system is more complex than the São João LFG collection system. This assumption can be made since the collection of the leachate was not planned and influences the LFG generation by the SWDS (the more leachate the less LFG is produced). Also, the size of both SWDS is different. While Gramacho landfill area is of 148ha, São João area is of 80ha. In this sense, Gramacho landfill has more wells and pipelines to collect the LFG than São João landfill. Therefore, the management of the gas collection system is more costly. Thus, it is expected that expenses related to the O&M costs are even higher and a decrease in the operational cost is not expected.

– Landfill operational costs: until 2008, the values presented in the IRR calculation spreadsheet consists of the actual operational costs registered by the project sponsor. Data from 2009 was taken from the accounting reports of the company (as of November, 2009) and confirmed with the audited balance sheet issued in 2010. From 2010 on, the estimative was done considering the costs previously observed adjusted by the inflation. If the values estimated for the years 2010 and 2011 are compared against the actual expenses, it can be seen that the actual values are on average 10% lower than the projections. In fact, as demonstrated above, even when the projected costs for 2010 on are disregarded the Project IRR does not surpass the benchmark.

Further, a simulation was conducted in order to verify possible scenarios where the IRR would equal the benchmark for the other parameters – revenues and CAPEX – as presented in Table 8.

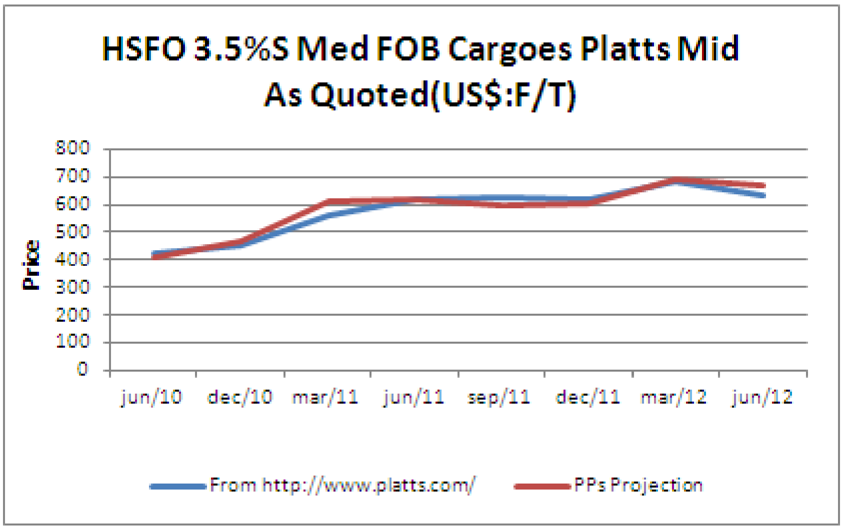
Table 8 – Variation of the selected parameters so the Project IRR equals the WACC (15.80%).

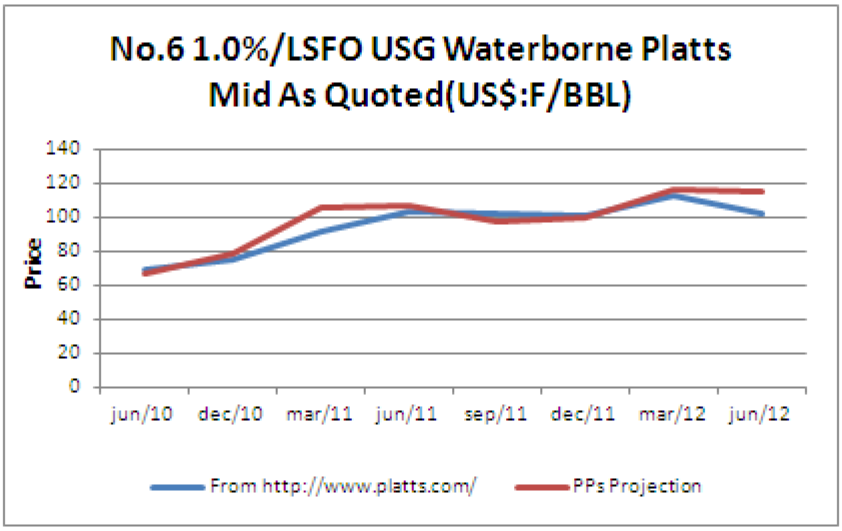
Parameter		**Variation so the IRR equals the WACC (%)**
Revenues	*Volume of LFG*	28.00
	Price of biogas sold to Petrobras	24.35
CAPEX	*Novo Gramacho*	44.90
	Gas Verde	70.60

Nevertheless, the variations in the values used in the analysis so that the IRR could surpass the benchmark, as presented in the table above, are not expected to occur because of the following:

i. <u>*Volume of LFG:*</u> the volume of LFG estimated by SCS is conservative. An updated study conducted on February 12th, 2012 by SCS showed that the generation of LFG will be lower than the one previously estimated. The latest study considered two different scenarios: the most likely scenario is the one in which the collection efficiency would be equal to 65%; and the optimistic scenario in which the collection efficiency of the LFG would higher and equivalent to 75%. When the result of both studies is compared, is can be observed a decrease in the estimative by 20% on average. The latest version of the SCS Report was supplied to the DOE.

ii. <u>*Price of biogas sold to Petrobras:*</u> The price of upgraded LFG to be sold to Petrobras is set out in the contract, but is also linked to variations in three different oil prices (3,5% FOB MED BASIS, 1,0% FOB US Golf and 1,0% FOB NWE). By the time of the investment decision, Project Participants estimated the future oil prices. An updated source was checked in order to confirm these estimative made by the PPs. The result is that the projections made by the PPs are consistent with the prices observed (Figure 11). Hence, significant variations are not expected.





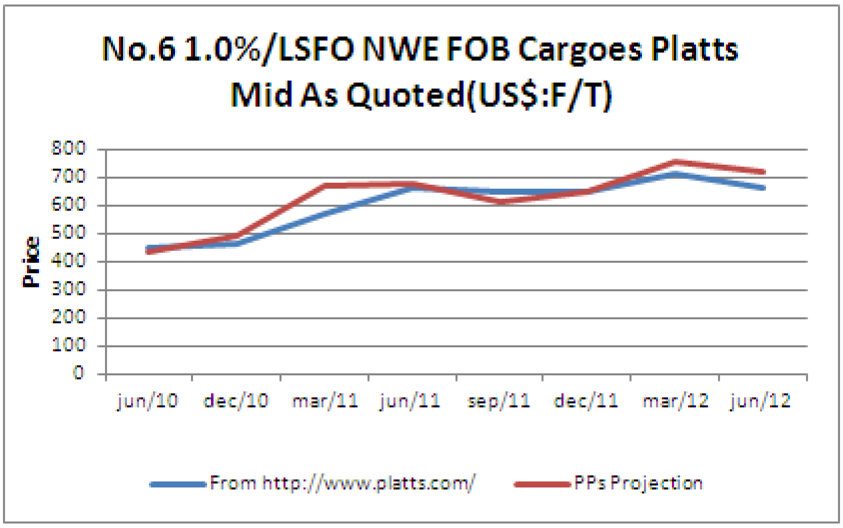


Figure 11 – Comparison between the fuel oil prices projections made by the PPs and the updated source.

iii. Novo Gramacho CAPEX: the CAPEX used was based on payments that were already made by the time of investment decision and projections based on the forecasted amount of residues to be disposed in the SWDS until its closure. Updated balance sheets confirm the projections are realistic and are not subjected to significant variations. As of 2011, the total CAPEX presented in the balance sheet was only 6% lower than the total forecasted. Considering that the LFG collection system was not completely implemented at that time, it is reasonable to assume that the CAPEX informed in the analysis will not decrease more than 10%.

iv. Gas Verde CAPEX: the Gas Verde CAPEX was estimated based on third party quotation. It also can be confirmed using audited balance sheets. As of 2011, 73% of the total investments previously forecasted were already made, as confirmed by the 2011 audited balance sheet. As of today, the LFG upgrading plant is still under construction and a significant amount of expenses will be done in 2012. Therefore, it is also reasonable to assume that the CAPEX will not be lower than 10% from what was initially estimated..

Further, the Project Participants also evaluated a possible scenario where COMLURB would not grant the authorization for the implementation of the CDM project. In this sense, the investment analysis of the project was revised to exclude all revenues and costs referred to in the concession contract. The following items of the cash flow were disregarded:

- Landfill operation incomes;
- Fixed concession costs,
- "Catadores" fund costs;
- Landfill operational costs - both until 2012 and after 2012, when the landfill was closed;

This scenario does not reflect the investment decision context. For simplicity, these cash flow items were completely disregarded. Please note that this is extremely conservative since some of the costs (mainly landfill operational costs referring to the maintenance of the LFG collection wells) would also have to be considered in the project scenario. In other words, the IRR should consider the incremental costs of the CDM project when compared to the baseline scenario.

The result is that the IRR of the project would be equal to 14.13%, which is still lower than the benchmark (15.80%). Thus, even when the costs and revenues mentioned above which are related to the concession contract are disregarded the project remains additional.

STEP 4. Common practice analysis

The Combined tool establishes that for those CDM project activities consisting of one of the measures that are listed in the definitions section of the tool, the approach presented in *Step 4a* shall be used. The measures listed in the tool are:

(a) Fuel and feedstock switch;

(b) Switch of technology with or without change of energy source (including energy efficiency improvement as well as use of renewable energies);

(c) Methane destruction;

(d) Methane formation avoidance.

The proposed CDM Project Activity matches option (c) since it consists of destructing the methane contained in the landfill[20]. Therefore, the approach provided in the *Step 4a* is to be used.

Step 4a: The proposed CDM project activity(s) applies measure(s) that are listed in the definitions section above

In accordance with the combined tool, the stepwise approach presented below shall be applied since the proposed CDM Project Activity consists of one of the measures listed in its definitions section.

<u>Sub-step 4a(1):</u> *Calculate the applicable output range as +/-50% of the design output or capacity of the proposed project activity.*

Output is defined by the "*Combined tool to identify the baseline scenario and demonstrate additionality*" as *goods or services with comparable quality, properties and application areas (e.g. clinker, lighting, residential cooking)*.

[20] Analogously to the example provided in the Annex 8 of the EB 62.

The proposed CDM Project Activity aims at supplying methane from the LFG displacing the use of natural gas. Therefore, the output is the total LFG collected and sent to the distribution network implemented as a result of the project.

It is estimated that the project will send to the distribution network an average of 35,757,397Nm^3/year of LFG, during the crediting period. Therefore, the applicable range is 17,878,698Nm^3/year and 53,636,095Nm^3/year.

<u>Sub-step 4a(2):</u> *In the applicable geographical area, identify all plants that deliver the same output or capacity within the applicable output range, calculated in Step 1, as the proposed project activity and have started commercial operation before the start date of the project. Note their number N_{all}. Registered CDM project activities and projects activities undergoing validation shall not be included in this step.*

The additionality tool states that the *applicable geographical area covers the entire Host Country as a default*. Therefore Brazil is identified as the applicable geographical area for the purpose of conducting the common practice analysis.

The starting date of the proposed CDM Project Activity is December 12th, 2008. Therefore, all landfill that have started supplying LFG to a natural gas distribution network before this date have to be assessed.

As discussed in STEP 2 above, a significant amount of the waste produced in the country (33.31%) is sent to open dumps and controlled landfills (Figure 12).

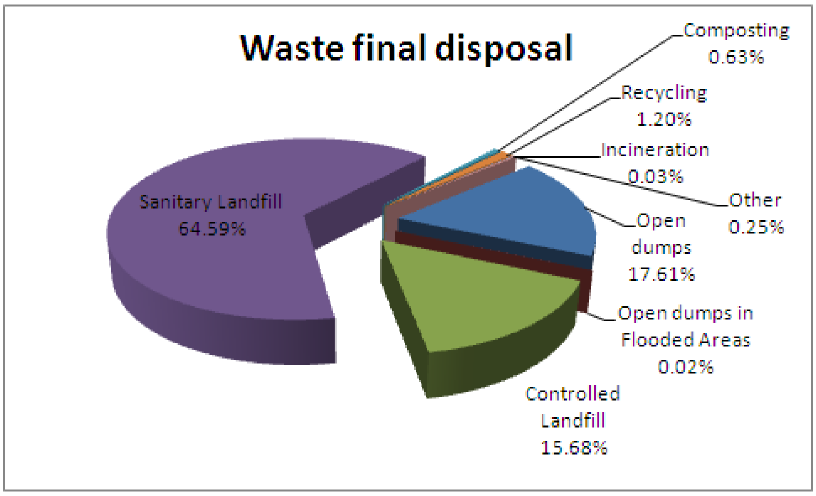


Figure 12 – Waste final disposal in Brazil, as of 2008 (Source: PNSB2008. For complete reference, please refer to Table 1 above)

In addition to this, only few of the existing Brazilian landfills have installed a collecting and flaring methane system. The majority of landfills operate with natural emission of methane to the atmosphere, through concrete wells. This situation also can be evidenced when analyzing the *Diagnóstico do Manejo de Resíduos Sólidos Urbanos* elaborated by the Brazilian Ministry of the Cities in 2008[21].

This research was conducted considering a sample of the major municipalities of the country. It indicates the sanitation situation of the Brazilian municipalities and is part of the National System of Sanitation Information. From the collected sample, the results were the following:

[21] Sistema Nacional de Informações sobre Saneamento: diagnóstico do manejo de resíduos sólidos urbanos – 2008. Brasília: MCIDADES.SNSA, 2010. Available at http://www.snis.gov.br/PaginaCarrega.php?EWRErterterTERTer=88.

- Only 42.7% of the final waste disposal units corresponded to sanitary and controlled landfills as well as open dumps (*Diagnóstico do Manejo de Resíduos Sólidos Urbanos*, page 135);
- Considering the sanitary landfills, open dumps and controlled landfills analyzed by this research, 739SWDS on total, only 7.8% of the units possessed a system to collect the landfill gas (Table 6.16, page 138);

From the list of SWDS considered in the research, only 17 landfills had an LFG capture system and an appropriate environmental permit allowing their operation. None of them includes the injection of upgraded LFG into a gas distribution grid. Nevertheless, 14 SWDS are either registered as CDM or under validation (including the proposed project activity) and in this sense, are disregarded. A spreadsheet containing this information was supplied to the DOE.

Therefore, the result is that $\boldsymbol{N_{all}} = \mathbf{3}$.

<u>Sub-step 4a(3):</u> *Within the plants identified in Step 2, identify those that apply technologies different to the technology applied in the proposed project activity. Note their number N_{diff}.*

From the list of SWDS mentioned above in *Sub-step 4a(2)*, 3 out of the 17 SWDS are not CDM Project activities. One landfill uses the LFG to generate electricity and the other two burn the LFG in flares. A spreadsheet containing this information was supplied to the DOE. Therefore, $\boldsymbol{N_{diff}} = \mathbf{3}$.

<u>Sub-step 4a(4):</u> *Calculate factor $F=1-N_{diff}/N_{all}$, representing the share of plants using a technology similar to the technology used in the proposed project activity in all plants that deliver the same output or capacity as the proposed project activity. The proposed project activity is regarded as common practice within a sector in the applicable geographical area if both the following conditions are fulfilled:*

(a) The factor F is greater than 0.2; and

(b) $N_{all}-N_{diff}$ is greater than 3.

From the above,

$F = 1 – 3 / 3 = 0$

$N_{all} – N_{diff} = 3 - 3 = 0$

Hence, the conditions of *sub-step4a(4)* are met and the project is additional.

Outcome of Step 4: the proposed project activity is not regarded as common practice. Therefore, it is additional.

B.5. Demonstration of additionality

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The additionality of the proposed project activity has been demonstrated using the *"Combined Tool to identify the baseline scenario and demonstrate additionality"***,** in line with the requirements of ACM0001. Please refer to section B.4. above for details.

CDM Prior Consideration and continuing and real actions to secure the CDM status

According to the "*Glossary of CDM Terms*" (EB66, Annex 63) the start date of the CDM Project Activity corresponds to "*the earliest date at which either the implementation or construction or real action of a CDM project activity or PoA begins*".

The identified starting date of the proposed project activity is 12/12/2008, which corresponds to the date when the contract for gas wells drilling was signed. For details on how the project starting date was identified please refer to Section C.1.1.

With regards to the demonstration of the prior consideration of the CDM, the "*Clean Development Mechanism Project Standard*", requires that the CDM consideration must be demonstrated by those projects for which the identified start date *is prior to the date of publication of the PDD for the global stakeholder consultation*.

In addition, paragraph 7 of the "Project Cycle Procedure establishes that "*For project activities with a start date on or after 2 August 2008, the project participants shall notify the designated national authority(ies) (DNAs) of the host Party(ies) of the project activity and the secretariat in writing of the commencement of the project activity and their intention to seek the CDM status within 180 days of the start date of the project activity as defined in the "Glossary of CDM terms", by using the "Prior consideration of the CDM form" (F-CDM-PC). Such notification is not necessary if:*

(a) *A PDD regarding the project activity has been published for global stakeholder consultation in accordance with paragraph 16 below; or (...)".*

The proposed CDM Project Activity was first published for the global stakeholder consultation process on 03/09/2008. Therefore, the notification mentioned above is not necessary and it is demonstrated that the CDM was considered while developing the proposed CDM Project Activity.

B.6. Emission reductions
B.6.1. Explanation of methodological choices
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Baseline Emissions

Baseline emissions for the proposed project activity are determined according to the following equation:

$$BEy = BE_{CH4,y} + BE_{EC,y} + BE_{HG,y} + BE_{NG,y} \qquad \textbf{Equation 1}$$

Where,

BE_y	=	Baseline emissions in year y (t CO_2e/yr)
$BE_{CH4,y}$	=	Baseline emissions of methane from the SWDS in year y (t CO_2e/yr)
$BE_{EC,y}$	=	Baseline emissions associated with electricity generation in year y (t CO_2/yr)
$BE_{HG4,y}$	=	Baseline emissions associated with heat generation in year y (t CO_2/yr)
$BE_{NG,y}$	=	Baseline emissions associated with natural gas use in year y (t CO_2/yr)

Baseline emissions associated with heat generation in year y ($BE_{HG,y}$) and electricity generation in year y ($BE_{EC,y}$) are not applicable to the proposed project activity.

Step (A): Baseline emissions of methane from the SWDS ($BE_{CH4,y}$)

Baseline emissions of methane from the SWDS are determined, based on the amount of methane that is captured under the project activity and the amount that would be captured and destroyed in the baseline (such as due to regulations). In addition, the effect of methane oxidation that is present in the baseline and absent in the project is taken into account[22].

$$BE_{CH4,y} = \left(1 - OX_{top\_layer}\right) \cdot \left(F_{CH4,PJ,y} - F_{CH4,BL,y}\right) \cdot GWP_{CH4}$$ **Equation 2**

Where,

$BE_{CH4,y}$	=	Baseline emissions of LFG from the SWDS in year *y* (t CO_2e/yr)
OX_{top_layer}	=	Fraction of methane in the LFG that would be oxidized in the top layer of the SWDS in the baseline (dimensionless)
$F_{CH4,PJ,y}$	=	Amount of methane in the LFG which is flared and/or used in the project activity in year *y* (t CH_4/yr)
$F_{CH4,BL,y}$	=	Amount of methane in the LFG that would be flared in the baseline in year *y* (t CH_4/yr)
GWP_{CH4}	=	Global warming potential of CH_4 (t CO_2e/t CH_4)

Step A.1: Ex post determination of $F_{CH4,PJ,y}$

During the crediting period, $F_{CH4,PJ,y}$ is to be determined as the sum of the quantities of methane flared and forwarded to the natural gas distribution network, considering the following equation:

$$F_{CH4,PJ,y} = F_{CH4,flared,y} + F_{CH4,EL,y} + F_{CH4,HG,y} + F_{CH4,NG,y}$$ **Equation 3**

Where,

$F_{CH4,PJ,y}$	=	Amount of methane in the LFG which is flared and/or used in the project activity in year *y* (tCH_4/yr)
$F_{CH4,flared,y}$	=	Amount of methane in the LFG which is destroyed by flaring in year *y* (tCH_4/yr)
$F_{CH4,EL,y}$	=	Amount of methane in the LFG which is used for electricity generation in year *y* (tCH_4/yr)
$F_{CH4,HG,y}$	=	Amount of methane in the LFG which is used for heat generation in year *y* (tCH_4/yr)
$F_{CH4,NG,y}$	=	Amount of methane in the LFG which is sent to the natural gas distribution network in year *y* (tCH_4/yr)

In the case of the project activity, $F_{CH4,HG,y}$ and $F_{CH4,EL,y}$ are zero since neither heat nor electricity will be generated using the biogas.

The ex-post determination of $F_{CH4,NG,y}$ is done using the *"Tool to determine the mass flow of a greenhouse gas in a gaseous stream"* and the gaseous stream the tool shall be applied to is the LFG delivery pipeline to the upgrading facility. Additionally, in the context of the proposed project activity, the following requirements listed in the methodology apply:

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[22] $OX_{top\text{-}layer}$ is the fraction of the methane in the LFG that would oxidize in the top layer of the SWDS in the absence of the project activity. Under the project activity, this effect is reduced as a part of the LFG is captured and does not pass through the top layer of the SWDS. This oxidation effect is also accounted for in the methodological tool "Emissions from solid waste disposal sites". In addition to this effect, the installation of a LFG capture system under the project activity may result in the suction of additional air into the SWDS. In some cases, such as with a high suction pressure, the air may decrease the amount of methane that is generated under the project activity. However, in most circumstances where the LFG is captured and used this effect was considered to be very small, as the operators of the SWDS have in most cases an incentive to main a high methane concentration in the LFG. For this reason, this effect is neglected as a conservative assumption.

- The gaseous stream the tool shall be applied to is the LFG delivery pipeline to the natural gas distribution system;
- CH_4 is the greenhouse gases for which the mass flow should be determined;
- The flow of the gaseous stream should be measured on continuous basis;
- The simplification offered for calculating the molecular mass of the gaseous stream is valid (equations 3 or 17 in the tool); and
- The mass flow will be summed to a yearly unit basis (tCH_4/yr).

For calculating $F_{CH4,NG,y}$, **Option A** of the Tool has been selected (*i.e.*, volume flow measured in dry basis and volumetric fraction measured in dry basis). The demonstration that the gaseous stream is dry follows alternative *b)* of the tool is used since it is forecasted that the temperature of the gaseous stream (T_t) is less than 60°C (333.15 K) at the flow measurement point.

The mass flow of greenhouse gas *i* ($F_{i,t}$) is determined as follows:

$$F_{i,t} = V_{t,db} * v_{i,t,db} * \rho_{i,t}$$ **Equation 4**

With

$$\rho_{i,t} = (P_t * MM_i) / (R_u * T_t)$$ **Equation 5**

Where,

$F_{i,t}$	=	Mass flow of *CH4* in the gaseous stream (gas sent to natural gas distribution network) in time interval *t* (kg gas/h)
$V_{t,db}$	=	Volumetric flow of the gaseous stream in time interval *t* on a dry basis (m^3 dry gas/h) – of the gas sent to natural gas distribution network
$v_{i,t,db}$	=	Volumetric fraction of CH_4 in the gaseous stream in time interval *t* on a dry basis (m^3 gas *i*/m3 dry gas)
$\rho_{i,n}$	=	Density of CH_4 in the gaseous stream in time interval t (kg gas *i*/m^3 gas *i*)
P_t	=	Absolute pressure of the gaseous stream in time interval t (Pa)
T_t	=	Temperature of the gaseous stream in time interval t (K)
MM_i	=	Molecular mass of CH_4 (kg/kmol)
R_u	=	Universal ideal gases constant (Pa.m^3/kmol.K)

The flow meters installed convert automatically the volumetric flow of the gaseous stream from actual conditions to normal conditions of temperature and pressure.

Amount of methane destroyed by flaring ($F_{CH4,flared,y}$)

$F_{CH4,flared,y}$ is determined as the difference between the amount of methane supplied to the flare(s) and any methane emissions from the flare(s), as follows:

$$F_{CH4,flared,y} = F_{CH4,sent\_flare,y} - \frac{PE_{flare,y}}{GWP_{CH4}}$$ **Equation 6**

Where,

$F_{CH4,flared,y}$	=	Amount of methane in the LFG which is destroyed by flaring in year *y* (t CH_4/yr)
$F_{CH4,sent\_flare,y}$	=	Amount of methane in the LFG which is sent to the flare in year *y* (t CH_4/yr)
$PE_{flare,y}$	=	Project emissions from flaring of the residual gas stream in year *y* (t CO_2e/yr)
GWP_{CH4}	=	Global warming potential of CH_4 (t CO_2e/t CH_4)

$F_{CH4,sent\_flare,y}$ is determined directly using the *"Tool to determine the mass flow of a greenhouse gas in a gaseous stream"*, applying the requirements described above where the gaseous stream the tool shall be applied to is the LFG delivery pipeline to the three enclosed flares.

In accordance with the methodology, the calculation of $F_{CH4,flared,y}$ will be performed separately for each flare and the sum will be used for the emission reductions calculation.

Therefore, to calculate $F_{CH4,sent\_flare,y}$ for the **enclosed flares, Option B** of the Tool has been selected (i.e., volume flow measured in wet basis and volumetric fraction measured in dry basis).

Under this option, the mass flow of greenhouse gas *i* ($F_{i,t}$) is determined using Equation 4 and Equation 5 presented above. As per the tool, the volumetric flow of the gaseous stream in time *t* on a dry basis ($V_{t,db}$) is determined by converting the measured volumetric flow from wet to dry basis, as follows:

$$V_{t,db} = V_{t,wb} / (1 + v_{H2O,t,db})$$ **Equation 7**

Where,

$V_{t,db}$	=	Volumetric flow of the gaseous stream in time interval *t* on a dry basis (m^3 dry gas/h)
$V_{t,wb}$	=	Volumetric flow of the gaseous stream in time interval *t* on a wet basis (m^3 wet gas/h)
$v_{H2O,t,db}$	=	Volumetric fraction of H_2O in the gaseous stream in time interval *t* on a dry basis (m^3 H_2O/m^3 dry gas)

The volumetric fraction of H_2O in time interval *t* on a dry basis ($v_{H2O,t,db}$) is estimated according to the equation presented below.

$$v_{H2O,t,db} = \frac{m_{H2O,t,db} * MM_{t,db}}{MM_{H2O}}$$ **Equation 8**

Where,

$v_{H2O,t,db}$	=	Volumetric fraction of H_2O in the gaseous stream in time interval *t* on a dry basis (m^3 H_2O/m^3 dry gas)
MM_{H2O}	=	Molecular mass of H_2O (kg H_2O/kmol H_2O)

The absolute humidity of the gaseous stream ($m_{H2O,t,db}$) is determined using **Option 2** specified in the Determination of the absolute humidity of the gaseous stream section of the tool. Under this option a simple and conservative approach is provided depending on the purpose of the data, *i.e.* baseline or project emissions.

The moisture content of the gaseous stream will be used to determine the baseline emissions. In this case, an assumption that the gaseous stream is saturated is conservative since the mass flow of greenhouse gas *i* is underestimated in this situation. Therefore, the following equation is to be used:

$$m_{H2O,t,db,Sat} = \frac{p_{H2O,t,Sat} * MM_{H2O}}{\left(P_t - p_{H2O,t,Sat}\right) * MM_{t,db}}$$ **Equation 9**

Where,

$m_{H2O,t,db,Sat}$	=	Saturation absolute humidity in time interval *t* on a dry basis (kg H_2O/kg dry gas)
$p_{H2O,t,Sat}$	=	Saturation pressure of H_2O at temperature T, in time interval *t* (Pa)
T_t	=	Temperature of the gaseous stream in time interval *t* (K)
P_t	=	Absolute pressure of the gaseous stream in time interval *t* (Pa)
MM_{H2O}	=	Molecular mass of H_2O (kg H_2O/kmol H_2O)
$MM_{t,db}$	=	Molecular mass of the gaseous stream in a time interval *t* on a dry basis (kg dry gas/kmol dry gas)

The molecular mass of the gaseous stream ($MM_{t,db}$) is determined using the simplified approach, as allowed by the methodology and further described below.

$$MM_{t,bd} = \sum_k \left(v_{k,t,db} * MM_k\right)$$ **Equation 10**

Where,

$MM_{t,db}$	=	Molecular mass of gaseous stream in time interval *t* on a dry basis (kg dry gas/kmol dry gas)
$v_{k,t,db}$	=	Volumetric fraction of gas *k* in the gaseous stream in time interval *t* on a dry basis (m^3 gas k/m^3 dry gas)
MM_k	=	Molecular mass of gas *k* (kg/kmol)
k	=	All gases, except H_2O, contained in the gaseous stream (e.g. N_2, CO_2, O_2, CO, H_2, CH_4, N_2O, NO, NO_2, SO_2, SF_6, and PFCs). See available simplification below.

Following the simplification approach provided by the tool, which is also allowed by ACM0001 methodology, the volumetric fraction of only the gases *k* that are greenhouse gases and are considered in the emission reduction calculation in the underlying methodology are to be monitored. In the context of the proposed project activity, the only gas that is to be monitored is the methane (CH_4). The difference to 100% will be considered as pure nitrogen.

Project Emissions from flaring:

Project emissions are related to the amount of methane not destroyed in the flares and will be calculated following the procedures of the methodological tool "*Project emissions from flaring*". As LFG is flared through more than one flare, $PE_{flare,y}$ is the sum of the emissions for each flare determined separately.

The project will install enclosed flares and Gramacho Landfill Gas Project will adopt the default flare efficiency. The calculation of flare efficiency will be made by the following steps:

STEP 1: Determination of the methane mass flow of the residual gas;

The mass flow of methane in the residual gaseous stream in the minute *m* ($F_{CH4,m}$) will be determined using the procedures set out by the "*Tool to determine the mass flow of a greenhouse gas in a gaseous stream*" and the following requirements apply:

- The gaseous stream tool shall be applied to the residual gas;
- The flow of the gaseous stream shall be measured continuously;
- CH_4 is the greenhouse gas *i* for which the mass flow should be determined;
- The simplification offered for calculating the molecular mass of the gaseous stream is valid (equations 3 and 17 in the tool); and
- The time interval *t* for which mass flow should be calculated is every minute *m*.

$F_{CH4,m}$, which is measured as the mass flow during minute *m*, shall then be used to determine the mass of methane in kilograms fed to the flare in minute *m* ($F_{CH4,RG,m}$). $F_{CH4,m}$ shall be determined on a dry basis. Please note that this parameter corresponds to $F_{CH4,sent\_flare,y}$. Therefore, the same methodological approaches apply to both parameters (Option B of the tool and Equation 7 to Equation 10 described above). Also, when estimating the humidity of the gaseous stream, the conservative assumption that it is dry is made. Hence, $m_{H2O,t,db}$ is assumed to equal 0, as per the methodological tool.

STEP 2: Determination of flare efficiency

The Gramacho Landfill Gas Project will install enclosed flares and use the default value for flare efficiency (Option A). The flares to be used by the proposed CDM Project Activity have a diameter of 3.098m and are 8.262m height. Therefore, the adjustment for flares defined as low height flares is **not** applicable.

Under Option A of the methodological tool, the flare efficiency for the minute *m* ($\eta_{flare,m}$) is 90% when the following two conditions are met to demonstrate that the flare is operating:

1. The temperature of the flare ($T_{EG,m}$) and the flow rate of the residual gas to the flare ($F_{RG,m}$) is within the manufacturer's specification for the flare ($SPEC_{flare}$) in minute *m*; and
2. The flame is detected in minute *m* ($Flame_m$).

Otherwise $\eta_{flare,m}$ is 0%.

STEP 3: Calculation of project emissions from flaring

Project emissions from flaring are calculated as the sum of emissions from each minute *m* in year *y*, based on the methane flow rate in the residual gas ($F_{CH4,RG,m}$) and the flare efficiency ($\eta_{flare,m}$), as follows:

$$PE_{flare,y} = GWP_{CH_4} \times \sum_{m=1}^{525600} F_{CH4,RG,m} \cdot \left(1 - \eta_{flare,m}\right) \times 10^{-3} \qquad \textbf{Equation 11}$$

Where,

$PE_{flare,y}$ = Project emissions from flaring of the residual gas stream in year *y* (tCO_2e)

GWP_{CH4} = Global Warming Potential (tCO_2e/tCH_4) valid for the commitment period

$F_{CH4,RG,m}$ = Mass flow of methane in the residual gas in the minute *m* (kg)

$\eta_{flare,m}$ = Flare efficiency in the minute *m*

Step A.1.1: Ex ante estimation of $F_{CH4,PJ,y}$

It is determined as follows:

$$F_{CH4,PJ,y} = \eta_{PJ} \cdot BE_{CH4,SWDS,y} / GWP_{CH4}$$ **Equation 12**

Where,

$F_{CH4,PJ,y}$ = Amount of methane in the LFG which is flared and/or used in the project activity in year *y* (t CH_4/yr)

$BE_{CH4,SWDS,y}$ = Amount of methane in the LFG that is generated from the SWDS in the baseline scenario in year *y* (t CO_2e/yr)

η_{PJ} = Efficiency of the LFG capture system that will be installed in the project activity, this is considered as 50% considering the default value provide in the methodology.

GWP_{CH4} = Global warming potential of CH_4 (t CO_2e/t CH_4)

$BE_{CH4,SWDS,y}$ is determined using the methodological tool *"Emissions from solid waste disposal sites"*. The following guidance should be taken into account when applying the tool:

- f_y in the tool shall be assigned a value of 0 because the amount of LFG that would have been captured and destroyed is already accounted for in $\boldsymbol{F_{CH4,BL,y}}$;
- In the tool, x begins with the year that the SWDS started receiving wastes (e.g. the first year of SWDS operation); and
- Sampling to determine the fractions of different waste types is not necessary because the waste composition can be obtained from previous studies (obtained from data from COMLURB).

Application A of the Tool is used (i.e., the project activity mitigates methane emissions from a specific existing SWDS-solid waste disposal site). A yearly selection has been chosen as the Gramacho landfill started receiving wastes in January 1993.

The amount of methane that would in the absence of the project activity be generated from disposal of waste at the solid waste disposal site ($BE_{CH4,SWDS,y}$) is calculated with a multi-phase model. The calculation is based on a first order decay (FOD) model.

$$BE_{CH_4,SWDS,y} = \varphi y \times (1-f_y) * GWP_{CH_4} * (1-OX) * \frac{16}{12} * F * DOC_{f,y} * MCFy * \sum_{x=1}^{y}\sum_{j} W_{j,x} * DOC_j \times e^{-k_j(y-x)} * \left(1-e^{-k_j}\right)$$ **Equation 13**

Where,

$BE_{CH4,SWSD,\,y}$ = Baseline methane emissions occurring in year y generated from waste disposal at the solid waste disposal site (SWDS) during a period ending in year y (tCO_2e/y)

φ = Model correction factor to account for model uncertainties (default value of 0.75), Option 1 in the Tool has been selected, value as per Table 3 of the Tool (Application A and humid wet conditions).

f = Fraction of methane captured at the SWDS and flared, combusted or used in another manner that prevents the emissions of methane to the atmosphere in year y. As this is already accounted for in $F_{CH4,BL,y}$, "f" in the Tool shall be assigned a value of 0.

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 oxidized in the soil or other material covering the waste) (default Tool value 0.1)

F = Fraction of methane in the SWDS gas (volume fraction) (0.5)

$DOC_{f,y}$ = Fraction of degradable organic carbon (DOC) that decomposes under the specific conditions occurring in the SWSD for year y (weight fraction). Default value of 0.5 used as per page 65 of the Tool.

MCF_y = Methane correction factor for year y (0.8)

$W_{j,x}$ = Amount of solid waste type j disposed or prevented from disposal in the SWDS in the year *x* (t)

DOC = Fraction of degradable organic carbon (by weight fraction) in the waste type *j*

k_j = Decay rate for the waste type *j (1/yr)*

j = Type of residual waste or types of waste in the MSW

x = Years in the time period in which waste is disposed at the SWSD, extending from the first year in the time period (x=1) to year (x = y)

y = Year for which methane emissions are calculated (considering a consecutive period of 12 months)

Step A.2: Determination of $F_{CH4,BL,y}$

NBR 13896/97 is the technical standard published by ABNT, the Brazilian Association of Technical Standards (*Associação Brasileira de Normas Técnicas*), which sets out the requirements for the development of the design, implementation and operation of landfills. In accordance with clause 5.3 of this technical standard, the design of landfills shall consider options aiming at minimizing gaseous emissions and promoting its capture and correct management.

In this sense, although there is no federal law requiring the destruction of the methane, the technical standard is considered as a requirement. Hence, in the case of the Gramacho Landfill Project *Case 4* is applicable (*i.e.*, There are technical requirement to destroy methane and a LFG capture system exists).

In accordance with the ACM0001 methodology, under *Case 4*, $F_{CH4,BL,y}$ is to be determined based on information in contracts of regulation requirements and data related to the existing LFG capture system, as follows:

$$F_{CH4,BL,y} = \max\ \{F_{CH4,BR,R,y}\ ;\ F_{CH4,BL,sys,y}\}$$ **Equation 14**

Where,

$F_{CH4,BL,R,y}$ = Amount of methane in the LFG which is flared in the baseline due to a requirement in year *y* (tCH_4/yr)

$F_{CH4,BL,sys,y}$ = Amount of methane in the LFG which is flared in the baseline in year *y* for the case of an existing LFG capture system (tCH_4/yr)

Further, the methodology requires that these two parameters are to be determined following the provisions of *Case 2* and *Case 3* described in the methodology.

Case 2: As mentioned above, the existent requirement (ABNT technical standard) does not specify the amount or percentage of LFG that should be destroyed but requires the installation of a capture system, without requiring the captured LFG to be flared. Then $F_{CH4,BL,R,y}$ is **zero**.

Case 3: There is no monitored data available, but there is historic data of the amount of methane that was captured. In this situation:

$$F_{CH4,BL,sys,y} = F_{CH4,hist,y}$$ **Equation 15**

In determining $F_{CH4,hist,y}$ it is assumed that the fraction of LFG that was recovered in the year prior to the implementation of the project activity will be the same fraction recovered under the project activity:

$$F_{CH4,hist,y} = \frac{F_{CH4,BL,x-1}}{F_{CH4,x-1}} \cdot F_{CH4,PJ,y}$$ **Equation 16**

Where,

$F_{CH4,hist,y}$ = Historical amount of methane in the LFG which is captured and destroyed ($t\ CH_4/yr$)

$F_{CH4,BL,x-1}$ = Historical amount of methane in the LFG which is captured and destroyed in the year prior to the implementation of the project activity ($t\ CH_4/yr$)

$F_{CH4,x-1}$ = Amount of methane in the LFG generated in the SWDS in the year prior to the implementation of the project activity ($t\ CH_4/yr$)

$F_{CH4,PJ,y}$ = Amount of methane in the LFG which is flared and/or used in the project activity in year *y* ($t\ CH_4/yr$)

The baseline 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 148 hectares, only 49 PDR shallow wells are installed. 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.

Based on historical data from the landfill (existing passive venting wells), a research conducted by the University of São Paulo determined the average recovery rate of methane from existent operational landfills in Brazil, which operated with passive venting systems[23].

The results related to Gramacho landfill demonstrated that the rate of LFG captured and destroyed in the SWDS equals 0.003. The article also determined the average value for the analysed landfills, which is 0.004.

[23] MAGALHÃES, G. H. C.; ALVES, J. W. S.; SANTO FILHO, F.; COSTA, R. M. and KELSON, M. *"Redução das incertezas sobre o Metano recuperado (R) em inventários de emissões de gases de efeito estufa por tratamento de resíduos, e sobre o parâmetro Adjustment Factor (AF) em projetos de coleta e destruição de metano em aterros no âmbito do Mecanismo de Desenvolvimento Limpo (MDL)"*. Available at http://www.cetesb.sp.gov.br/userfiles/file/mudancasclimaticas/biogas/file/docs/artigos_dissertacoes/magalhaes_alves_santofilho_costa_kelson_pt.pdf

Then, conservatively, this value is used. The year prior to the implementation of the proposed project activity is 2011, since the project will only be fully operational in the end of 2012.

$F_{CH4,BL,y} = ((0.004*64,136) / 64,136) * F_{CH4,PJ,y}$

<u>Case 4 Outcome</u>: Based on information presented above, the results for Case 2 and Case 3 are compared and the maximum value is used. Therefore,

$F_{CH4,BL,y} = \max \{F_{CH4,BR,R,y} ; F_{CH4,BL,sys,y}\}$

$F_{CH4,BL,y} = \max \{0 ; (0.004 * F_{CH4,PJ,y})\}$

$F_{CH4,BL,y} = 0.004 * F_{CH4,PJ,y}$

Steps (B) and (C) of the methodology ACM0001 are not applicable since there won't be electricity generation and heat generation in the project activity.

Step (D): Baseline emissions associated with natural gas use ($BE_{NG,y}$)

$BE_{NG,y}$ is estimated as follows:

$$\mathrm{BE}_{\mathrm{NG,y}} = 0.0504 \times F_{CH4,NG,y} \times EF_{CO2,NG,y} \qquad \textbf{Equation 17}$$

Where,

$BE_{NG,y}$ = Baseline emissions associated with natural gas use in year *y* (t CO_2/yr)

$EF_{CO2,NG,y}$ = Average CO_2 emission factor of natural gas in the natural gas network in year *y* (tCO_2/TJ)

$F_{CH4,NG,y}$ = Amount of methane in the LFG which is sent to the natural gas distribution network in year *y* (tCH_4/yr)

$EF_{CO2,NG,y}$ is determined using the *"Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion"*.

Project Emissions

Sources of project emissions are electricity and fossil fuel consumption, as presented in the equation below:

$$\mathrm{PE_y} = \mathrm{PE_{EC,y}} + \mathrm{PE_{FC,y}} \qquad \textbf{Equation 18}$$

Where,

$PE_{EC,y}$ = Emissions from consumption of electricity due to the project activity in year *y* (t CO_2/yr).

$PE_{FC,y}$ = Emissions from consumption of fossil fuels due to the project activity, for purpose other than electricity generation, in year *y* (t CO_2/yr).

The project emissions (PE_y) will be calculated following the procedures set out by the *"Tool to estimate the baseline, project and/or leakage emissions from electricity consumption"*. During the crediting period, electricity from the grid will be consumed for the operation of the active LFG collection system and LFG upgrading facility. In addition, it will also be considered the emissions of the potential diesel generator for emergency purposes.

The project will consume electricity from the grid. Therefore, Option **A.1** of the "*Tool to calculate baseline, project and/or leakage emissions from electricity consumption"* is used. Under this option, 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:

$$PE_{EC,\,grid,y} = \sum_{j} EC_{PJ,\,j,\,y} \times EF_{EL,\,j,\,y} \times \left(1 + TDL_{j,\,y}\right)$$ **Equation 19**

Where,

$PE_{EC,grid,\,y}$	=	Project emissions from electricity consumption from the grid 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*
j	=	Sources of electricity consumption in the project

Electricity sources *j* corresponds to all the sources of electricity consumed for the operation of the LFG capture system, for the processing and upgrading of the LFG, for transportation of the LFG to the flare, for the compression of the LFG into the natural gas network, etc. For the *ex-ante* estimation of electricity consumed, the installed power of the active LFG collection system and LFG upgrading facility equipment was used.

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 emission factor for the grid to which the project activity is connected as the core data to be determined in the baseline scenario. Thus $EF_{EL\,,y} = EF_{grid,CM,y}$.

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 electricity systems

According to 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. If such delineations are not available, project participants should define the project electricity system and any connected electricity system and justify and document their assumptions in the CDM-PDD*".

Brazilian DNA published Resolution #8, issued on 26th May, 2008, defines the Brazilian Interconnected Grid as a single system that covers all the five macro-geographical regions of the country (North, Northeast, South, Southeast and Midwest). Hence this figure will be used to calculate the baseline emission factor of the grid.

- **STEP 2** – Choose whether to include off-grid power plants in the project electricity system (optional).

  Option I of the tool is chosen, which is to include only grid power plants in the calculation.

- **STEP 3 -** Select a method to determine the operating margin (OM).

  The calculation of the operating margin emission factor ($EF_{grid,OM,y}$) is based on one of the following methods:

  (a) Simple OM, or

  (b) Simple adjusted OM, or

  (c) Dispatch data analysis OM, or

  (d) Average OM.

The simple operating margin can only be used where low-cost/must-run resources[24] constitute less than 50% of total grid generation in: 1) average of 5 most recent years, or 2) based on long-term normalities for hydroelectricity production. Table 9 shows the share of hydroelectricity in the total electricity production for the Brazilian interconnected system. The results show the non-applicability of the simple operating margin to the proposed CDM Project Activity.

Table 9 - Share of hydroelectricity generation in the Brazilian interconnected system, 2007 to 2011

Year	Share of hydroelectricity (%)
2007	92.79%
2008	88.62%
2009	93.27%
2010	88.77%
2011	91.18%

Source: *ONS: Histórico de Geração, 2011. Available at* <*http://www.ons.org.br/historico/geracao_energia.aspx*>.

The fourth alternative, an average operating margin, is an oversimplification and does not reflect in any way the impact of the project activity on the operating margin. The use of the dispatch data analysis method is only applicable to the *ex-post* vintage for determining the emission factor, which is not the vintage chosen by the project participants. Therefore, the simple adjusted operating margin will be used to determine the grid emission factor.

Further, the *ex-ante* data vintage is the chosen to estimate the operating margin. Hence, in accordance with the methodology, *the emission factor is determined once at the validation stage, thus no monitoring and recalculation of the emissions factor during the crediting period is required. For grid power plants, use a 3-year generation-weighted average, based on the most recent data available at the time of submission of the CDM-PDD to the DOE for validation.*

[24] Low operating cost and must run resources typically include hydro, geothermal, wind, low-cost biomass, nuclear and solar generation.

The PDD was submitted to the DOE for validation in 2012. Therefore, data from 2009, 2010 and 2011 are to be used to determine this parameter. In accordance with the explanation provided above in STEP 2, off-grid power plants are not considered in the grid emission factor calculation.

- **STEP 4 -** Calculate the operating margin emission factor according to the selected method

According to the tool "*the simple adjusted OM emission factor ($EF_{grid,OM\text{-}adj,y}$) is a variation of the simple OM, where the power plants / units (including imports) are separated in low-cost/must-run power sources (k) and other power sources (m).*"

The simple adjusted OM was calculated based on the net electricity generation and a CO_2 emission factor for each power unit – i.e. similarly to **Option A** of the simple OM method – as follows:

$$EF_{grid,OM-adj,y} = (1-\lambda_y)\cdot\frac{\sum_m EG_{m,y}\times EF_{EL,m,y}}{\sum_m EG_{m,y}} + \lambda_y\cdot\frac{\sum_k EG_{k,y}\times EF_{EL,k,y}}{\sum_k EG_{k,y}} \qquad \textbf{Equation 20}$$

Where,

$EF_{grid,OM-adj,y}$	=	Simple adjusted operating margin CO_2 emission factor in year *y* (tCO_2/MWh)
λ_y	=	Factor expressing the percentage of time when low-cost/must-run power units are on the margin in year *y*
$EG_{m,y}$	=	Net quantity of electricity generated and delivered to the grid by power unit *m* in year *y* (MWh)
$EG_{k,y}$	=	Net quantity of electricity generated and delivered to the grid by power unit *k* in year *y* (MWh)
$EF_{EL,m,y}$	=	CO_2 emission factor of power unit *m* in year *y* (tCO_2/MWh)
$EF_{EL,k,y}$	=	CO_2 emission factor of power unit *k* in year *y* (tCO_2/MWh)
m	=	All grid power units serving the grid in year *y* except low-cost/must-run power units
k	=	All low-cost/must run grid power units serving the grid in year *y*
y	=	The relevant year as per the data vintage chosen in Step 3

Determination of $EF_{EL,m,y}$

Considering that only data on electricity generation and the fuel types used in each of the power units was available, the emission factor was be determined based on the CO_2 emission factor of the fuel type used and the efficiency of the power unit, as per **Option A2** of the simple OM method. The following formula was used:

$$EF_{EL,m,y} = \cdot\frac{EF_{CO2,m,i,y}\cdot 3.6}{\eta_{m,y}} \qquad \textbf{Equation 21}$$

Where,

$EF_{EL,m,y}$	=	CO_2 emission factor of power unit *m* in year *y* (tCO_2/MWh)

$EF_{CO2,m,i,y}$	=	Average CO_2 emission factor of fuel type *i* used in power unit *m* in year *y* (tCO_2/GJ)
$\eta_{m,y}$	=	Average net energy conversion efficiency of power unit *m* in year *y* (ratio)
m	=	All power units serving the grid in year *y* except low-cost/must-run power units
y	=	The relevant year as per the data vintage chosen in Step 3

Determination of $EG_{m,y}$

Information used to determine this parameter was supplied by ONS, which is an official source, as recommended by the tool. ONS is a non-profit corporate entity, founded on 26 August 1998, and is responsible for coordinating and controlling the operation of generation and transmission facilities in the Brazilian Interconnected System (SIN) under supervision and regulation of the ANEEL[25].

- **STEP 5** - Calculate the build margin (BM)emission factor

In terms of vintage, **option 1** was chosen. In this sense, the build margin was calculated using the most recent information available on units already built for sample group *m* at the time of CDM-PoA-DD submission to the DOE, *i.e.* 2011.

The sample group of power units *m* used to calculate the build margin was determined following the guidance provided by the tool as further discussed in section B.6.3. below. The build margin was calculated following the same approach described above in step 4.

- **STEP 6** – Calculate the combined margin (CM) emissions factor

The combined margin calculation is based on method ***a)*** provided by the tool, as follows:

$$EF_{grid,CM,y} = EF_{grid,OM,y} \cdot w_{OM} + EF_{grid,BM,y} \cdot w_{BM}$$ **Equation 22**

Where,

$EF_{grid,BM,y}$	=	Build margin CO_2 emission factor in year y (tCO_2/MWh);
$EF_{grid,OM,y}$	=	Operating 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. As mentioned above, the *ex-ante* approach is used.

In order to calculate project emissions resulting from combustion of fossil fuels (diesel will be used for emergency purposes in a backup generator), the ¨*Tool to calculate project or leakage emissions from fossil fuel combustion*¨ will be used. Project emissions related to this source are estimated using the following formulae:

$PE_{FC,j,y} = SUM(FC_{i,j,y} * COEF_{i,y})$ **Equation 23**

Where,

[25] http://www.ons.org.br/institucional/modelo_setorial.aspx?lang=en

$PE_{FC,j,y}$ = Are the CO_2 emissions from fossil fuel combustion in process j during the year y (tCO_2/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 proposed project activity will consume diesel oil only for emergency purposes. The CO_2 emission coefficient $COEF_{i,y}$ will be calculated using Option B of the Tool since the necessary data for Option A is not available. As per Option B, the CO_2 emission coefficient $COEF_{i,y}$ is calculated based on net calorific value and CO_2 emission factor of the fuel type i, as follows:

$COEF_{i,y} = NCV_{i,y} * EF_{CO2,i,y}$ **Equation 24**

Where,

$COEF_{i,y}$ = Is the CO_2 emission coefficient of fuel type i in year y (tCO_2/mass or volume unit)

$NCV_{i,y}$ = Is the weighted average net calorific value of the fuel type i in year y (GJ/mass or volume unit)

$EF_{CO2,i,y}$ = Is the weighted average CO_2 emission factor of fuel type i in year y (tCO_2/GJ)

i = Are the fuel types combusted in process j during the year y

Leakage

According with ACM0001 there is no need to account for leakage.

Emission reductions

Emission reductions will be calculated using the formula below:

$ER_y = BE_y - PE_y$ **Equation 25**

Where,

ER_y = Emission reductions during the year y (tCO_2e)

BE_y = Baseline emissions in year y (tCO_2e)

PE_y = Project emissions in year y (tCO_2e)

B.6.2. Data and parameters fixed ex ante

"ACM0001 Methodology"

Data / Parameter	OX_{top_layer}
Unit	Dimensionless
Description	Fraction of methane that would be oxidized in the top layer of the SWDS in the baseline
Source of data	Consistent with how oxidation is accounted for in the methodological tool "*Emissions from solid waste disposal sites*"
Value(s) applied	0
Choice of data or Measurement methods and procedures	As per the applicable tool
Purpose of data	Calculation of baseline emissions
Additional comment	Applicable to Step A. The LFG is captured and used. Therefore, this effect is considered to be very small, as the operators of the SWDS have in most cases an incentive to main a high methane concentration in the LFG. For this reason, this effect is neglected as a conservative assumption.

Data / Parameter	$F_{CH4,BL,x-1}$
Unit	t CH_4/yr
Description	Historical amount of methane in the LFG which is captured and destroyed in the year prior to the implementation of the project activity
Source of data	Information recorded by the SWDS operator
Value(s) applied	257
Choice of data or Measurement methods and procedures	Data from for 2011 is used since the project is expected to be fully operation in the end of 2012. Moreover, historical data from a research conducted from a reputed Brazilian University is used to estimate the amount of methane in the LFG which is captured and destroyed in the year prior to the implementation of the project activity.
Purpose of data	Calculation of baseline emissions
Additional comment	In the case of the proposed project activity Case 4 is applicable. Therefore, the maximum value between Case 2 and Case 3 is to be used. The value used refers to Case 3 of Step A.2. for details please refer to section B.6.1. above.

Data / Parameter	***GWP_{CH4}***
Unit	tCO_2e/tCH_4
Description	Global Warming Potential of CH_4
Source of data	IPCC
Value(s) applied	21 for the first commitment period. Shall be updated according to any future COP/MOP decisions.
Choice of data or Measurement methods and procedures	As per the applicable methodology
Purpose of data	Calculation of baseline emissions
Additional comment	-

Data / Parameter	***NCV_{CH4}***
Unit	TJ/t CH_4
Description	Net calorific value of methane at reference conditions
Source of data	Technical literature
Value(s) applied	0.0504
Choice of data or Measurement methods and procedures	As per the applicable methodology
Purpose of data	Calculation of baseline emissions
Additional comment	-

Data / Parameter	η_{PJ}
Unit	Dimensionless
Description	Efficiency of the LFG capture system that will be installed in the project activity
Source of data	-
Value(s) applied	50%.
Choice of data or Measurement methods and procedures	Default value provided by the applicable methodology
Purpose of data	Calculation of baseline emissions
Additional comment	Applicable to Step A.1.1

"Tool Emissions from solid waste disposal sites"

Data / Parameter	$\varphi_{default}$
Unit	-
Description	Default value for the model correction factor to account for model uncertainties
Source of data	-
Value(s) applied	0.75
Choice of data or Measurement methods and procedures	As per the applicable methodological tool *"Emissions from solid waste disposal sites"*. This parameter is used to determine the baseline emissions following the procedures related to *Application A*. Further, the project is located at Rio de Janeiro state (southeast region of Brazil) which possesses humid/wet weather conditions[26]: MAT = 23.7ºC MAP = 1.171mm. Therefore, the value correspondent to this condition as presented in Table 3 of the methodology is chosen.
Purpose of data	Calculation of baseline emissions
Additional comment	As per Table 3 since the project participants have chosen to apply Option 1 to determine this parameter.

Data / Parameter	f_y
Unit	-
Description	Fraction of methane captured at the SWDS and flared, combusted or used in another manner that prevents the emissions of methane to the atmosphere in year y
Source of data	ACM0001
Value(s) applied	0
Choice of data or Measurement methods and procedures	In accordance with the ACM0001 methodology this value is to be assigned since the amount of LFG that would have been captured and destroyed is already accounted for in Equation 2. As per the applicable methodological tool *"Emissions from solid waste disposal sites"*, for application A, this parameter is determined once for the crediting period ($f_y = f$).
Purpose of data	Calculation of baseline emissions
Additional comment	-

[26] The climatic conditions are based on long-term averages from 1973 to 1990 and were taken from EMBRAPA - Brazilian Agricultural Research Company, available at http://www.bdclima.cnpm.embrapa.br/resultados/balanco.php?UF=&COD=207.

Data / Parameter	***OX***
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	Based on an extensive review of published literature on this subject, including the IPCC 2006 Guidelines for National Greenhouse Gas Inventories
Value(s) applied	0.1
Choice of data or Measurement methods and procedures	As per the applicable methodological tool *"Emissions from solid waste disposal sites"*
Purpose of data	Calculation of baseline emissions
Additional comment	When methane passes through the top layer, part of it is oxidized by methanotrophic bacteria to produce CO_2. The oxidation factor represents the proportion of methane that is oxidized to CO_2. This should be distinguished from the methane correction factor (MCF) which is to account for the situation that ambient air might intrude into the SWDS and prevent methane from being formed in the upper layer of SWDS

Data / Parameter	***F***
Unit	-
Description	Fraction of methane in the SWDS gas (volume fraction)
Source of data	IPCC 2006 Guidelines for National Greenhouse Gas Inventories
Value(s) applied	0.5
Choice of data or Measurement methods and procedures	As per the applicable methodological tool *"Emissions from solid waste disposal sites"*
Purpose of data	Calculation of baseline emissions
Additional comment	Upon biodegradation, organic material is converted to a mixture of methane and carbon dioxide.

Data / Parameter	$DOC_{f,default}$
Unit	Weight fraction
Description	Default value for the fraction of degradable organic carbon (DOC) in MSW that decomposes in the SWDS
Source of data	IPCC 2006 Guidelines for National Greenhouse Gas Inventories"
Value(s) applied	0.5
Choice of data or Measurement methods and procedures	The proposed project activity corresponds to *Application A* described in the applicable methodological tool *"Emissions from solid waste disposal sites"*. Therefore, in accordance with the requirements set out by tool, the default value was chosen.
Purpose of data	Calculation of baseline emissions
Additional comment	This factor reflects the fact that some of the degradable organic carbon does not degrade, or degrades very slowly, in the SWDS.

Data / Parameter	$MCF_{default}$
Unit	-
Description	Methane correction factor
Source of data	IPCC 2006 Guidelines for National Greenhouse Gas Inventories
Value(s) applied	0.8
Choice of data or Measurement methods and procedures	The proposed project activity matches *Application A* described in the tool *"Emissions from solid waste disposal sites"*. The Gramacho Landfill does not meet the criteria of managed SWDS. Nevertheless, it has depths greater than or equal to 5 meters (Gramacho Landfill is 50 meters depth). Hence, the value corresponding to **unmanaged solid waste disposal sites – deep** is chosen.
Purpose of data	Calculation of baseline emissions
Additional 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.

<table>
<tr><td>Data / Parameter</td><td>DOC_j</td></tr>
<tr><td>Unit</td><td>-</td></tr>
<tr><td>Description</td><td>Fraction of degradable organic carbon in the waste type j (weight fraction)</td></tr>
<tr><td>Source of data</td><td>IPCC 2006 Guidelines for National Greenhouse Gas Inventories (adapted from Volume 5, Tables 2.4 and 2.5)</td></tr>
<tr><td>Value(s) applied</td><td>
<table>
<tr><th>DOC_j
(% wet waste)</th><th>Waste type j</th></tr>
<tr><td>43%</td><td>Wood and wood products</td></tr>
<tr><td>40%</td><td>Pulp, paper and cardboard</td></tr>
<tr><td>15%</td><td>Food, food waste, beverages and tobacco</td></tr>
<tr><td>24%</td><td>Textiles</td></tr>
<tr><td>20%</td><td>Garden, yard and park waste</td></tr>
<tr><td>0%</td><td>Glass, plastic, metal, other inert waste</td></tr>
</table>
</td></tr>
<tr><td>Choice of data
or
Measurement methods and procedures</td><td>Values for MSW, as per Table 4 of the methodological tool “Emissions from solid waste disposal sites”.</td></tr>
<tr><td>Purpose of data</td><td>Calculation of baseline emissions</td></tr>
<tr><td>Additional comment</td><td>-</td></tr>
</table>

<table>
<tr><td>Data / Parameter</td><td>k_j</td></tr>
<tr><td>Unit</td><td>1/yr</td></tr>
<tr><td>Description</td><td>Decay rate for the waste type j</td></tr>
<tr><td>Source of data</td><td>IPCC 2006 Guidelines for National Greenhouse Gas Inventories (adapted from Volume 5, Table 3.3)</td></tr>
<tr><td>Value(s) 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>0.40</td></tr>
</table>
</td></tr>
<tr><td>Choice of data
or
Measurement methods and procedures</td><td>As per Table 5 of the methodological tool “Emissions from solid waste disposal sites”.</td></tr>
<tr><td>Purpose of data</td><td>Calculation of baseline emissions</td></tr>
<tr><td>Additional comment</td><td>The project is located at Rio de Janeiro state (southeast region of Brazil) which possesses humid/wet weather conditions[26]:
MAT = 23.7ºC
MAP = 1.171mm</td></tr>
</table>

Data / Parameter	W_x
Unit	t
Description	Total amount of waste disposed in a SWDS in year *x*
Source of data	COMLURB Public Announcement and Reports issued by COMLURB
Value(s) applied	Large amount of data. Please refer to the CERs calculation spreadsheet
Choice of data or Measurement methods and procedures	COMLURB was the public institution who administrated the landfill previously to the implementation of the project activity.
Purpose of data	Calculation of baseline emissions
Additional comment	This parameter does not need to be monitored during the crediting period since the landfill was closed in 2012.

"Project emissions from flaring"

Data / Parameter	$SPEC_{flare}$
Unit	Temperature - ºC Flow rate or heat flux – kg/h or m^3/h
Description	Manufacturer's flare specification for temperature and flow rate
Source of data	Flare manufacturer
Value(s) applied	Not used for *ex-ante* calculations
Choice of data or Measurement methods and procedures	The flare specifications set by the manufacturer for the correct operation of the flare for the selected parameters are: *(a) Minimum and maximum inlet flow rate, if necessary converted to flow rate at reference conditions or heat flux:* Min. – 500Nm^3/h / Max. 5,000Nm^3/h *(b) Minimum and maximum operating temperature:* 1,000ºC – 1,200ºC
Purpose of data	Calculation of project emissions
Additional comment	Information regarding the maintenance schedule is not mentioned since it is not required for projects applying Option A to determine flare efficiency of an enclosed flare, as it is the case of the proposed project activity.

"Tool to determine the mass flow of a greenhouse gas in a gaseous stream"

Data / Parameter	***Ru***
Unit	$Pa.m^3/kmol.K$
Description	Universal ideal gases constant
Source of data	As per the applicable tool
Value(s) applied	8,314
Choice of data or Measurement methods and procedures	-
Purpose of data	Calculation of project emissions
Additional comment	-

Data / Parameter	***Pn***
Unit	Pa
Description	Atmospheric pressure at normal conditions
Source of data	As per the applicable tool
Value(s) applied	101,325
Choice of data or Measurement methods and procedures	-
Purpose of data	Calculation of project emissions
Additional comment	-

Data / Parameter	***Tn***
Unit	K
Description	Temperature at normal conditions
Source of data	As per the applicable tool
Value(s) applied	273.15
Choice of data or Measurement methods and procedures	-
Purpose of data	Calculation of project emission
Additional comment	-

Data / Parameter	MM_i
Unit	kg/kmol
Description	Molecular mass of greenhouse gas *i*
Source of data	Tool
Value(s) applied	16.04 (for methane)
Choice of data or Measurement methods and procedures	-
Purpose of data	Calculation of project emissions
Additional comment	-

"Tool to calculate the emission factor for an electricity system"

Data / Parameter	$EF_{CO2,m,i,y}$
Unit	tCO_2/GJ
Description	CO_2 emission factor of fossil fuel type *i* used in power unit *m* in year *y*
Source of data	IPCC default values at the lower 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(s) applied	Large amount of data. Please refer to the emission factor calculation spreadsheet which is attached to the PDD.
Choice of data or Measurement methods and procedures	As per the recommendation of the *"Tool to calculate the emission factor for an electricity system"*. IPCC default values are being used since this information is neither provided by fuel suppliers nor regional and/or local default values are publicly available.
Purpose of data	Calculation of the project emissions due to electricity consumption
Additional comment	-

Data / Parameter	$EG_{m,y}$ and $EG_{k,y}$
Unit	MWh
Description	Net electricity generated by power plant/unit *m* or *k* in year *y*
Source of data	Official publications. Data from the Electric System National Operator was used.
Value(s) applied	Large amount of data. Please refer to the emission factor calculation spreadsheet which is attached to the PDD.
Choice of data or Measurement methods and procedures	Once for each crediting period using the most recent three historical years for which data is available at the time of submission of the CDM-PoA-DD to the DOE for validation (*ex-ante* option).
Purpose of data	Calculation of the project emissions due to electricity consumption
Additional comment	For methodological choices details, please refer to section E.6.1.

Data / Parameter	$\eta_{m,y}$
Unit	-
Description	Average net energy conversion efficiency of power unit *m* in year *y*
Source of data	Default values provided in Annex 1 of the *"Tool to calculate the emission factor for an electricity system"*
Value(s) applied	Large amount of data. Please refer to the emission factor calculation spreadsheet which is attached to the PDD.
Choice of data or Measurement methods and procedures	As per the recommendation of the *"Tool to calculate the emission factor for an electricity system"*.
Purpose of data	Calculation of the project emissions due to electricity consumption
Additional comment	For methodological choices details, please refer to section E.6.1.

Data / Parameter	$EF_{grid,OM\text{-}adj,y}$
Unit	tCO_2/MWh
Description	Simple adjusted operating margin CO_2 emission factor in year *y*
Source of data	Official publications (data from ONS), IPCC default values and default values provided by the *"Tool to calculate the emission factor for an electricity system"*
Value(s) applied	0.3669
Choice of data or Measurement methods and procedures	The *ex-ante* calculation vintage of this parameter was chosen as per the procedures of the *"Tool to calculate the emission factor for an electricity system"*.
Purpose of data	Calculation of the project emissions due to electricity consumption
Additional comment	For methodological choices details, please refer to section E.6.1.

Data / Parameter	$EF_{BM,2011}$
Unit	tCO_2/MWh
Description	Build Margin CO_2 emission factor in year *y*
Source of data	Official publications (data from ONS), IPCC default values and default values provided by the *"Tool to calculate the emission factor for an electricity system"*
Value(s) applied	0.0572
Choice of data or Measurement methods and procedures	The *ex-ante* calculation vintage of this parameter was chosen as per the procedures of the *"Tool to calculate the emission factor for an electricity system"*.
Purpose of data	Calculation of the project emissions due to electricity consumption
Additional comment	For methodological choices details, please refer to section E.6.1.

B.6.3. Ex ante calculation of emission reductions

>>

a) Baseline emissions of methane from the SWDS ($BE_{CH4,y}$)

Year	*$BE_{CH4,SWSD,y}$ ($t_{CO2}e$)*	*$F_{CH4,PJ,y}$ (t CH_4/yr)*	*$F_{CH4,BL,y}$ (t CH_4/yr)*	*$BE_{CH4,y}$ (tCO_2,y)*
01/01/2013 – 31/12/2013	904,868	21,544	86	450,624
01/01/2014 – 31/12/2014	752,373	17,914	72	374,682
01/01/2015 - 31/12/2015	640,284	15,245	61	318,862
01/01/2016 – 31/12/2016	555,992	13,238	53	276,884
01/01/2017 – 31/12/2017	490,989	11,690	47	244,513
01/01/2018 – 31/12/2018	439,520	10,465	42	218,881
01/01/2019 - 31/12/2019	397,681	9,469	38	198,045

The following data was used to calculate the *ex-ante* methane estimative (as per the Tool *"Emissions from solid waste disposal sites"* :

- *MFC (Methane Conversion Factor):* MCF value is adopted according with the type of SWDS. The Gramacho Landfill is an unmanaged SWDS, and is more than 50 meters depth; thus, the MCF adopted is equal to 0.8
- Oxidation factor, reflecting the amount of methane from SWDS that is oxidised in the soil or other material covering the waste: 0.1 (default value as per the Tool)
- Model correction factor to account for model uncertainties: 0.75 (default value as per the Tool Application A and wet conditions)
- 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), as presented in the table below:

Table 10 – Historical deposited solid waste at the site.

Year	Deposited waste (tons)	Year	Deposited waste (tons)	Year	Deposited waste (tons)
1978	1,118,052	**1990**	1,460,856	**2002**	2,473,918
1979	1,140,448	**1991**	1,588,614	**2003**	2,359,715
1980	1,188,954	**1992**	1,548,614	**2004**	2,333,759
1981	1,165,236	**1993**	1,646,374	**2005**	2,337,625
1982	1,316,298	**1994**	1,669,443	**2006**	2,474,464
1983	1,375,749	**1995**	1,800,209	**2007**	2,450,064
1984	1,220,121	**1996**	2,325,161	**2008**	2,500,916
1985	1,242,562	**1997**	2,414,508	**2009**	2,373,953
1986	1,316,425	**1998**	2,390,021	**2010**	2,533,873
1987	1,344,678	**1999**	2,403,311	**2011**	1,703,891
1988	1,438,915	**2000**	2,454,563	**2012**	295,843
1989	1,459,531	**2001**	2,417,409		

The composition of the solid waste used to calculate *ex-ante* estimative of methane generation was based in an historical data prepared by COMLURB. The historical average of each type of waste concentration is presented in the table below (data from 2009 report), which is comparable to municipal solid waste -MSW- (heterogeneous mix of different solid waste types collected by the municipality of Rio de Janeiro, including household waste, garden/park waste and commercial/institutional waste):

Table 11 – Waste types historically disposed at the project site.

Category	% (wet basis)
Wood and wood products	1.69%
Pulp, paper and cardboard	18.05%
Food, food waste, beverages and tobacco	53.28%
Textiles	1.66%
Garden, yard and park waste	1.85%
Glass, plastic, metal, other inert waste	23.46%

b) Baseline emissions associated with natural gas use

ACM0001 does not provide a guide for the *ex-ante* calculation of these baseline emissions. Therefore, it has been estimated that 90% of the collected gas ($F_{CH4,PJ,y}$) will be derived to the gas purification process. The balance of LFG collected is considered to be burned in the enclosed flares while the upgrading facility stops (e.g. during maintenance or emergencies) or when there is an excess of LFG.

The IPCC emission factor for the natural gas[27] is equal to 58.3tCO_2e/TJ. Applying these figures to Equation 17, we obtain the results presented in the below table.

Year	$F_{CH4,NG,y}$ (tCH_4/yr)	$BE_{NG,y}$ (tCO_2/yr)
01/01/2013 – 31/12/2013	19,390	56,974
01/01/2014 – 31/12/2014	16,122	47,372
01/01/2015 - 31/12/2015	13,720	40,315
01/01/2016 – 31/12/2016	11,914	35,008
01/01/2017 – 31/12/2017	10,521	30,915
01/01/2018 – 31/12/2018	9,418	27,674
01/01/2019 -31/12/2019	8,522	25,040

c) Grid Emission Factor Calculation.

The calculation of the combined margin CO_2 emission factor for grid connected power generation ($EF_{grid,CM,y}$) follows the steps established in the "*Tool to calculate the emission factor for an electricity system*". The results are presented below.

- **STEP 1 -** Identify the relevant electricity systems

Following Resolution #8, issued by the Brazilian DNA on 26th May, 2008, the Brazilian Interconnected Grid corresponds to the system to be considered. It covers all the five macro-geographical regions of the country (North, Northeast, South, Southeast and Midwest) as presented in the figure below.

27 Value at the upper limit of the uncertainty at a 95% confidence interval as per the "*Tool to calculate project or leakage CO2 emissions from fossil fuel combustion*"..

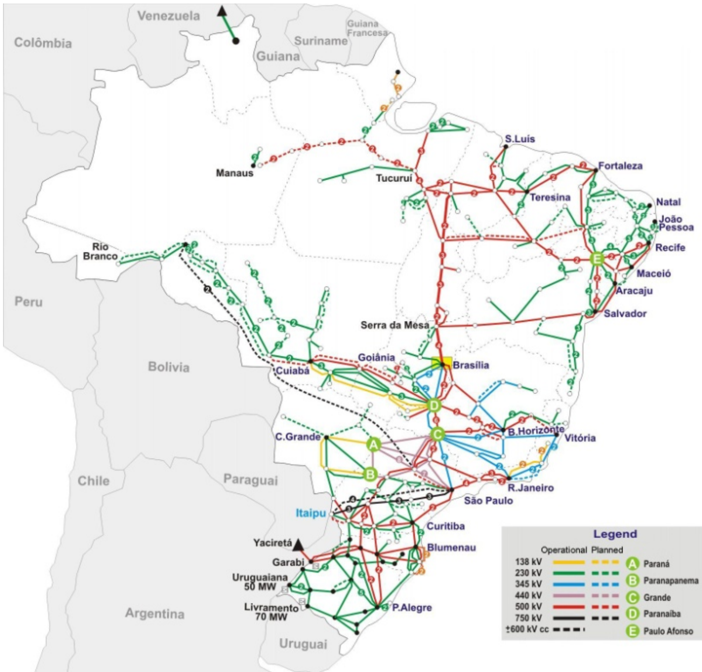


Figure 13: Brazilian Interconnected System. (*Source:* Electric System National Operator)

- **STEP 2** – *Choose whether to include off-grid power plants in the project electricity system (optional)*

  Option I was chosen and only grid connected power plants are considered.

- **STEP 3** - *Select a method to determine the operating margin (OM)*

  The simple adjusted operating margin and *ex-ante* data vintage were chosen for the calculation of this parameter. Data from 2009, 2010 and 2011 were used in the calculation. Please refer to section E.6.1. for the proper justification.

- **STEP 4** - Calculate the operating margin emission factor according to the selected method

  A spreadsheet containing all data used to determine the operation margin was supplied to the DOE. The result is presented below.

$$\boxed{EF_{grid,OM\text{-}adj,y} = 0.3669 tCO_2e/MWh}$$

- **STEP 5** - Calculate the build margin (BM) emission factor

  As described above in section E.6.1., the *ex-ante* vintage was the option chosen to determine the build margin (option 1).

  The sample group of power units *m* used to calculate the build margin was identified following the procedure provided by the tool. The result is discussed below and is presented in detail in the spreadsheet supplied to the DOE which is also attached to the CDM-PoA-DD.

  (a) *Identify the set of five power units, excluding power units registered as CDM project activities, that started to supply electricity to the grid most recently ($SET_{5\text{-}units}$) and determine their annual electricity generation ($AEG_{SET\text{-}5\text{-}units}$, in MWh);*

From the most recent consolidated information the $SET_{5\text{-}units}$ are: UHE Foz do Rio Claro, UHE Salto, UHE Caçu, UHE S.R. Verdinho and UHE Barra dos Coqueiros. The electricity generated by these set of plants ($AED_{SET\text{-}5\text{-}units}$) in 2011 was 1,561,998MWh.

(b) Determine the annual electricity generation of the project electricity system, excluding power units registered as CDM project activities (AEG_{total}, in MWh). Identify the set of power units, excluding power units registered as CDM project activities, that started to supply electricity to the grid most recently and that comprise 20% of AEG_{total} (if 20% falls on part of the generation of a unit, the generation of that unit is fully included in the calculation) ($SET_{\geq 20\%}$) and determine their annual electricity generation ($AEG_{SET\text{-}\geq 20\%}$, in MWh);

Not considering the CDM project activities, in 2011, the Brazilian electricity System generated (AEG_{total}) 479,683,003MWh. A large number of plants comprise 20% of AEG_{total}. This information ($SET_{\geq 20\%}$) can be checked in the calculation spreadsheet attached to this CDM-PoA-DD. The annual electricity generation of $SET_{\geq 20\%}$, corresponding to the parameter $AEG_{SET\text{-}\geq 20\%}$, is 95,936,601MWh.

(c) From $SET_{5\text{-}units}$ and $SET_{\geq 20\%}$ select the set of power units that comprises the larger annual electricity generation (SET_{sample}); Identify the date when the power units in SET_{sample} started to supply electricity to the grid. If none of the power units in SET_{sample} started to supply electricity to the grid more than 10 years ago, then use SET_{sample} to calculate the build margin. Ignore steps (d), (e) and (f).

From data presented in items (a) and (b), it can be observed that $SET_{\geq 20\%}$ is greater than $SET_{5\text{-}units}$. Therefore, SET_{sample} corresponds to $SET_{\geq 20\%}$. The oldest plant comprised in SET_{sample} started to supply electricity to the grid in January 1998. Hence, steps *(d), (e)* and *(f)* of the tool are applicable.

(d) Exclude from SET_{sample} the power units which started to supply electricity to the grid more than 10 years ago. Include in that set the power units registered as CDM project activity, starting with power units that started to supply electricity to the grid most recently, until the electricity generation of the new set comprises 20% of the annual electricity generation of the project electricity system (if 20% falls on part of the generation of a unit, the generation of that unit is fully included in the calculation) to the extent is possible. Determine for the resulting set ($SET_{sample\text{-}CDM}$) the annual electricity generation ($AEG_{SET\text{-}sample\text{-}CDM}$, in MWh);

Plants which have started to supply electricity to the grid more than 10 years ago were excluded. Six registered CDM Projects were included in the SET_{smaple}. The electricity generation by resultant set of plants, corresponds to the parameter $AEG_{SET\text{-}sample\text{-}CDM}$, is 67,906,711MWh.

If the annual electricity generation of that set is comprises at least 20% of the annual electricity generation of the project electricity system (i.e. $AEG_{SET\text{-}sample\text{-}CDM} \geq 0.2 \times AEG_{total}$), then use the sample group $SET_{sample\text{-}CDM}$ to calculate the build margin. Ignore steps (e) and (f).

From the results presented above, $AEG_{SET\text{-}sample\text{-}CDM}$ is lower than AEG_{total}. Then, steps (e) and (f) were applied.

(a) Include in the sample group $SET_{sample\text{-}CDM}$ the power units that started to supply electricity to the grid more than 10 years ago until the electricity generation of the new set comprises 20% of the annual

electricity generation of the project electricity system (if 20% falls on part of the generation of a unit, the generation of that unit is fully included in the calculation);

(b) *The sample group of power units m used to calculate the build margin is the resulting set ($SET_{sample\text{-}CDM\text{->}10yrs}$).*

Power plants that started to supply electricity to the grid more than 10 years ago were included. The resultant set $SET_{sample\text{-}CDM\text{->}10yrs}$ is identified in the grid emission factor calculation spreadsheet.

The build margin was calculated following the same approach described above in Step 4, and considered the set of plants identified above. As mentioned previously, this parameter will be validated since the *ex-ante* option was chosen.

The result for the build margin emission factor is presented below.

$$\boxed{EF_{grid,BM,2011} = 0.0572 tCO_2e/MWh}$$

- **STEP 6** – Calculate the combined margin (CM) emissions factor

Applying the results presented above in STEPS 4 and 5 above to Equation 22 presented in section E.6.1. and considering the weights $w_{OM} = 0.5$ and $w_{BM} = 0.5$ (as per method ***a)*** of the tool) we obtain,

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

$$EF_y = 0.5 \times 0.3669 + 0.5 \times 0.0572$$

$$\boxed{EF_{grid,CM,y} = 0.2121 tCO_2e/MWh}$$

d) Project emissions due to electricity consumption from the grid

The electricity consumed by the LFG capture system and LFG upgrading facility was estimated considering the installed capacity of the equipment used in these two processes. For the purpose of *ex-ante* estimative, it was assumed that equipment will operate at full capacity during 8760hours/year. The result is that the estimated electricity consumption from the grid by the project activity is equal to 77,049MWh/year. As presented above, the combined margin grid emission factor of 0.2121tCO_2/MWh.

Transmission losses are equal to determined using information made publicly available by the Electric Power Commercialization Chamber (CCEE form the Portuguese *Câmara de Comercialização de Energia Elétrica*), a not-for-profit, private, civil organization company that is in charge of carrying out the wholesale transactions and commercialization of electric power within the Brazilian Interconnected System, for both Regulated and Free Contracting Environments and for the spot market[28]. Technical distribution losses are determined using information published by ANEEL, specifically related to the local power utility (AMPLA). The result is that TDL is of 11.54%.

Plugging this number into Equation 19, we obtain the total project emissions related to the consumption of electricity from the grid, as presented in the table below.

[28] Information available at <http://www.ccee.org.br/cceeinterdsm/v/index.jsp?vgnextoid=25afa5c1de88a010VgnVCM100000aa01a8c0RCRD>.

Year	Electricity Consumed (MWh)	Grid Emission Factor (tCO_2e/MWh)	TDL_y (%)	tCO_2e
01/01/2013 – 31/12/2013	77,049	0.2121	11.54	18,228
01/01/2014 – 31/12/2014	77,049			18,228
01/01/2015 - 31/12/2015	77,049			18,228
01/01/2016 – 31/12/2016	77,049			18,228
01/01/2017 – 31/12/2017	77,049			18,228
01/01/2018 – 31/12/2018	77,049			18,228
01/01/2019 -31/12/2019	77,049			18,228

e) Project emissions due to fossil fuel consumption

Have been calculated considering the use of diesel for emergency purposes. As diesel is used only for emergency purposes, then for the *ex-ante* estimation information provided by the manufacturer is used. In accordance with the manufacturer specifications, the diesel generator, when used during emergencies, is expected to operate during 500h/year, as a maximum. Conservatively, the maximum consumption of the diesel generator is considered (110.6L/h). The result is that $55.3m^3/yr$ of diesel oil are expected to be consumed for emergency purposes. The density of diesel oil, as per the *2011 Brazilian Energy Balance*[29], is equal to $840kg/m^3$. Therefore, the forecasted consumption of diesel oil is of 46t/yr.

For the determination of the diesel oil emission factor the following parameters are used for *ex-ante* estimative:

$EF_{CO2} = 0.0741tCO_2/GJ$, as per 2006 IPCC

$NCV_{diesel} = 42.3GJ/t$, as per *Brazilian Energy Balance 2011*[29]

Applying the above figures to Equation 24, we obtain:

$COEF_{i,y} = NCV_{i,y} * EF_{CO2,i,y}$

$COEF_{i,y} = 42.3 * 0.0741 = 3.16tCO_2/t$

Then, plugging the estimated diesel oil consumption and emission factor to Equation 23, we obtain:

$PE_{FC,j,y} = SUM(FC_{i,j,y} * COEF_{i,y})$

$PE_{FC,j,y} = 46 * 3.16 = 147tCO_2/yr$

f) Project emission due to flaring

The calculation of the *ex-ante* methane emissions from flaring of vent gas has been estimated using the balance of methane in the LFG collected by the proposed project activity system and the methane in the LFG sent to the upgrading process. It is assumed that all the methane not injected to the natural gas distribution grid due to inefficiencies of the process will be flared in the enclosed flares.

As per the tool, the default value shall only be used when the registered $T_{EG,m}$ and $F_{RG,m}$ are in accordance with the manufacturer's specification and flame is detected in minute *m* (please refer to Section B.6.1 above). Nevertheless, the default flare efficiency of 90% has been used in the *ex-ante* emission reductions calculation..

It was assumed that 90% the biogas collected will enter the upgrading facility. Considering the flare efficiency is 90%, then the project emissions due to flaring gases have been estimated as:

[29] Available at https://ben.epe.gov.br/downloads/Relatorio_Final_BEN_2011.pdf

Year	*$PE_{flare,y}$ ($tCO_2e/year$)*
01/01/2013 – 31/12/2013	4,524
01/01/2014 – 31/12/2014	3,762
01/01/2015 - 31/12/2015	3,201
01/01/2016 – 31/12/2016	2,780
01/01/2017 – 31/12/2017	2,455
01/01/2018 – 31/12/2018	2,198
01/01/2019 -31/12/2019	1,988

B.6.4. Summary of ex ante estimates of emission reductions

Year	**Baseline emissions (t CO_2e)**	**Project emissions (t CO_2e)**	**Leakage (t CO_2e)**	**Emission reductions (t CO_2e)**
01/01/2013 – 31/12/2013	507,598	22,899	0	484,699
01/01/2014 – 31/12/2014	422,054	22,137	0	399,917
01/01/2015 - 31/12/2015	359,176	21,576	0	337,600
01/01/2016 – 31/12/2016	311,892	21,155	0	290,737
01/01/2017 – 31/12/2017	275,427	20,830	0	254,597
01/01/2018 – 31/12/2018	246,555	20,573	0	225,983
01/01/2019 - 31/12/2019	223,085	20,363	0	202,721
Total	**2,345,787**	**149,533**	**0**	**2,196,254**
Total number of crediting years	7			
Annual average over the crediting period	335,112	21,362	0	313,751

B.7. Monitoring plan

B.7.1. Data and parameters to be monitored

ACM0001 Methodology

Data / Parameter	**Management of SWDS**
Unit	-
Description	Management of SWDS
Source of data	Use different sources of data: – Original design of the landfill; – Technical specifications for the management of the SWDS; – Local or national regulations
Value(s) applied	-
Measurement methods and procedures	Project participants should refer to the original design of the landfill to ensure that any practice to increase methane generation have been occurring prior to the implementation of the project activity Any change in the management of the SWDS after the implementation of the project activity should be justified by referring to technical or regulatory specifications
Monitoring frequency	Annually
QA/QC procedures	-
Purpose of data	Calculation of baseline emissions
Additional comment	-

Data / Parameter	$F_{CH4,BL,R,y}$
Unit	t CH_4 / yr
Description	Amount of methane in the LFG which is flared due to a requirement in year *y*
Source of data	Information of the host country's regulatory requirements relating to LFG, contractual requirements, or requirements to address safety and odour concerns
Value(s) applied	0
Measurement methods and procedures	The existing requirement related to methane destruction in landfills is the ABNT technical standard. The version available during the validation does not specify the amount or percentage of LFG that has to be destroyed. Any future revision of the technical standard is to be assessed during the periodic verifications.
Monitoring frequency	Annually
QA/QC procedures	-
Purpose of data	Calculation of baseline emissions
Additional comment	-

Data / Parameter	$\rho_{reg,y}$
Unit	Dimensionless
Description	Fraction of LFG that is required to be flared due to a requirement in year *y*
Source of data	Information of the host country's regulatory requirements relating to LFG, contractual requirements, or requirements to address safety and odour concerns
Value(s) applied	0
Measurement methods and procedures	The existing requirement related to methane destruction in landfills is the ABNT technical standard. The version available during the validation does not specify the amount or percentage of LFG that has to be destroyed. Any future revision of the technical standard is to be assessed during the periodic verifications.
Monitoring frequency	Annually
QA/QC procedures	-
Purpose of data	Calculation of baseline emissions
Additional comment	-

Data / Parameter	$\boldsymbol{Op_{j,h}}$
Unit	-
Description	Operation of the equipment that consumes the LFG
Source of data	Project participants
Value(s) applied	Not used for *ex-ante* calculations.
Measurement methods and procedures	In the context of the proposed project activity, equipment unit *j* using *the LFG* consists of the LFG upgrading facility and flares. Hence, the following parameters are to be used to ensure that the plant is operating in hour *h*: *For the LFG upgrading facility* • Products generated. Monitor the generation of upgraded LFG which is sold to the consumer. This information can be cross-checked with invoices; *For the flaring system* • Flame. Flame detection system is used to ensure that the equipment is in operation; $Op_{j,h}$=0 when: • No products are generated in the hour *h* • Flame is not detected continuously in hour *h* (instantaneous measurements are made at least every minute); Otherwise, $Op_{j,h}$=1
Monitoring frequency	Hourly
QA/QC procedures	Flow meters and flame detectors shall be subject to a regular maintenance and testing regime to ensure accuracy. Calibration shall be according to manufacturers specifications. Accuracy of the flow meters and flame detectors is described in the monitoring tables of parameters $\boldsymbol{V_{t,wb}/V_{t,db}}$ and $Flame_m$, respectively.
Purpose of data	Calculation of baseline emissions
Additional comment	This is monitored to ensure methane destruction is claimed for methane used in the upgrading LFG facility when it is operational

Data / Parameter	$EG_{EC,y}$
Unit	MWh
Description	Amount of electricity consumed by the project activity in year *y*
Source of data	Electricity meters
Value(s) applied	77,049
Measurement methods and procedures	Sources of consumption shall include, where applicable, electricity consumed for the operation of the LFG capture system, for any processing and upgrading of the LFG, for transportation of the LFG to the flare, for the compression of the LFG into the natural gas network, etc Electricity meters will measure the electricity consumed by the LFG capture system and LFG upgrading facility.
Monitoring frequency	Continuous
QA/QC procedures	Electricity meter will be subject to regular maintenance and testing to ensure accuracy. The calibration periodicity will be in accordance with the manufacturer recommendation. The accuracy of the equipment, as per the manufacturer specification is 1% (Accuracy class 1%).
Purpose of data	Calculation of Project Emissions
Additional comment	This parameter is required for calculating project emissions from electricity consumption due to an alternative waste treatment process *t* ($PE_{EC,y}$) using the "*Tool to calculate baseline, project and/or leakage emissions from electricity consumption*". In accordance with ACM0001, this parameter is equivalent to $EC_{PJ,k,y}$ in the tool.

Note: the depth and height of the water table in the SWDS is not monitored as the MCF has been selected as a default value as per Application A of the methodological tool *"Emissions from solid waste disposal sites"*.

"Tool to determine the mass flow of a greenhouse gas in a gaseous stream"

Data / Parameter	$V_{t,wb}$
Unit	m^3 wet gas/h
Description	Volumetric flow of the gaseous stream in time interval *t* on a wet basis
Source of data	Onsite measurements
Value(s) applied	Not used for *ex-ante* calculations.
Measurement methods and procedures	Volumetric flow measurement should always refer to the actual pressure and temperature. Instruments with recordable electronic signal (analogical or digital) will be used. Three flow meters (one for each flare), all of them manufactured by FLUID COMPONENTS INTERNATIONAL LLC., are used.
Monitoring frequency	In accordance with the methodology it is monitored and aggregated every minute (in order to determine the flare efficiency) and monthly reported.
QA/QC procedures	Periodic calibration against a primary device provided by an independent accredited laboratory is mandatory. Calibration and frequency of calibration is according to manufacturers specifications every 18 months. The accuracy of the equipment, as per the manufacturer's specification is ±2% reading ±0.5% full scale (Standard).
Purpose of data	Calculation of baseline emissions

Additional comment	This parameter is used to determine the flow of gaseous stream sent to the enclosed flares ($F_{CH4,flared,y}$). The total value to be used in the calculations corresponds to the individual value monitored for each flare used in the project.

Data / Parameter	$V_{t,db}$
Unit	m^3 dry gas/h
Description	Volumetric flow of the gaseous stream in time interval *t* on a dry basis
Source of data	Onsite measurements
Value(s) applied	Not used for *ex-ante* calculations.
Measurement methods and procedures	Volumetric flow measurement should always refer to the actual pressure and temperature. Calculated based on the wet basis flow measurement plus water concentration measurement.
Monitoring frequency	In accordance with the methodology it is monitored on an hourly basis. It will be monthly aggregated and reported.
QA/QC procedures	Periodic calibration against a primary device provided by an independent accredited laboratory is mandatory. . The calibration periodicity will be in accordance with the manufacturer recommendation. The D/A conversion maximum error, as per the manufacturer is 0.15%.
Purpose of data	Calculation of baseline emissions
Additional comment	This parameter is used to determine the flow of methane in the LFG sent to the natural gas distribution network ($F_{CH4,NG,y}$). The meter is installed after the LFG upgrading facility.

Data / Parameter	$v_{i,t,db}$
Unit	m^3 gas *i*/m^3 dry gas
Description	Volumetric fraction of greenhouse gas *i* in a time interval *t* on a dry basis
Source of data	Onsite measurements
Value(s) applied	Not used for *ex-ante* calculations.
Measurement methods and procedures	In accordance with the methodology it is monitored on an hourly basis using a gas analyzer operating in dry-basis. Volumetric flow measurement should always refer to the actual pressure and temperature.
Monitoring frequency	In accordance with the methodology it is monitored on an hourly basis. It will be monthly aggregated and reported.
QA/QC procedures	Calibration should include zero verification with an inert gas (e.g. N2) and at least one reading verification with a standard gas (single calibration gas or mixture calibration gas). All calibration gases must have a certificate provided by the manufacturer and must be under their validity period. The gas analyzers will be calibrated internally once a week, using certified samples. The accuracy of the equipment, as per the manufacturer specification is less than 1% (linearity difference).
Purpose of data	Calculation of baseline emissions
Additional comment	This parameter is used to determine the flow of methane in the LFG sent to the natural gas distribution network ($F_{CH4,NG,y}$). The meter is installed after the LFG upgrading facility.

Data / Parameter	$v_{k,t,db}$
Unit	m^3 gas *i*/m^3 dry gas
Description	Volumetric fraction of greenhouse gas *k* in a time interval *t* on a dry basis
Source of data	Onsite measurements
Value(s) applied	Not used for *ex-ante* calculations.
Measurement methods and procedures	In accordance with the methodology it is monitored on an hourly basis using a gas analyzer operating in dry-basis. Volumetric flow measurement should always refer to the actual pressure and temperature.
Monitoring frequency	In accordance with the methodology it is monitored on an hourly basis. It will be monthly aggregated and reported.
QA/QC procedures	Calibration should include zero verification with an inert gas (e.g. N2) and at least one reading verification with a standard gas (single calibration gas or mixture calibration gas). All calibration gases must have a certificate provided by the manufacturer and must be under their validity period. The gas analyzers will be calibrated internally once a week, using certified samples. The accuracy of the equipment, as per the manufacturer specification is less than 1% (linearity difference).
Purpose of data	Calculation of baseline emissions
Additional comment	This parameter will be used to calculate the molecular mass of the gaseous stream ($MM_{t,db}$) while determining the moisture content of the gaseous stream sent to flares. This equipment is installed next to the flow meter measuring the total LFG recovered from the landfill, which is before the bifurcation of the pipeline into the pipeline that sent LFG to the upgrading facility or to the enclosed flares.

Data / Parameter	T_t
Unit	K
Description	Temperature of the gaseous stream in time interval *t*
Source of data	Onsite measurements
Value(s) applied	Not used for *ex-ante* calculations.
Measurement methods and procedures	Instruments with recordable electronic signal (analogical or digital) are required. The temperature will be measured by the flow meters turbines which possesses temperature sensors.
Monitoring frequency	In accordance with the methodology it is monitored on an hourly basis. It will be monthly aggregated and reported.
QA/QC procedures	Periodic calibration against a primary device provided by an independent accredited laboratory is mandatory. . The calibration periodicity will be in accordance with the manufacturer recommendation. In accordance with the temperature sensors manufacturer' specification the maximum error that can be verified is 0.10ºC.
Purpose of data	Calculation of baseline emissions
Additional comment	The gaseous stream corresponds to the total LFG collected by the active collecting system. This parameter is measured to to assure the applicability condition of the tool is met and to determine the saturation pressure of H_2O.

Data / Parameter	$P_{H20,t,Sat}$
Unit	Pa
Description	Saturation pressure of H_2O at temperature T_t, in time interval *t*
Source of data	As per the applicable tool
Value(s) applied	Not used for ex-ante calculations.
Measurement methods and procedures	This parameter is solely a function of the gaseous stream temperature T_t and can be found at reference listed below for a total pressure equal to 101,325 Pa
Monitoring frequency	In accordance with the methodology it is monitored on an hourly basis.
QA/QC procedures	This parameter will be determined using the reference listed in the tool.
Purpose of data	Calculation of baseline emissions
Additional comment	Fundamentals of Classical Thermodynamics; Gordon J. Van Wylen, Richard E. Sonntag and Borgnakke; 4º Edition 1994, John Wiley & Sons, Inc.

Data / Parameter	P_t
Unit	Pa
Description	Pressure of the gaseous stream in time interval *t*
Source of data	Onsite measurements
Value(s) applied	Not used for ex-ante calculations.
Measurement methods and procedures	The pressure will be measured by the flow meters turbines which possesses pressure sensors.
Monitoring frequency	In accordance with the methodology it is monitored on an hourly basis.
QA/QC procedures	Periodic calibration against a primary device provided by an independent accredited laboratory is mandatory. . The calibration periodicity will be in accordance with the manufacturer recommendation. The accuracy of the equipment, as per the manufacturer specification is of ±0.65%
Purpose of data	Calculation of baseline emissions
Additional comment	Please note that this parameter is applicable to the simplified approach to determine the moisture content of the gaseous stream. In accordance with the methodological tool, the conservative assumption that the gaseous stream is dry is to be made when calculating the project emissions - in the context of the proposed project activity, project emissions from flaring. In this situation $m_{H2O,t,db}$ is equal to 0, and is not necessary to measure the gaseous stream pressure. In this sense, this parameter is only used when calculating baseline emissions.

"Project emissions from flaring"

Data / Parameter	$T_{EG,m}$
Unit	^{o}C
Description	Temperature in the exhaust gas of the enclosed flare in minute *m*
Source of data	Project participants
Value(s) applied	Not used for *ex-ante* calculations.
Measurement methods and procedures	Measure the temperature of the exhaust gas stream in the flare by a Type N thermocouple.
Monitoring frequency	Once per minute
QA/QC procedures	Thermocouples will be replaced or calibrated every year. The accuracy of this measurement as indicated by the manufacturer is ±1.5ºC
Purpose of data	Calculation of project emissions
Additional comment	Unexpected changes such as a sudden increase/drop in temperature can occur for different reasons. These events should be noted in the site records along with any corrective action that was implemented to correct the issue.

Data / Parameter	$Flame_m$
Unit	Flame on or Flame off
Description	Flame detection of flare in the minute *m*
Source of data	Project Participants
Value(s) applied	Not used for *ex-ante* calculations.
Measurement methods and procedures	Measure using a fixed installation optical flame detector type Ultra Violet detector
Monitoring frequency	Once per minute. Detection of flame recorder as a minute that the flame was on, otherwise recorded as a minute that the flame was off
QA/QC procedures	Equipment shall be maintained and calibrated in accordance with manufacturer's recommendations. It will be replaced after 10,000 operating hours. The spectral range of the equipment is 190 – 270nm and its maximum sensitivity is 210 ± 10nm.
Purpose of data	Calculation of project emissions
Additional comment	-

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

Data / Parameter	$TDL_{project,y}$
Unit	%
Description	Average technical transmission and distribution losses for providing electricity to source *j* in year *y*
Source of data	Electric Power Commercialization Chamber (CCEE) and Brazilian Electricity Regulatory Agency (ANEEL) or a default value.
Value(s) applied	11.54
Measurement methods and procedures	This parameter is to be estimated for the transmission and distribution networks of the Brazilian electricity grid. The technical distribution losses will not contain other type of losses (e.g. commercial losses/theft). The distribution losses are based on references from utilities (AMPLA is the local power utility), network operators or other official documents from ANEEL [30]. The transmission losses occurring within the Brazilian interconnected grid are based on information provided by CCEE[31].
Monitoring frequency	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	-
Purpose of data	Calculation of project emissions
Additional comment	Information from 2011 was used with the purpose of calculating expected emission reductions. The default value of 20%, as specified in the methodological tool, is to be used in the case this information is not promptly available during periodic verifications.

Tool to determine project emissions from fossil fuel combustion

[30] AMPLA Technical Note nº50/2012-SRE/ANEEL (http://www.aneel.gov.br/cedoc/nreh20121265.pdf)

[31] CCEE Annual Report (http://www2.ccee.org.br/cceeinterdsm/v/index.jsp?qryRELATORIO-ANO=64b1b60530cb6310VgnVCM1000005e01010a____&contentType=ARQUIVO&vgnextoid=1d9da5c1de88a010VgnVCM100000aa01a8c0RCRD&x=11&y=9).

Data / Parameter	$FC_{i,j,y}$
Unit	m^3/yr
Description	Quantity of fuel type *i* combusted in process *j* during the year y (*i* = diesel oil)
Source of data	Onsite measurements
Value(s) applied	55.3
Measurement methods and procedures	This parameter will be monitored using volume meters. Diesel oil will be used only in the emergency diesel generator. Therefore, it is assumed that the fuel is to be supplied from small daily tanks. In this sense, rulers are used to determine the volume of the fuel consumed. The requirements of the methodology regarding the measurement methods are to be applied, as follows: The ruler gauge must be part of the daily tank and calibrated at least once a year (consisting of a visual inspection to ensure the measurement is possible) and have a book of control for recording the measurements (on a daily basis or per shift). In accordance with the national requirements[32], precision of visual measurements from ruler gauges is ±20mm.
Monitoring frequency	Continuously
QA/QC procedures	The consistency of metered fuel consumption quantities is to be cross-checked with available purchase invoices from the financial records.
Purpose of data	Calculation of project emissions
Additional comment	-

Data / Parameter	$\rho_{,i,y}$
Unit	kg/m^3
Description	Weighted average density of fuel type *i* in year *y* (*i* = diesel oil)
Source of data	National default value from the *Brazilian Energy Balance 2011*[29]
Value(s) applied	840
Measurement methods and procedures	-
Monitoring frequency	Review appropriateness of the value annually
QA/QC procedures	The information shall be well documented and reliable sources are to be used.
Purpose of data	Calculation of project emissions
Additional comment	Applicable since $FC_{i,j,y}$ is measured in volume units.

[32] ANP and INMETRO Ordinance #1, dated 19/06/2000. Available in Portuguese at http://nxt.anp.gov.br/NXT/gateway.dll/leg/folder_portarias/portarias_conj/2000/pconj%201%20-%202000.xml?f=templates$fn=default.htm&sync=1&vid=anp:10.1048/enu

Data / Parameter	***$NCV_{,i,y}$***
Unit	GJ/ton
Description	Weighted average net calorific value of fuel type *i* in year *y* (*i* = diesel oil)
Source of data	c) Regional or national default values
Value(s) applied	42.3
Measurement methods and procedures	-
Monitoring frequency	Review appropriateness of values annually
QA/QC procedures	Verify if the value is within the uncertainty range of the IPCC default values as provided in Table 1.2, Vol. 2 of the 2006 IPCC Guidelines. If the values fall below this range collect additional information from the testing laboratory to justify the outcome or conduct additional measurements. The laboratories in a), b) or c) should have ISO17025 accreditation or justify that they can comply with similar quality standards.
Purpose of data	Calculation of project emissions
Additional comment	Option c) is used since a liquid fuel is considered and is based on well documented reliable sources (*i.e.* Brazilian Energy Balance). Information used with the purpose of calculating expected emission reductions is in accordance with the values provided in 2006 IPCC Guidelines.

Data / Parameter	***$EF_{CO2,i,y}$***
Unit	tCO_2/GJ
Description	Weighted average CO_2 emission factor of fuel type *i* in year *y* (*i* = diesel oil)
Source of data	d) IPCC default values at the upper limit of the uncertainty at 95% confidence interval as provided in Table 1.2 of Chapter 1 of Vol.2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories
Value(s) applied	0.0748
Measurement methods and procedures	Not applicable since IPCC default value is used.
Monitoring frequency	Any future revisions of the IPCC Guidelines should be taken into account.
QA/QC procedures	Not applicable since IPCC default value is used.
Purpose of data	Calculation of project emissions
Additional comment	-

Data / Parameter	$EF_{CO2,i,y}$
Unit	tCO_2/TJ
Description	Weighted average CO_2 emission factor of fuel type *i* in year *y* (*i* = natural gas)
Source of data	IPCC default values at the upper limit of the uncertainty at 95% confidence interval as provided In Table 1.2 of Chapter 1 of Vol.2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories
Value(s) applied	58.3
Measurement methods and procedures	Not applicable since IPCC default value is used.
Monitoring frequency	Any future revisions of the IPCC Guidelines should be taken into account.
QA/QC procedures	Not applicable since IPCC default value is used.
Purpose of data	Calculation of baseline emissions
Additional comment	Option d) is used since the source mentioned in option a) is not available. Further the fuel considered – *i.e.* natural gas - is not liquid. Therefore, option c) could not be used. This parameter is used to determine $EF_{CO2,NG,y}$ from ACM0001. Following the procedures of the methodology, it is to be determined using the "*Tool to determine project emissions from fossil fuel combustion*".

B.7.2. Sampling plan
>>
Not applicable. This section is intentionally left blank.

B.7.3. Other elements of monitoring plan
>>
Data transmission, processing and storage

The variables described in item B.7.1 will be automatically registered in a supervisory computer system. There is a responsible person in charge of data checking in order to keep the process functioning.

If the automatic transmission fails, the responsible person will contact an operator to register data manually.

- If data can be retrieved subsequently, they will be reintegrated on the server.
- If data cannot be retrieved, no emissions reductions will be claimed for the period of data failure.

Concerning data storage, all information will be stored physically on the disk of the server machine.

- A backup of the server will be done.
- A copy of the backup on a portable electronic storage device will be held securely at Novo Gramacho office.
- Copies of the files will be stored up to two years after the end of the crediting period or the last issuance of CERs for this project activity whichever occurs later.

Calibration and Maintenance Procedures, Malfunction of Equipment

Flow meters: should be subject to a regular maintenance and testing regime to ensure accuracy, in compliance with national laws (such as noise testing and lubrication, among others).

Gas analyzers: are subject to periodic maintenance (such as tightening the fittings, change filters, and electrical tests, among others). The gas analyzers will be calibrated internally once a week, using certified samples.

Thermocouples: should be calibrated or replaced every year.

Electricity meters: Calibration frequency: according to the manufacturer recommendation.

If the monitoring equipment fails, the equipment supplier will be immediately notified. If possible, repairs will be carried out. If the damaged equipment cannot be repaired, it will be replaced at the earliest by the same or an equivalent unit. In some cases, portable tools will be used in order to carry out daily monitoring of the missing parameter(s). This data will be recorded on paper.

Responsibilities

The CDM aspects of the project are managed by the managers of both plants (Gas Verde and Novo Gramacho), who supervises the CDM Project Managers who is in charge of monitoring activities (preparing the monitoring report). It is the ultimate responsibility of the Director to ensure the content of the monitoring report is correct at the time of requesting issuance.

The preparation of the monitoring plan is the responsibility of the CDM Project Manager, who reports to the Director for CDM matters (collection and storage of monitoring data) and to the Coordinator of Operations for operational matters.

The CDM Project Managers supervises the calibration and maintenance procedures.

Maintenance programs are carried out on site by the Field Technician, who also makes sure the monitoring tools are operating correctly.

Quality Assurance & Quality control

The monitoring report is the responsibility of the Director. As such, he will be allowed to control consistency of monitored data by any means, such as on-site audit, visual control of data existence on the server, cross-checking of data on the server with data provided by the field technician and/or the maintenance director and/or the monitoring director.

Training

Employees involved in the monitoring will be trained internally and/or externally at least once every two years. Training will include: Review of equipment, Calibration requirements, Configuration of monitoring equipment, maintenance requirements.

Flaring of biogas by an "emergency flare" at the site of biogas capture

During the periods when the upgrading facility is closed due to the scheduled maintenance, reparation of equipment as described above, or other emergency, project participants should ensure that the captured biogas is flared at the site of its capture. Any of the flares installed will be used as emergency flares.

SECTION C. Duration and crediting period
C.1. Duration of project activity
C.1.1. Start date of project activity
>>
12/12/2008

In accordance with the "*Glossary of CDM Terms*" (EB66, Annex 63) the start date of the CDM Project Activity corresponds to "*the earliest date at which either the implementation or construction or real action of a CDM project activity or PoA begins*".

The following timeline shows relevant dates connected to the implementation of the Gramacho Landfill Gas Project as a CDM project activity.

DATE	Related CDM activity	Project timeline
05/07/07	Contract between Novo Gramacho and COMLURB was signed; CERs are considered in the contract. The signed contract included the following revenue sources: 1) Revenues paid by COMLURB for the disposal of urban waste in the Gramacho landfill in the period 2007-2012. 2) Right to sell CER (certified emission reduction) 3) Right to sell LFG in raw or purified for final consumers as well as sell of CO_2 liquid. <u>This contract did not obligate the PP to make investment in the project.</u>	
18/10/07	Contract for CDM consultancy between Novo Gramacho Energia Ambiental and ARCADIS Tetraplan	
03/09/08	First Global Stakeholder Process (PDD using ACM0001 and AM0069)	
12/12/08 – (**start date) first investment decision** (considering LFG extraction and flaring system and direct sell of LFG to GPC Quimica)		Contract signed for the wells drilling with Perfurasolo (well drillings began on 13/01/09)
26/03/09	First LoA obtained	
29/04/09	Submission of the first PDD to UNFCCC	
30/06/09	ERPA signed with KfW	
29/09/09	Withdrawn of the first PDD by the project participants.	
30/12/09 – **second investment**		Due to no continuity of trading for

decision (considering the upgrade of the LFG to inject into natural gas distribution network and not the sell of LFG to GPC Quimica)		the execution of the contract with GPC Química the first design of the project activity changed: the use of biogas to produce Town Gas (by GPC Química) has been replaced by the upgrading of the LFG and its injection in the REDUC natural gas distribution grid. The collection and flaring component remain the same (with some upgrades). The investment decision to upgrade the biogas and sent it to a natural gas distribution grid was made on 30/12/2009, when the contract with Petrobras was signed. During this period the necessary arrangements have been done to obtain the upgrading gas facility license.
02/05/11	Contract with independent CDM consultant for revision of first PDD and modification considering the upgrade of LGF injected into natural gas distribution grid (in colaboration with ARCADIS Tetraplan)	
06/02/12	Proposal with DNV for validation of revised PDD.	

Therefore, the identified starting date of the proposed project activity is 12/12/2008, which represents the date when the contract signed for the wells drilling was signed, or rather, the first relevant contract signed by the project developer.

C.1.2. Expected operational lifetime of project activity
>>
15 years

C.2. Crediting period of project activity
C.2.1. Type of crediting period
>>
Renewable crediting period

C.2.2. Start date of crediting period
>>
01/01/2013

C.2.3. Length of crediting period

7 years – 0 months

SECTION D. Environmental impacts
D.1. Analysis of environmental impacts
>>

In Brazil, the sponsor of any project that involves construction, installation, expansion or operation of any polluting or potentially polluting activity or any other capable to cause environmental degradation is obliged to secure a several permits from the relevant environmental agency (federal and/or local, depending on the project).

Licenses required by the Brazilian environmental regulation (National Environmental Council – from the Portuguese CONAMA - *Conselho Nacional do Meio Ambiente* nr. 237/97[33]) are:

- The preliminary license (*Licença Prévia* or LP);
- The construction license (*Licença de Instalação* or LI); and
- The operating license (*Licenca de Operação* or LO).

However, this regulation was only approved when the SWDS was already operational. Then, grant the environmental permits to the landfill, FEEMA – Fundação Estadual de Engenharia e Meio Ambiente (Rio de Janeiro State's environmental authority) requested the project sponsor to provide copies of all the technical drawings related to the implementation of the proposed project activity (LFG active capture system, LFG upgrading facility, among others).

No transboundary impacts additional to those already observed before the implementation of the project are expected. Additionally, the impacts due to the implementation of the project 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).

In this sense, FEEMA issued, on 02/06/2008 the Installation Licence # FE014252. This Installation License will expire in 02/06/2011. NGEA is already providing its renewal by the INEA (State Environmental Institute, the environmental agency that replaced FEEMA). The renewal process protocol was supplied to the DOE.

There is a second license for Novo Gramacho Energia Ambiental S/A issued by INEA - an Operating License nº. IN001527, dated on March 22nd, 2010, valid through March 22nd, 2015. This license authorizes NGEA operating the plant to capture and burning in flares the landfill gas generated in Gramacho Landfill. This License does not replace the Installation License issued by FEEMA mentioned above.

The biogas purification plant also had its Installation License nº IN015860 issued by INEA on 21 February 2011, valid through February 21st, 2014. This license was allowed for the deployment of the Separation, Purification System and Transport of landfill gas per duct. To obtain this license, supported by the actual laws - federal and state environmental legislation, was not necessary to carry out the Environmental Impact Assessments (there is a letter filed by the environmental agency that serves as evidence).

D.2. Environmental impact assessment
>>

[33] Available at: http://www.mma.gov.br/port/ conama/res/res97/res23797.html.

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. Local stakeholder consultation
E.1. Solicitation of comments from local stakeholders
>>

According to Resolution nr. 7, issued on March 5th 2008[34], Brazilian Designated National Authority (*Comissão Interministerial de Mudanças Globais do Clima – CIMGC)*, requests, among other documents, comments from local stakeholders in order to provide the Letter of Approval for a project.

The Resolution determines that the project proponent has to send invite for comments, at least, the following agents involved in and affected by project activity:

- Municipal governments and City Councils;
- State and Municipal Environmental Agencies;
- Brazilian Forum of NGOs and Social Movements for Environment and Development;
- Community associations;
- State Attorney for the Public Interest (state and federal);

The same resolution also requires that at the time these letters are sent, a version of the PDD in the local language and a declaration stating how the project contributes to the sustainable development of the country must be made available to these stakeholders at least 15 days previous to the starting of the Global Stakeholder Process (GSP).

The Portuguese version of the PDD was published at the internet website <http://sites.google.com/site/consultadcp/> on 06/07/2012 which is also the date when the invitation letters were sent to the following agents:

- Municipality of Duque de Caxias
- Legislative Chamber of Duque de Caxias
- State Environmental Agency (*FEEMA – Fundação Estadual de Engenharia e Meio Ambiente*)
- Municipal Environmental Secretariat
- Brazilian Forum of NGOs and Social Movements for Environment and Development (*FBOMS - Fórum Brasileiro de ONG's e Movimentos Sociais para o Meio Ambiente e Desenvolvimento*)
- State Public Attorney of Rio de Janeiro
- Federal Public Attorney
- ACAMJG – Associação dos Catadores de Materiais Recicláveis de Jardim Gramacho
- Municipality of Rio de Janeiro

Copies of the letters and post office confirmation of receipt are available upon request and will be submitted to the DOE during the validation of the Project Activity.

E.2. Summary of comments received
>>

[34] Available at: <http://www.mct.gov.br/>.

No comments have been received yet.

E.3. Report on consideration of comments received

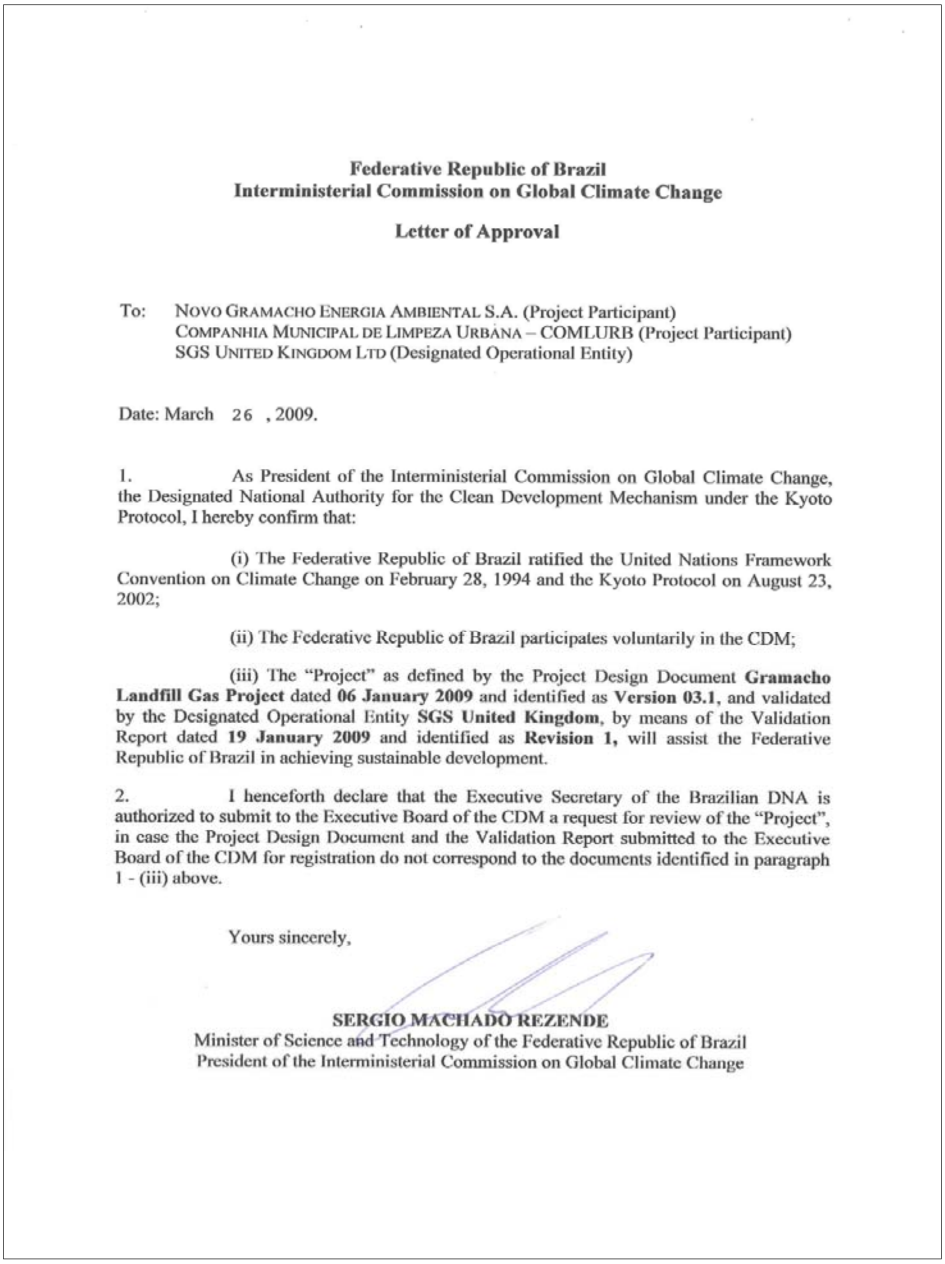
>>

No comments have been received yet.

SECTION F. Approval and authorization

>>

The proposed CDM project activity has already been submitted for registration. The Letter of Approval (LoA) was granted by the Brazilian DNA on March 26th, 2009 (Figure 14). A copy of the original document is available with Project Participants.



Federative Republic of Brazil
Interministerial Commission on Global Climate Change

Letter of Approval

To: Novo Gramacho Energia Ambiental S.A. (Project Participant)
Companhia Municipal de Limpeza Urbana – COMLURB (Project Participant)
SGS United Kingdom Ltd (Designated Operational Entity)

Date: March 26 , 2009.

1. As President of the Interministerial Commission on Global Climate Change, the Designated National Authority for the Clean Development Mechanism under the Kyoto Protocol, I hereby confirm that:

(i) The Federative Republic of Brazil ratified the United Nations Framework Convention on Climate Change on February 28, 1994 and the Kyoto Protocol on August 23, 2002;

(ii) The Federative Republic of Brazil participates voluntarily in the CDM;

(iii) The "Project" as defined by the Project Design Document **Gramacho Landfill Gas Project** dated **06 January 2009** and identified as **Version 03.1**, and validated by the Designated Operational Entity **SGS United Kingdom**, by means of the Validation Report dated **19 January 2009** and identified as **Revision 1**, will assist the Federative Republic of Brazil in achieving sustainable development.

2. I henceforth declare that the Executive Secretary of the Brazilian DNA is authorized to submit to the Executive Board of the CDM a request for review of the "Project", in case the Project Design Document and the Validation Report submitted to the Executive Board of the CDM for registration do not correspond to the documents identified in paragraph 1 - (iii) above.

Yours sincerely,

SERGIO MACHADO REZENDE
Minister of Science and Technology of the Federative Republic of Brazil
President of the Interministerial Commission on Global Climate Change

Figure 14 – Letter of Approval related to the first submission of the project.

Nevertheless, the project was withdrawn during the review process. As it can be observed, the above mentioned LoA refers to a different DOE and version of documents. In this sense, after the conclusion of the validation, an update of the LoA is to be requested.

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Appendix 1: Contact information of project participants

Organization name	Novo Gramacho Energia Ambiental S.A.
Street/P.O. Box	Rua da Assembléia, 10 – 15° andar, sala 1504
Building	
City	Rio de Janeiro
State/Region	Rio de Janeiro
Postcode	
Country	Brazil
Telephone	+ 55 (21) 2222-0430
Fax	+ 55 (21) 2222-0430
E-mail	
Website	
Contact person	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 name	Companhia Municipal de Limpeza Urbana – COMLURB
Street/P.O. Box	Rua Major Ávila, 358 – 2nd floor
Building	
City	Rio de Janeiro
State/Region	Rio de Janeiro
Postcode	20511-900
Country	Brazil
Telephone	+ 55 21 2204-9999
Fax	+ 55 21 2214-7272
E-mail	comlurb_pce@rio.rj.gov.br
Website	http://www.rio.rj.gov.br/comlurb
Contact person	Mrs. Angela Nobrega Fonti
Title	President
Salutation	Ms.
Last name	Nabrega Fonti
Middle name	-
First name	Angela
Department	Board
Mobile	

Direct fax	
Direct tel.	
Personal e-mail	afonti.comlurb@rio.rj.gov.br

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Appendix 2: Affirmation regarding public funding

No public funding for this project has been obtained.

- - - - -

Appendix 3: Applicability of selected methodology

BASELINE INFORMATION

Not applicable. This section is intentionally left blank. Please refer to sections B.6.1 and B.6.3. for details regarding the emission factor of the Brazilian Interconnected Grid calculation.

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Appendix 4: Further background information on ex ante calculation of emission reductions

Not applicable. This section is intentionally left blank.

- - - - -

Appendix 5: Further background information on monitoring plan

This section is intentionally left blank. For details, please, refer to B.7.1. and B.7.2

- - - - -

Appendix 6: Summary of post registration changes

Not applicable. This section is intentionally left blank.

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History of the document

Version	Date	Nature of revision
04.1	11 April 2012	Editorial revision to change version 02 line in history box from Annex 06 to Annex 06b.
04.0	EB 66 13 March 2012	Revision required to ensure consistency with the "Guidelines for completing the project design document form for CDM project activities" (EB 66, Annex 8).
03	EB 25, Annex 15 26 July 2006	
02	EB 14, Annex 06b 14 June 2004	
01	EB 05, Paragraph 12 03 August 2002	Initial adoption.
Decision Class: Regulatory **Document Type:** Form **Business Function:** Registration		