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

CONTENTS

Annexes

SECTION A. General description of project activity

A.1. Title of the project activity:

- Title: “Exploitation of the biogas from Controlled Landfill in Solid Waste Management Central – CTRS / BR.040”, hereinafter referred to as “the Project”
- Current version number of this document: Version 1
- Date of completion: 03/12/2008

A.2. Description of the project activity:

The Project will consist of a collection, transport and treatment system for landfill gas with production of electricity for self-consumption and incorporation to the national grid. Since the landfill gas major constituent is methane, whose GHG potential is 21 times the CO2, the Project will reduce the emission of GHG into the atmosphere by means of methane destruction in high temperature flares and of displacement of electricity generated from fossil fuel sources.
The landfill site occupies a total area of 114,9 ha, with an area of 65 ha. planned for municipal waste treatment and disposal. The area around the landfill may be considered humid, with an average annual precipitation of 1460 mm and an average temperature of 21°C. The climate is classified as “tropical with winter rains”.
The landfill began accepting waste in 1975. By the end 2006, more than 17.400.000 m^3 of solid urban waste have been filled over the landfill. The maximum landfill height is about 64 meters. The lifetime of the landfill was 32 years, ending on December 2007.
Currently the scenario existing prior to the start of implementation of the Project is that there are 123 landfill gas vents (or passive gas wells) installed over the 65-hectare area, venting the gas from inside the waste mass to the top of each vent, only few of them are occasionally lighted on by the landfill management. This scenario is the same as the baseline scenario, as hereinafter will be clearly demonstrated.
It is estimated that Consòrcio Horizonte Asja would need a total 500 kW installed capacity for satisfying energy requirements of the LFG plant itself (mainly for the blowers) during operation.
The project will have a positive impact over sustainable development mainly in the following ways:
a) Environmental Benefits
An environmental benefit achieved by Project is the destruction of methane that otherwise would be emitted to the atmosphere, thus increasing the impact on global warming. The project will also generate electricity from renewable source avoiding the generation of the same amount of energy by fossil fuels to the grid.
b) Social / Income Generation Benefits / Labour Capacitating
As landfill gas electricity generation projects is a wide new venture in Brazil (only a few projects are already generating electricity from the landfill gas), new capacitated job positions will be created. A team of engineers and operators will be hired and trained in order to run the project and to make continuous monitoring and maintenance of the collecting system, gas station and power house. These job positions will receive a salary higher than the one actually paid by the market, as the project needs a more skilled labour.

A.3. Project participants:

Name of Party Involved (host) indicates a Host Party)	Private and/or public entity(ies) project participants (as applicable)	Kindly indicate if the Party involved wishes to be considered as project participant (Yes / No)
Brazil (host)	• Consórcio Horizonte Asja • Asja Brasil Serviços para o Meio Ambiente Ltda.	No
Argentina	Aria.biz S.A.	No

Consórcio Horizonte Asja is a joint venture between ASJA BRASIL Serviços para o Meio Ambiente Ltda. and ARIA.BIZ S.A..

A.4. Technical description of the project activity:

A.4.1. Location of the project activity:

The Project is locate in CTRS / BR.040 Landfill, to be found on highway BR.040, section Belo Horizonte – Sete Lagoas, near km 531, Jardim Filadélfia neighbourhood in Belo Horizonte (MG)

A.4.1.1. Host Party(ies):

Brazil

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

Minas Gerais

A.4.1.3. City/Town/Community etc.:

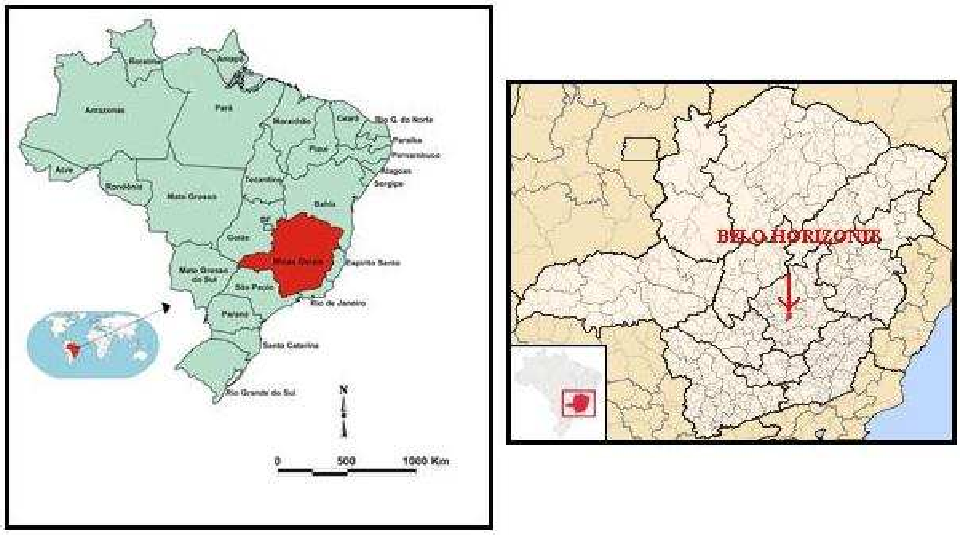
Belo Horizonte

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

CTRS / BR.040 landfill is located at coordinates:

Latitude S: 19° 54' 57,1”
Longitude W: 44° 01' 05,1”

The pictures below presents the detailed location of the landfill:



Picture A.4.1.4-1 Project location

Picture A.4.1.4-2 CTRS / BR.040 landfill location
Source: Google Earth.

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

The Project is categorized in the following Sectoral Scopes:

• *Sectoral Scope 13 – Waste Handling and Disposal:* used to calculate emission reductions due to the production of methane from the decomposition of municipal solid waste to the atmosphere; and
• *Sectoral Scope 1 - Energy industries (renewable - / non-renewable sources):* applied to calculate

the grid-emission factor of CO2e and the emission reductions from the sale of renewable electricity to the grid.

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

BASELINE SCENARIO

The baseline scenario, as identified in section "B.4 Description of how the baseline scenario is identified and description of the identified baseline scenario", is the same as the scenario existing prior to the start of implementation of the Project: BAU Business As Usual scenario.
The BAU scenario for CTRS / BR.040 landfill consist in that the LFG arising from the landfill at present is vented for safety reasons thanks to passive venting wells built to discharge LFG as the dumped wastes height increased over the landfill's operational years.
According to the field survey presented in Annex 3, the existing practice is to light occasionally some of the total 123 vents: the daily average number of lighted wells can be conservatively overestimated to be equal to 20%,
No equipment or machinery are installed nor any other system is in operation at the CTRS / BR.040 Landfill.

PROJECT SCENARIO

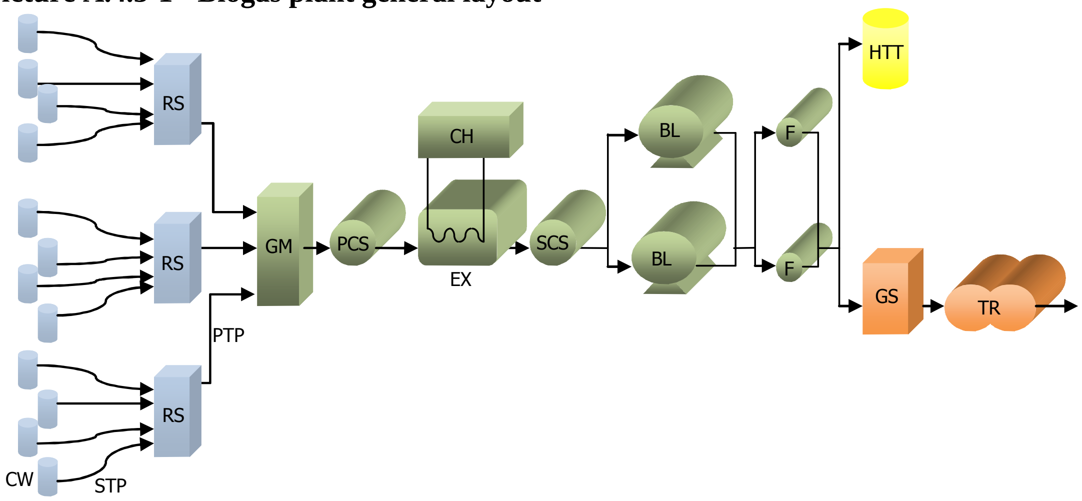
1 Biogas plant general layout

The whole general layout includes landfill gas collecting, pre-treatment, power generation and flare combustion systems; Consòrcio Horizonte Asja is responsible for all the design, construction, operation and maintenance process.
In Consòrcio Horizonte Asja's Biogas Plant the following sections are recognized:

1. biogas collection section
2. biogas conveying section
3. biogas suction, treatment, analysis and torch combustion section
4. electricity generation, transformation and distribution section

These sections are generically showed in picture A.4.3.1 below:

Picture A.4.3-1 - Biogas plant general layout



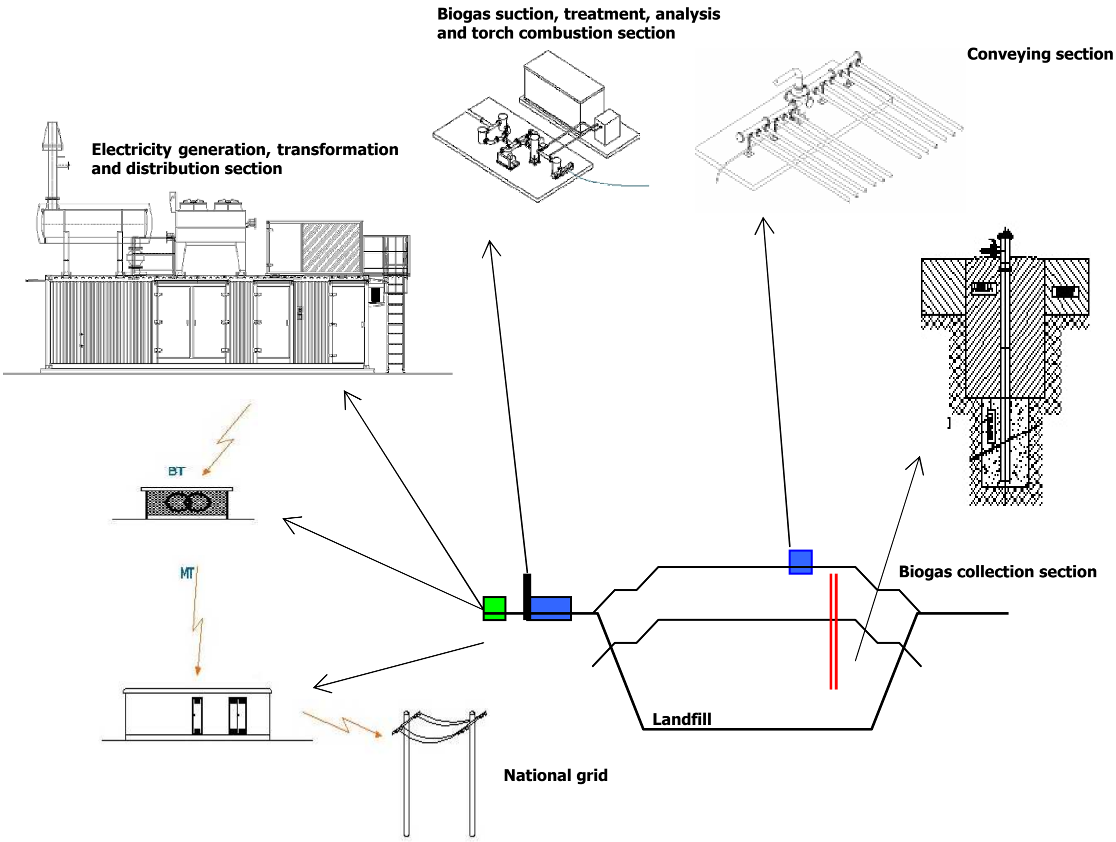
Collection Section	Suction and Control Section	Electricity generation and Torch Section

<u>Collection Section</u>	<u>Suction and Control Section</u>	<u>Electricity generation and Torch Section</u>
CW: Capture Well	**GM**: General Intake Manifold	**GS**: Generation Set
STP: Biogas Secondary Transport Pipelines	**PCS**: Primary Condensate Separator (Cyclonic)	**HTT**: High Temperature Torch
RS: Regulation Substation	**EX**: Pipe bundle Heat Exchanger	**TR**: Transformer
PTP: Biogas Primary Transport Pipelines	**SCS**: Secondary Condensate Separator	
	CH: Chiller	
	F: Dry filter	
	BL: Multistage Blower	

Therefore the plant is divided in two main sections:

- BIOGAS FLARING PLANT: divided in the subsections 1, 2 and 3 as mentioned above;
- ELECTRICITY GENERATION PLANT: section 4.

A more detailed scheme of a working plant is showed in picture A.4.3.2 as follows:



Picture A.4.3-2 – Scheme of working plant

In the following sub chapters, all the technical equipment which will be used in the CTRS / BR.040 biogas plant will be evaluated in more detail.

2 Biogas collection section

2.1 Vertical wells

To set up the biogas collection section, in order to ensure a full coverage of the landfill, the waste body will be drilled by means of special drills, to create boreholes with an average diameter of 100 cm down to a maximum depth of 50 metres down from ground level, however at list 3 meters up from the bottom of the landfill. Drilling machines are showed in the following picture A.4.3-3

Picture A.4.3.3 - Coil drill and bucket

To ensure a regular outflow of biogas, a submersed pump is dropped within HDPE pipes, one each 3 ÷ 5 wells, in order to remove the leachate from the wells and keep them empty.
A *well-head* is fitted onto the top of the well to prevent the vacuum applied to cause air suction into the wells.
In CTR / BR.040 Landfill Consòrcio Horizonte Asja forecast to drill 165 vertical wells, fit them with macro slotted HDPE pipe DN 200 PE 80 PN 10, and install at list 32 leachate pumps.

2.2 Well heads

Each well is fitted with a well head consisting of a carbon steel pipe, complete with a flanged side section bearing a butterfly valve type that enables the well to be connected or cut out from the vacuum system.
The well head are equipped with threaded pipe unions to allow the installation of a submersible pump for leachate removal from the well and fitted with wiring and control float; in this case, the leachate accumulated within well can be easily extracted without removing the well head.
One of the threaded pipe unions will be used for gas sampling and physical and chemical measuring of gas characteristics.
The well head mounting and the connection between all well devices must be performed with particular care to avoid air insertion through waste body that could bring bacteria working under aerobic condition within landfill, therefore inhibiting methane production.

3 Biogas conveying system

The biogas conveying system main components are: HDPE pipelines from well heads to substations of regulation; substations of regulation; HDPE pipelines from substations of regulation to the lines manifolds; HDPE pipelines from lines manifolds to the suction station.

3.1 HDPE pipelines

The biogas conveyance grid is constituted by some HDPEpipelines which links each well and convey the gas to a substation of regulations.
Pipelines from well heads to substation of regulation are connected in parallel, to ensure a more effective management of the extraction process, bearing in mind that this system can be useful to manage wells

created with different techniques or in different periods and therefore highly heterogeneous as flow and percentage of methane produced.
During the normal operational phases, the biogas flows through the pipelines towards the vacuum station; hence in case of accidental breakdown of the pipes, the biogas does not exit from the pipe moving along the atmosphere.
All pipes are laid on the landfill surface with appropriate slopes, in order to ensure a regular flow of the condensate to the collection points.
All the pipes are welded on site with the addition of the special parts necessary to finish the work according to the highest workmanlike standards.
From each substation of regulation to lines manifolds, HDPE DN 200 connection pipelines will be laid, from lines manifolds to the suction station there will be 2 connecting HDPE DN400 pipelines.

3.2 Substation of regulation and lines manifolds

The substation of regulation is made of galvanised steel and fitted with an inlet for each pipe coming from a single biogas well; the biogas capacity at each entry point flowing from the relative well can be regulated with a hand wheel valve, and a central barrel is provided for condensate separation.
Each control station has twelve or more entry points (the number can be further increased) and it is connected to one primary DN 200 mm HDPE pipeline which it is in charge to transfer the biogas from the substation of regulation to the line manifolds.
For CTR / BR.040 Landfill Consòrcio Horizonte Asja forecast to install 13 substation of regulation and 2 lines manifolds, from substations to manifolds the pipelines should be HDPE DN 200, from manifolds to the suction station the 2 lines should be HDPE DN 400.

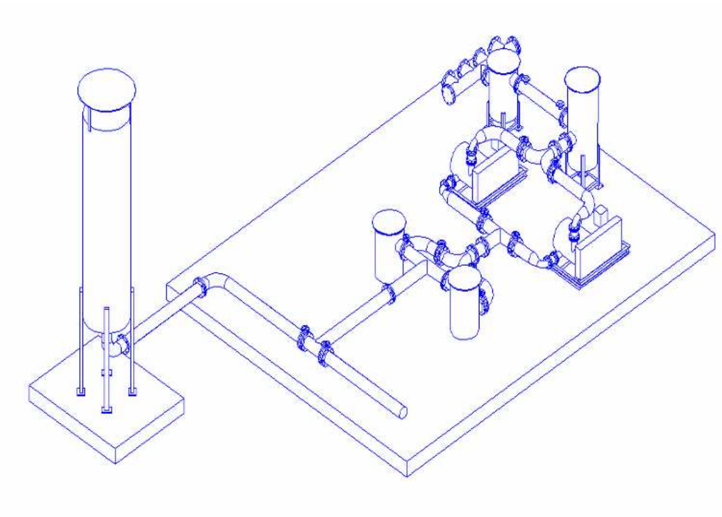
4 Biogas suction and pre-treatment system with Torch section

4.1 Biogas treatment section

In substations of regulation and in line manifolds the condensate can be discharged in order to keep the whole LFG collecting and conveying system in the best operating conditions and to purify LFG as much as possible before entering the suction station section. Through the pipelines the LFG extracted from the landfill reaches a carbon steel manifold which collects the biogas from the 2 lines in a separator/coalescer filter for a first coarse separation of the condensate. Manifold interior surfaces are preserved by chemical biogas attack through the use of a particular protective covering.
Two multistage turbo blower/exhauster specially engineered for this particular application are present; these devices are able to apply enough difference in pressure for all the biogas capture lines and, at the same time, are able to push treated biogas to feed the engines and flares. After the blower/exhauster and before the engines, biogas pass through a series gas/water & glycol tube nest heat exchangers that can cool the LFG to a temperature lower than 10 °C, by means of a set of chillers.
The condensate formed is then separated by a coalescer filter, situated downstream of the tube nest, therefore a sizeable share of the impurities (sulphurated, aromatic, halogenated compounds), trapped in the condensate itself, are eliminated from the LFG stream.
In CTR / BR.040 Landfill's Suction station Consòrcio Horizonte Asja forecast to install two multistage centrifugal blowers in parallel that would be able to achieve the below mentioned technical performance:

Inlet Pressure: - 2000 mm WC
Outlet Pressure: + 1500 mm WC

Covers with soundproof material are installed to wrap the blowers in order to minimize the noise produced.
This section is designed with two blowers with the same characteristics in parallel to ensure trouble-free operation even in the event of a failure occurring in one of the machines.
Afterwards, biogas passes through a dry filter which consists in barrels made on site in carbon steel fitted with polyester filters, in order to remove solid impurities from the gas flow (as well as a share of the micro-contaminants that would be harmful to the electric energy generating sets).
Part of a biogas treatment section is sketched in picture A.4.3.4



Picture A.4.3.4 - Blower plant with torch

4.2 Flaring Section

This section will be equipped with enough high temperature enclosed flares to ensure the LFG captured would be completely and safely destroyed. Each flare installed In CTRS / BR.040 plant will be assembled and designed to ensure a combustion temperature between 800 °C and 1200 °C and will be equipped with all the equipment need to monitor the flare's combustion efficiency in continuous, according to the "*Tool to determine project emissions from flaring gases containing methane*" specifications: i.e. flow meter on the inlet pipeline and a K-type thermocouple temperature probe and an exhaust gas sampling point to measure unburned methane and oxygen content in the exhaust gases, both thermocouple and sampling point will be installed at 80% of torch's height.

4.3 Monitoring system

The biogas analysis and control system of the plant main goals are:

- monitor the biogas extracted from the wells, to determine its quality, quantity, pressure and temperature;
- control the flow of biogas by means of an inverter that regulates blower's working regime changing the feeding electricity's frequency and thus the rotation speed of the blower's electrical motors;
- detect any type of malfunctioning and give out an alarm if any hazardous situation occur (e.g. high oxygen content in the LFG).

The analytical instruments installed includes a CH_4 (methane) analyser and an O_2 (oxygen) analyser.

An excessive percentage of oxygen in biogas composition is perceived by a remote alarm which close automatically the general valve to break off the gas flow.
Moreover, a management and alarm device for the most important parameters (pressure, temperature, capacity, frequency, etc…) related to plant operation is installed.
In particular LFG flow (on main line, on each torch and generating sets feeding lines), combustion efficiency for each flare, and Project's electricity productions and consumptions and all the others relevant parameters, as stated in section "**B.7.**" of this PDD, are considered and monitored.

5 Biogas Utilization System

This system the electricity generation, transformation and distribution section, is composed of the following main sections:

5.1 Electricity generation section

The gas coming from the suction and treatment section is conveyed, through a mild pressure line, to internal combustion-engine generating sets.
This is a well known and high reliable technology for biogas utilization; furthermore internal combustion-engine generating sets have enough low capital costs, modular design and are available in many different sizes to be installed step by step as the biogas flow increases.
High performances and reliability are guaranteed for these equipments.
Two steps are foreseen in electricity generation section installation: the first will have 500 kW installed ; the second will have a 4MW total installed capacity.
According to the LFG production prediction, the forecasted electricity generation and plant self consumption amounts are, year by year, listed in the following table:

Table A.4.3-1 – Electricity consumption and production[1]

Years	Engine working hours	Electricity Consumed by the Project Activity $EC_{PJ,}$ - (MWh / y)	Electricity Generation - kW installed	Electricity produced $EL_{LFG,y}$ - (MWh / y)
2009 (4 months)	2,500	605	500	520
2010	7,500	2,865	4,500	27,510
2011	7,500	2,865	4,500	27,510
2012	7,500	2'865	4,500	25,250
2013	7,500	2,865	4,500	20,983
2014	7,500	2,865	4,500	17,704
2015	7,500	2,865	4,500	15,127
2016	7,500	2,865	4,500	13,057
2017	7,500	2,865	4,500	11,360
2018	7,500	2,865	4,500	9,941
2019 (8 months)	5,000	1,910	4,500	5,823

5.2 Grid connection System

The power produced is transformed from low voltage to medium voltage by means of ad hoc equipment and then is transferred to the national distribution network; all the devices installed to synchronise and protect the generating sets and the power lines are placed in special prefabricated containers or electric cubicles.

5.3 Landfill gas flaring

When the generating section will be in regular operation, the LFG exceeding the maximum capacity of generators and/or during periodical engines maintenance stops will be flared in the high temperature flares; before that time, the LFG extracted from the landfill will be conveyed to the flaring section to be destroyed, therefore avoiding the corresponding methane quantity to be emitted in the atmosphere.

5.4 Control system

It is the instrumental system able to control all of the chemical and physical parameters of biogas as well as to control the main equipments of the plant both for the feeding and for the generating section.
All data from analyzers and various instruments on the lines are acquired in a control system PLC that control all the automatic operations of the plant (inverter operation to adjust blower's performance in order to keep Pressure constant in engine's feeding line, oxygen content, etc..).
The gas engine-generator sets have an own local control and regulation system supplied together with the sets from the engine supplier. The system governs all regulation and control processes needed for correct sets running, ex.: combustion and feeding mixture regulations, self checking, automatic gas-engine starts and stops, etc..

[1] The nominal installed capacity is 4.5MW but it is considered to be 90% electricity effective thus counting as 4.05 MW for the electricity production calculations.

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

Table A.4.4.1 Total Emission Reductions

Year	Annual Estimation of emission reductions in tonnes CO2e
2009 (4 months)	96,275
2010	234,565
2011	191,679
2012	159,500
2013	134,678
2014	115,598
2015	100,606
2016	88,566
2017	78,693
2018	70,437
2019 (8 months)	42,276
Total number of crediting years:	**10**
Annual average over the crediting period of estimated reductions: (tonnes of CO2e)	**119,352**

A.4.5. Public funding of the project activity:

No public funding is needed for the "Exploitation of the biogas from Controlled Landfill in Solid Waste Management Central – CTRS / BR.040" Project Activity.

SECTION B. Application of a baseline and monitoring methodology

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

The Project applies two methodologies:
• Version 09.1 of *ACM0001 – Consolidated methodology for landfill gas project activities;*
• Version 08 of *ACM0002 – Consolidated baseline methodology for grid-connected electricity generation from renewable sources*;
And the related Tools:
• Version 05.2 of the *Tool for the demonstration and assessment of additionality;*
• Version 01 of the *Tool to determine project emissions from flaring gases containing methane.*

• Version 01 of the *Tool to calculate baseline, project and/or leakage emissions from electricity consumption* .
• Version 01.1 of the *Tool for calculation of emission factor for electricity systems*.
• Version 02 of the *Tool to calculate project or leakage CO2 emissions from fossil fuel combustion.*
• Version 04 of the *Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site*.

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

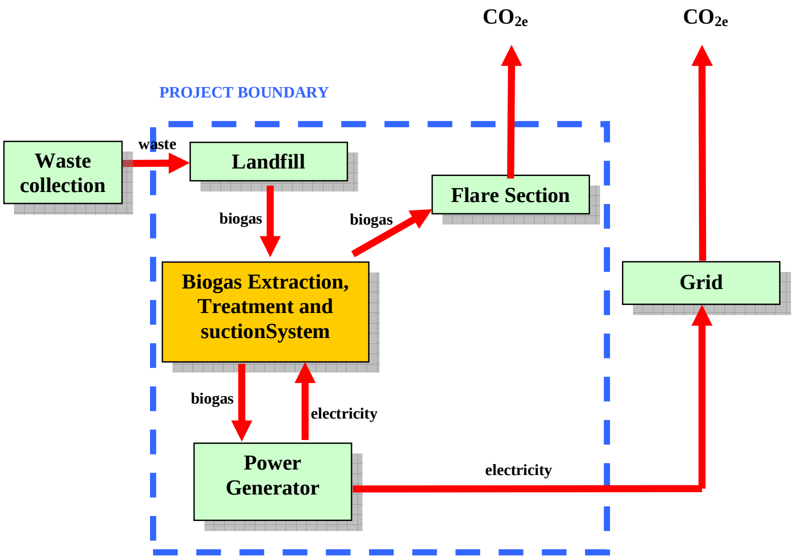
a) ACM0001
ACM0001 is applicable to the Project because the baseline scenario is the partial or total atmospheric release of the gas, usual practice of the CTRS / BR.040 landfill management as demonstrated in the following sections and in Annex III “Baseline information”, and the project activity includes the flaring and electricity generation of the captured gas.
The boundary of the project are CTRS / BR.040 landfill and the all the power generation sources connected to the Brazilian electric grid.

b) ACM0002
ACM0002 is applicable because the Project is a grid connected electricity generation from landfill gas new power plant installation activity. The geographic and system boundaries for the relevant electricity grid are clearly identified for Brazilian national grid and information on the characteristics of the grid is available and is summarized in Annex III “Baseline information”.

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

As for ACM0001, the project boundary is the site of the project activity where the gas is captured, destroyed and/or used.
Furthermore, according to methodology ACM0002, the project boundary comprises the physical, geographical site of the renewable generation source.
Also, any electricity sources for the project activity operation (from grid or captive) shall be included in the project boundary. According to methodology ACM0002, Brazilian national Power Grid is chosen as electric system for this project, and project boundary includes all the plants connected to it.

Picture B.3. 1: Flow diagram of the project boundary



The following project activities and emission sources are considered within the project boundaries:

Table B.3. 2: Summary of gases and sources included in the project boundary, and justification/explanation where gases and sources are not included

	Source	Gas	Included?	Justification / Explanation
Baseline	Emissions from decomposition of waste at the landfill site	CH_4	Yes	The major source of emissions in the baseline, a passive venting system with only partial methane destruction (see AF calculation hereinafter in the section B)
		N_2O	No	N2O emissions are small compared to CH4 emissions from landfills. Exclusion of this gas is conservative.
		CO_2	No	CO_2 emissions from the decomposition of organic waste are not accounted
	Emissions from electricity consumption	CO_2	No	No electricity is consumed in the baseline scenario.
		CH_4	No	Excluded for simplification. This is conservative.
		N_2O	No	Excluded for simplification. This is conservative.
	CO2 emissions from electricity generation in fossil fuel fired power plants that is displaced due to the project activity.	CO_2	Yes	Since the methodology ACM0002 is used, only CO_{2e} emissions from electricity generation in fossil fuel fired power that is displaced (net displacement) due to the project activity shall be included.
		CH_4	No	Minor emission source.
		N_2O	No	Minor emission source.

	Source	Gas	Included?	Justification / Explanation
Project Activity	Emissions from on-site electricity use	CO_2	Yes	May be an important emission source, for this Project electricity for self consumptions is foreseen to be generated by the renewable energy power plant itself when in normal operation
		CH_4	No	Excluded for simplification. This emission source is assumed to be very small.
		N_2O	No	Excluded for simplification. This emission source is assumed to be very small.
	On-site fossil fuel due to the project activity other than for electricity generation	CO_2	No	No fossil fuel will be consumed for the Project Activity
		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.

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

Methodology ACM0001 version 09 established the procedures for the selection of the most plausible baseline scenario; the steps are the following:

Step 1: Identification of alternative scenarios.

According to the *"Tool for the demonstration and assessment of additionality"* (used step by step in the following section B.5 "Description of how the anthropogenic emissions of GHG by sources are reduced below those that would have occurred in the absence of the registered CDM project activity (assessment and demonstration of additionality) of this document), the alternatives scenarios to the proposed Project were divided in two groups:

1. alternative LFG scenarios
2. alternative power generation scenarios

1. The selected alternatives for LFG scenarios are the following:

LFG1: The project activity (i.e. capture of landfill gas and its flaring and/or its use) undertaken without being registered as a CDM project activity;

LFG2: Continuation of the landfill operation (Business as Usual – BAU scenario);

LFG3: Implementation of the CDM project activity considering only the LFG destruction in flares;

LFG1 and LFG3 are not realistic since in the absence of a CDM project being developed at the landfill site, therefore without revenues from CERs, revenues from electricity sale aren't enough to recover the project investments and operational costs for the flaring and power generation, of course if no revenues are expected (LFG3 case) the Project wouldn't be economically feasible at all, as explained in the following section B.5.

Except the simple passive venting system in order to reduce LFG explosion risks, Brazilian government does not mandate to flare or collect the LFG emitted from landfills and most landfills in Brazil are releasing LFG directly to the atmosphere without any previous treatment or utilization. Landfill gas release entirely into the atmosphere (LFG2) is the common practice in Brazil and is in compliance with the local regulation.
So, as showed in section B5 , sub-step 1b of the "*Tool for the demonstration and assessment of additionality*" , the project activity is not the only alternative that is in compliance with all regulations (e.g. because it is required by law).

2. According to ACM0001, since in the Project LFG is used for generation of electric energy for export to a grid, the following alternative power generation scenarios in the absence of the project activity have also be separately determined:

P1: Power generated from landfill gas undertaken without being registered as CDM project activity;
P2: Existing or construction of a new on-site or off-site fossil fuel fired cogeneration plant;
P3: Existing or construction of a new on-site or off-site renewable based cogeneration plant;
P4: Existing or construction of a new on-site or off-site fossil fuel fired captive power plant;
P5: Existing or construction of a new on-site or off-site renewable based captive power plant;
P6: Existing and/or new grid-connected power plants.

Other renewable sources are not applicable to the project site and/or there is a lack of renewable energy source in the area except for LFG, so options P3 and P5 are not credible alternatives to the baseline scenario.
Making use of any fossil fuel fired power plant is not interesting because of Brazilian grid relative low CO_2 emission factor. Implementation of alternatives P2 and P4 would degrade the quality of national electric energy, so they can be discarded (see following section B5).
Moreover, without CDM or financial support, there is no economic incentive for LFG collection and electricity generation system. As already mentioned, electricity revenues do not cover all the investment and operational costs required for power generation from landfill gas, therefore is hardly possible that the project owner will be able to afford to install the necessary equipments.
Projects comparable with the projects activity in Brasil have been carried out due to the assistance received from international funds (this is further described in the "common practice" section).
Alternative P1 is therefore not a realistic alternative.

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

Step 2: Identify the fuel for the baseline choice of energy source taking into account the national and/or sectoral policies as applicable
In baseline scenario LFG 2, BAU scenario, there are no fossil fuel consumptions.
For the "energy" scenario P6 it has to be taken into account that Brazilian energetic matrix is practically renewable (Table B.4.1); hydro power plants respond itself for more than 70% of total installed capacity; resulting in a relative low CO_2 grid emission factor.
Since no other renewable source of energy is available in the baseline scenario, the choice that leads to lower emissions is to choose the grid as energy source and than assume the grid's emission factor as representative of the fuel mix used in the baseline.

Table B.4.1 – Energetic sources of Brazilian electric grid

OPERATING ENTERPRISES							
Type		**Installed Capacity**		**%**	**Total**		**%**
		N.° of Power Units	**(kW)**		**N.° of Power Units**	**(kW)**	
Hydro		707	77.525.822	70,24	707	77.525.822	70,24
Gas	Natural	85	10.588.402	9,59	114	11.769.430	10,66
	Process	29	1.181.028	1,07			
Oil	Diesel	596	3.316.596	3,01	617	4.613.790	4,18
	Residual Oil	21	1.297.194	1,18			
Biomass	Sugar cane Bagasse	252	3.376.063	3,06	302	4.553.595	4,13
	Black Liqueur	13	859.217	0,78			
	Wood	30	255.517	0,23			
	Biogas	3	41.590	0,04			
	Rice Husk	4	21.208	0,02			
Nuclear		2	2.007.000	1,82	2	2.007.000	1,82
Mineral Coal	Mineral Coal	8	1.455.104	1,32	8	1.455.104	1,32
Eolic		17	272.650	0,25	17	272.650	0,25
Imports	Paraguay		5.650.000	5,46		8.170.000	7,4
	Argentina		2.250.000	2,17			
	Venezuela		200.000	0,19			
	Uruguay		70.000	0,07			
Total		**1.767**	**110.367.391**	**100**	**1.767**	**110.367.391**	**100**

Source: http://www.aneel.gov.br/aplicacoes/capacidadebrasil/OperacaoCapacidadeBrasil.asp (Consulted on 2088, November 17th).

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

Please refer to section B.5 for demonstration of all the above mentioned exclusions of alternatives from further consideration (financial analysis, barrier analysis, etc).

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

Table B.4.2 Baseline scenario

Scenario	Baseline		Description of situation
	Landfill gas	Electricity	
	LFG2	P6	The atmospheric release of landfill gas to the atmosphere with partial LFG destruction - BAU scenario. The electricity is obtained from an existing/new grid-connected power plant.

Description of the identified Baseline scenario
Currently the scenario existing prior to the start of implementation of the Project, the BAU scenario, consists in 123 landfill gas vents (or passive gas wells) installed over the 65-hectare area, venting the gas arising from the wastes from inside the waste mass to the top of each vent, only few of them are occasionally lighted on by the landfill management (see Survey Report on Annex III). This scenario is the same as the baseline scenario, as it has been above clearly demonstrated.

B.5. Description of how the anthropogenic emissions of GHG by sources are reduced below those that would have occurred in the absence of the registered CDM project activity (assessment and demonstration of additionality):

CDM revenues were seriously considered in the decision to go ahead with the Project activity as the following timeline of events demonstrates:

1. On May the 7th 2008 Consórcio Horizonte Asja bid successfully for biogas exploitation contract referring to CTRS / BR.040 Landfill in the Municipality of Belo Horizonte (Minas Gerais, Brasil) in public bid N° 183/2007 – SLU "Exploração do biogás gerado no Aterro Sanitário CTRS / BR.040 no município de Belo Horizonte - MG, com o objetivo de obter RCE - Redução Certificada de Emissão com respectiva venda no Mercado de Carbono", "Exploitation of the biogas from Controlled Landfill in Solid Waste Management Central – CTRS / BR.040, in order to seek for CERs – Certified Emission Reduction and sell them in Carbon Market "
2. On August the 7th 2008 the concession contract between Municipality of Belo Horizonte and Consòrcio Horizonte Asja for the right to exploit the landfill gas arising from wastes CTRS / BR.040 landfill was signed, this has been assumed to be the Project's starting date hereinafter in section **C.1.1**
3. On October the 1st 2008 Consórcio Horizonte Asja made the following communications:
   - Prot. ESBRMG/ER/01/08 : information request to Brazilian DNA about the current Brazilian law system about landfill gas;
   - Prot. ESBRMG/ER/02/08 : communication to Brazilian DNA of a the intention to seek CDM status for the Project;
   - Prot. ESBRMG/ER/03/08 : communication to UNFCCC of the commencement of a CDM project activity.

4. On October the 10th the Brazilian DNA answered (oficio n° 058/2008) to the abovementioned request on current laws about LFG stating that, as for DNA knowledge, in Brazil there are no mandatory requirements for LFG destruction / use
5. The Project obtained the Environmental Permit on November the 14th 2008, LO n° 1823/08;
6. November the 18th 2008 the Municipality of Belo Horizonte (Superintendência de Limpieza Urbana) authorized Consórcio Horizonte Asja to start working on CTRS / BR.040 site

From the last event on, the **implementation timeline** foreseen for the proposed Project is:

1. November ÷ December 2008: earthworks;
2. January ÷ May 2009: construction works;
3. February ÷ July 2009: wells drilling and LFG collection system assembly;
4. May ÷ July 2009: LFG suction and treatment station installation works and power plant assembling;
5. August 2009: plant commissioning :
6. September 2009: start of the production.

According to the requirement of consolidated methodology ACM0001, the *"Tool for the demonstration and assessment of additionality - Version 5.1"* should be applied in a conservative and transparent manner to show that CDM assistance is required for the project activity to be successfully implemented. Besides, ACM0001 requires that the additionality test shall be applied for each alternative of the baseline considered in the baseline determination.
The "*Tool for the demonstration and assessment of additionality*" foresees four steps:
Step 1: Identification of alternatives to the project activity consistent with current laws and regulations.
Step 2: Investment analysis
Step 3: Barrier analysis
Step 4: Common practice analysis

The steps 1 and 2 will be followed for each alternative separately in order to demonstrate additionality, then step 3 will be applied, even if optional, to the remaining alternative scenarios and the latter will be step 4.
As from previous section B.4**,** the alternatives scenarios to the proposed Project were divided in two groups:

1. alternative LFG scenarios
2. alternative power generation scenarios

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

1. Alternative LFG scenarios

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

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

LFG1. The project activity (capture of landfill gas and its flaring and use for electricity generation) undertaken without being registered as a CDM project activity;
LFG2: Continuation of the landfill operation (Business as Usual – BAU scenario);
LFG3: Implementation of the CDM project activity considering only the LFG destruction in flares.

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

In Brazil there are no policies regarding mandatory landfill gas capture or destruction requirements due to safety issues or local environmental regulations nor policies which promote the productive use of landfill gas such as those for the production of renewable energy, or those that promote the processing of organic waste.[1]

Since 2000, the *Política Nacional de Resíduos Sólidos* (National Solid Waste Policy) has been under discussion, but it isn't yet approved. The scope of the policy is to obligate the use of engineering technologies to transform open dumps on sanitary landfill, applying NBR 81419 (Brazilian Standard on the presentation of landfill design projects). However, the Policy does not prescribe landfill gas destruction nor promote the landfill gas use for the production of renewable energy.

In 2002, the *PROINFA – Programa de Incentivo a Fontes Alternativas* was created, in order to incentive the generation of 3.300 MW of renewable sources to generate electricity, divided in three groups: wind-energy (1.100 MW), small-hydro power plants (1.100 MW) and biomass (1.100 MW, including biogas, wood, solid waste, rice husk, etc.). Despite of achieving the goals, no landfill-gas-to- energy project was implemented.

Outcome of Step 1b

The analysis of the compliance of the alternatives listed previously with the local/national regulation results in the assessment that LFG1, LFG2 and LFG3 scenario are all perfectly legal alternatives.

Step 2. Investment Analysis

Sub-step 2a: Determine appropriate analysis method.

The project will have proceeds from power sales as well as from emission reduction credits, so Option I stated in "*Tool for the Demonstration and Assessment of Additionality" (version05.2)* is not applicable.

Option II is based on the comparison of returns of the project investment with the investment required for an alternative to the project. In this case, the LFG2 alternative to the CDM project activity is simply not to install flaring and generation equipment at the site, and therefore does not involve investments of comparable scale to the Project. Consequently, Option II is not applicable to this project.

Option III must be used, where the returns of the investment in the project activity is compared to benchmark returns that are available to any investor in the country.

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

The IRR was chosen as the relevant financial indicator for the Project.

The likelihood of development of this project, as opposed to the continuation of current activities (i.e. no collection and controlled combustion of LFG) will be determined by comparing its IRR with the benchmark of interest rates available to a local investor.

The reference rate for investments in Brazil is the SELIC (Sistema Especial de Liquidação e de Custódia), which is the market indicator for the governemnt securities of Tesouro Nacional and of Banco do Brasil.

In the last Copom (Comité de Politica Monetaria do Banco Central do Brasil) meeting, held in last September 2008, The SELIC has been stated to be 13,66% (source: Banco Central do Brasil, HTTP://www.bcb.gov.br/?COPOMJUROS).

Referring to similar Project's benchmarks for IRR it we can consider public bid n° 002/2008, 14th of November 2008 from Prefeitura Municipal de Anápolis (GO) – Brazil, who's object is the same as Belo

[1] The DNA has been contacted to provide information regarding Brazilian regulatory requirements and confirmed that there's at present non mandatory requirement about landfill gas destruction, letter protocol *Oficio n° 058/2008/CIMG*

Horizonte's one has been for this Project. The public bid Document states that benchmark IRR for national companyes for the Anápolis Project is assumed to be equal to 15%.
Since the Project has higher risks than Anápolis Project, foreing investment risks, has high investment too and since the last year's SELIC rising trend (from 11,18% to 13,66% now), we think to the 16% IRR benchmark to be a conservative assumption.

Sub-step 2c: Calculation and comparison of financial indicators.
The Tables below show the financial analysis for the project activity. As shown, the project IRR (without carbon finance) is very low, and lower than any rate of return available to investors in Brazil, even lower than the Brazilian "Poupança" rate, which is the official rate of return given for small savings accounts (6,43%) without any risk.
These results show that project is still not an economically attractive course of action without the sale of CERs.
For IRR calculation the input number are the revenue, variable costs, depreciation, income tax and investment. The cash flow result is provided in the following tables:

Tab. B. 5.1: Main financial data

Financial parameters	
Annual average output (MWh)	134,160
Total electricity delivered to the grid (MWh)	174,785
Expected electricity sale price (Euro/kWh)	52.87
Average installed capacity (MW)	4.05
Total investment (Euro)	4,582,015
Life time of this project (years)	10
Crediting period (years)	10
VAT (%)	10%
Depreciation rate	10%
Annual operation cost on CERs production (Euro/y)	149,200
Annual operation cost (Euro/MWh)	30

Tab. B.5.2: Financial analysis result

REVENUE ANALYSIS	**Revenue Without CERs (€/ton)**	**Revenue With CERs (€/ ton)**
CER Price (€/ton)	€0	€15
Total Investment IRR	5.18%	16.43%

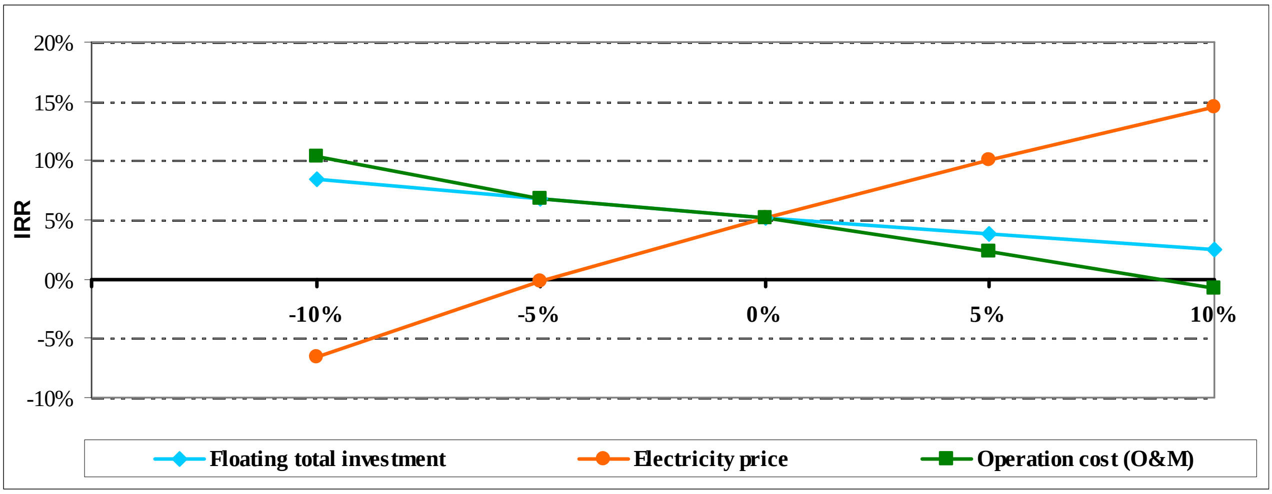
Sub-step 2d: Sensitivity analysis.
Sensitivity analysis is conducted in order to assess whether the conclusion regarding the financial attractiveness is robust to reasonable variations in the critical assumptions.
The most suitable financial indicators in this project are the total investment, the electricity revenue and the operation cost.
The table below shows how these parameters should vary in order to reach the benchmark.

Tab. B.5.3: Sensitivity analysis.

Total investment IRR sensitivity analysis						
	-10%	-5%	0%	5%	10%	on benchmark 16%
Floating total investment	8,41%	6,72%	5,18%	3,75%	2,42%	**-28,00%**
Electricity price	-6,60%	-0,20%	5,18%	10,00%	14,48%	**11,77%**
Operation cost (O&M)	10,40%	6,72%	5,18%	2,32%	-0,78%	**-21,77%**

As it can be seen, the project IRR remains lower benchmark even in the case where these parameters change in favour of the project.
An other analysis was made in the box "on benchmark 16%", considering how much the electricity price of the MWh would have to increase and how much the operational costs and investments would have to decrease to achieve a 16% project IRR. The results show that the project investment need to decrease by 28% and the O&M costs by 22% in order to achieve the expected IRR. However, this is not feasible due to the maintenance regime required on the generation equipment and the qualified personnel required to ensure the adequate gas field balancing and operation of the project.
It's also unlikely that energy price would increase by 12% from it's current value, as it can be clear if we consider the Brazilian hydroelectric energy descending trend of prices in official bids (Santo Antônio, Dec/2007, R$ 78,87/Mwh; Jirau, May/2008, R$ 71,40/Mwh); moreover, forecasts for the next 2009 bid that will be done in Amazonas are of more lower price level than the abovementioned values. (source: Globo - Economia e Negocios – 19/05/2008). Therefore, without extra revenue from CDM, this project is not attractive financially.

Chart B.5.4: The impact from changes of floating total investment, electricity revenue and operation cost on IRR



As it can be seen the variations obtained are not realistic scenarios.
It can be seen just in the situations of very favorable scenarios (but hardly realistic) it would be possible to reach the 16% benchmark. The IRR is quite lower than the benchmark based on realistic assumptions so alternative LFG1 cannot be considered as financially attractive without the support of the CDM benefits.

Scenario LFG1 is not likely to happen in the absence of a CDM project being developed at the landfill site since LFG revenues (electricity) are insufficient to recover the project investments and operational costs of the project. The investment analysis above shows that it is not possible to develop the project without CDM benefits.

2. **Alternative power generation scenarios**

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

Define realistic and credible alternatives to the project activity(s) through the following Sub-steps:

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

P1: Power generated from landfill gas undertaken without being registered as CDM project activity;
P2: Existing or construction of a new on-site or off-site fossil fuel fired cogeneration plant;
P3: Existing or construction of a new on-site or off-site renewable based cogeneration plant;
P4: Existing or construction of a new on-site or off-site fossil fuel fired captive power plant;
P5: Existing or construction of a new on-site or off-site renewable based captive power plant;
P6: Existing and/or new grid-connected power plants.

A CDM project activity is additional if anthropogenic emissions of greenhouse gases are reduced below those that would have occurred in the absence of the registered CDM project activity.
Existing grid connected power plants in Brazil are practically renewable sources based (see **Table 4** in Annex III). Under this situation, scenarios P2 and P4 cannot be considered an alternative to the project activity since it is clear that not only project activity but also P3, P4 and P6 alternatives would achieve higher GHG ERs than P2 and P4 scenarios.
Alternative P1 practically is the same as LFG1 since LFG fuelled power generation section, according to the reliable and best available techniques, has to be built accompanied by LFG capture, treatment and emergency flaring section: for this reason alternative P1 will be no further considered as a separate alternative project scenario but comprised in LFG1 and just LFG1 will be further analyzed.
Other renewable sources cannot be considered alternatives to the project activity since they are not applicable to the project site and/or there is a lack of renewable energy source in the area (i.e. no hydroelectric energy source), and has to be taken into consideration that the biogas arising from the landfill would continue to be emitted into the atmosphere as described in the baseline scenario if other renewable source would have been used to produce the same amount of electricity as the Project would produce using LFG. Options P3, P5 are therefore not credible alternatives to the project activity and will not be further considered.

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

Alternative scenario LFG1 and P6 left are in compliance with mandatory laws and regulations; there is no special requirement to the referred area, so none of the alternatives would be vetoed for legal questions.

Outcome of Step 1b

The analysis of the compliance of the alternatives listed previously with the local/national regulation results in the assessment that both of them are perfectly legal alternatives.

Step 3. Barrier Analysis

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

Although Brazil occupies the third position in CO_2 emission reduction in the world, the proposed use of biogas from the CTRS landfill is one of the fewest landfill-gas-to-energy CDM projects to be developed

in the country (see **Table 1** in Annex III); from 26 projects registered only 6 generate electricity, according to Brazilian DNA's statistics.
The Project will then face different barriers, most of them common for other alternatives and some particular for the proposed project activity, such as:

• *Investment barriers*
As happen in most developing countries, in Brazil waste management sector is not given priority within the economy, so that project developers often face difficulties in obtaining investments funds for solid waste management projects. Moreover, the tipping fees (price for waste disposal) are very low compared to values in industrialized countries, so that even when investment has been secured, these revenues may not be enough to cover expenses for the proper operation and maintenance of the project activity.

• *Barriers due to prevailing practice:*
As presented in **Table 1** and **Table 2** in Annex III most of the landfills in Brazil do not destroy systematically the produced gas; according to *Pesquisa Nacional de Saneamento Básico 2000* (National Research of Basic Sanitation 2000) there are 1452 cities attended by sanitary landfills all over the country but from that only 96 carry out CDM LFG projects, representing less than 7% of total: considering this, we can say that project activity it is not a common practice in Brazil.
Also, among all projects concerning the collection and destruction of LFG undertaken as CDM Project Activities only a few of them have the generation of electricity (**Table 3** and **1** in Annex III): only 6 on 29 total CDM PA, between these 6 units projected to generate electric energy from LFG only 3 are nowadays operating.
Even if the Project can not be considered as "first of its kind", it can not be considered as a prevailing practice either.

• *Technological barriers:*
As mention above, collecting and destroying the biogas from landfill can still be considered as a new technology in Brazil. There are few companies with sufficient know-how to assess and develop reliably a biogas collection system in a landfill.
Furthermore, most of the equipments must be imported, such as enclosed flares, generating sets, flow-meters and continuous methane analyzers. Brazilian companies only produce HDPE pipeline, temperature and pressure readings, and they are in general representatives of international manufacturers.
Previous CDM Projects in Brazil, listed in **Table 1**, faced the same difficult when acquiring equipments specific to LFG handling.
Another barrier is related to skilled and/or properly trained labor to operate and maintain the technologies implemented in this project, which is scarce in Brazil. There is not enough education/training institution to supply this demand, leading to equipment disrepair and malfunctioning, unless project proponents support specialized training.
There is also a lack of infrastructure for implementation of electricity generation from LFG. Since there are few operational landfill gas recoveries to energy project in Brazil financed through electricity selling and CDM structure, there is no national provider of equipment and services for work related electricity generation with LFG. Consequently, for the proposed project it is foreseen the importation of most of specific equipments in order to support implementation.

Sub-step 3 b. Show that the identified barriers would not prevent the implementation of at least one of the alternatives (except the proposed project activity):

From all alternatives raised in Step 1 only LFG 2, LFG 3 and P6 are left after Previous Step , the following table summarizes the barrier analysis of these alternatives respect to the barriers identified in the sub-step 3a above.

Table B.5.5 – Alternative scenarios barrier analysis

Alternative		Investment barriers	Barriers due to prevailing practice	Tecnologichal Barriers
LFG 2	Continuation of the landfill operation (Business As Usual - BAU)	This alternative **would not be prevented** by this barrier since no additional investment is needed	This alternative **would not be prevented** by this barrier, once this is common practice in Brazil	This alternative **would not be prevented** by this barrier since it is not required any installation of of new technology
LFG 3	Implementation of the CDM project activity considering only the LFG destruction in flares	This barrier **would prevent** the implementation of the project as no income would be generated to payback the investments needed	This barrier **would prevent** the implementation of the project as the systematically flaring of landfill gas is not a common practice and there is no projects like proposed except those registered as CDM in Brazil	This barrier **would prevent** the implementation of the project once there is no national manufactures of the main equipments required for this kind of plants (hih temperatiure flares, measurements & control systems, etc)
P 6	Existing and/or new grid-connected power plants	This alternative **would not be prevented** by this barrier since no additional investment is needed	This alternative **would not be prevented** by this barrier, once this is common practice in Brazil	This alternative **would not be prevented** by this barrier since it is not required any installation of of new technology

The project activity can be therefore considered additional because not only Project activity itself but also alternatives LFG 2 and P6 are not prevented by any of the above identified barriers.
Sub-steps 3a – 3b are therefore both satisfied.

Step 4. Common Practice Analysis

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

As it has been clearly demonstrated in the sections above, there are no activities similar to the proposed Project activity currently implemented in Brazil except for other CDM project activities that, according to the "*Tool for the assessment of additionality*", doesn't have to be included in this analysis.

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

This step does not apply since no similar activities exist.

Since sub-steps 4a and 4b are both satisfied *the* proposed project activity is additional.

To conclude, it was proved that the proposed project activity is not the baseline scenario, the only possible alternative to the project activity is carrying it out without being registered as CDM project activity.

The investment analysis provides essential evidence that the CDM revenue enables the proposed project to be developed in Brazil. However, without any support from CDM the proposed project activity would not occur, instead the landfill operator would continue the current prevailing practice of not flaring or generating electricity from LFG.

Based on the above analysis, it can be demonstrated that **the proposed project is additional**.

B.6. Emission reductions:

B.6.1. Explanation of methodological choices:

For predicting the amount of CERs, the Approved Consolidated Methodology ACM0001 Version 9.01 and ACM0002 Version 8 have been used.

According to ACM0001, Version 9.01 baseline emissions are calculated with the following formula:

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

Where:

BE_y= Baseline emissions in year *y* (tCO_2e)

$MD_{project,y}$= The amount of methane that would have been destroyed/combusted during the year, in tonnes of methane (tCH_4) in project scenario

$MD_{BL,y}$ = The amount of methane that would have been destroyed/combusted during the year in the absence of the project due to regulatory and/or contractual requirement, in tonnes of methane (tCH_4)

GWP_{CH4} = Global Warming Potential value for methane for the first commitment period is 21 tCO_2e/tCH_4

$EL_{LFG,y}$ = Net quantity of electricity produced using LFG, which in the absence of the project activity would have been produced by power plants connected to the grid or by an onsite/ off-site fossil fuel based captive power generation, during year y, in megawatt hours (MWh)

$CEF_{elecy,BL,y}$ = CO_2 emissions intensity of the baseline source of electricity displaced, in tCO_2e/MWh This is estimated as per equation (15) below

$ET_{LFG,y}$ = The quantity of thermal energy produced utilizing the landfill gas, which in the absence of the project activity would have been produced from onsite/offsite fossil fuel fired boiler, during the year *y* in TJ, for this Project is equal to 0 since no thermal energy will be produced

$CEF_{ther,BL,y}$= CO_2 emissions intensity of the fuel used by boiler to generate thermal energy which is displaced by LFG based thermal energy generation, in tCO_2e/TJ; for this Project is equal to 0 since no thermal energy will be produced

For this Project, since regulatory or contractual requirements do not specify $MD_{BL,y}$ and no historic data exists for LFG captured and destroyed, an “Adjustment Factor” (AF) is used and justified, taking into account the project context.

$$MD_{BL,y} = MD_{project,y} \bullet AF \quad \textbf{(2)}$$

Estimating AF

Baseline scenario consist in a passive LFG venting system with partial LFG destruction by flaring since some of the wells are on occasion manually lighted on, as described and assessed in Annex III "Baseline information". Therefore a **specific system for collection and destruction of methane** exists and, according to ACM0001 requirements, the ratio of the destruction efficiency of the baseline system to the destruction efficiency of the system used in the project has been used and the following procedure followed.

Step 1: Estimation of the destruction efficiency of the system

The following formula has been used:

$$\varepsilon_{BL} = \frac{MD_{Hist}}{MG_{Hist}} \quad \textbf{(3)}$$

Where:

ε_{BL} =	Destruction efficiency of the baseline system (fraction)
MD_{Hist} =	Amount of methane destroyed historically measured for the previous year before the start of project activity (tCH_4)
MG_{Hist} =	Amount of methane generated historically for the previous year before the start of project activity, estimated using the actual amount of waste disposed in the landfill as per the latest version of the "*Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site*" (tCH_4)

Since no measured data are available, for the estimation of MD_{Hist} has been chosen the following approach:

1. MD_{Hist} can be evaluated as a fraction of MG_{Hist}:

   $$MD_{Hist} = \eta_{BL} * MG_{Hist} \quad \textbf{(3.1)}$$

   Where MG_{Hist} is the amount of methane generated historically for the previous year before the start of project activity, estimated as per the latest version of the "*Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site*" (tCH_4)

2. The abovementioned η_{BL} is the overall destruction efficiency in the baseline and has been calculated with the following formula

   $$\eta_{BL} = \eta_{PV} * \eta_{LFGF} * (N_{fw}/N_{vw}) \quad \textbf{(3.2)}$$

   Where:

   - η_{PV} = Passive Venting System efficiency, CTRS / BR.040 landfill has a passive venting system, which is way less efficient than the active systems because of the pressure: in the passive system landfill gas is emitted to the atmosphere due to variation of the barometric pressure. As per measurements made in 11 Dutch landfills, an average collection efficiency value of passive system is equal to 37%[1]

[1] http://www.mnp.nl/ipcc/Archive/AR4FOD/ExpRevFOD/FODrev/FOD_AChapter10.doc

- η LFGF = LFG Flaring efficiency . It can be considered that lighted wells can burn methane less efficiently than an open flare, in the "Tool to determine project emissions from flaring gases containing methane" open flares are defined as devices where the residual gas is burned in an open air tip with or without any auxiliary fluid assistance, therefore it is conservative to adopt for these wells the open flare efficiency value which is equal to 50%.
- Nfw= number of wells lighted on, as from the survey presented in Annex III "Baseline information" , the average is 23, in this calculation we consider 25 wells lighted to be conservative. Moreover the ignited wells are conservatively considered to remain lighted all day long, for the whole year , not taking into account seasonal rains, windy days and the frequent quenching attested from the survey.
- N_{vw}= number of wells that can be ignited, as shown in Annex III the total number of wells that can be lighted on is 124.

The calculation is therefore as follows:

$$\eta_{BL} = 37\% * 50\% * (25/124) = 3.8\%$$

As per formula (3.1):

$$MD_{Hist} = 3.8\% * MG_{Hist}$$

Therefore, according to formula (3) the final baseline efficiency value is:

$$\varepsilon_{BL} = \frac{MD_{Hist}}{MG_{Hist}} = 3.8\% \bullet \frac{MG_{Hist}}{MG_{Hist}} = 3.8\% \qquad \textbf{(3.3)}$$

Step 2: Estimation of the destruction efficiency of the system used in the project activity
According to the ACM0001, it has been selected the following
Option-2:
The destruction efficiency of the system used in the project activity is estimated every year as follows:

$$\varepsilon_{PR\,y} = \frac{MD_{project\,y}}{MG_{PR\,y}} \qquad \textbf{(4)}$$

Where:

$\varepsilon_{PR\,y}$ =	Destruction efficiency of the system used in the project activity for year *y* (fraction)
$MD_{project,y}$ =	Amount of methane destroyed by the project activity during the year *y* of the project activity (tCH_4).
$MG_{PR,y}$ =	Amount of methane generated during year y of the project activity estimated using the actual amount of waste disposed in the landfill as per the latest version of the "*Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site*", (tCH_4).

Step 3: Estimation of the adjustment factor (AF)
Since Option 2 has been used in Step 2 and the efficiency of the system used in the Project will be estimated every year , then the Adjustment Factor is calculated every year with the following formula:

$$AF_{y,} = \frac{\varepsilon_{BL}}{\varepsilon_{PRy}} \qquad \textbf{(5)}$$

Where:

AF_y = Adjustment factor for year *y*, this factor will be used in equation **(2)** in place of AF

The methane destroyed by the project activity ($MD_{project,y}$) during a year will be determined by monitoring the quantity of methane actually flared and gas used to generate electricity and the total quantity of methane captured.
The sum of the metered quantities fed to the flares and to the power plant will be compared annually with the total quantity of methane generated estimated *ex-ante* with the "*Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site*" as showed later on this Section. The lowest value of the two must be adopted as $MD_{project,y}$.

Since the Project will capture only a fraction of the whole LFG generated from the wastes in CTRS / BR.040 landfill because of the following causes:

- the degassing system has his own efficiency to be take into account through a Capture Efficiency;
- the enclose flares have their destruction efficiency that in this Project will be continuously monitored according to the "*Tool to determine project emissions from flaring gases containing methane*"

Total quantity of methane generated is then the highest value and the following procedure applies : the working hours of the energy plant will be monitored and no emission reduction could be claimed for methane destruction in the energy plant during non-operational hours and $MD_{project,y}$. will be estimated as:

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

Where:

$MD_{flared,y}$ = Quantity of methane destroyed by flaring (tCH_4)
$MD_{electricity,y}$ = Quantity of methane destroyed by generation of electricity (tCH_4)
$MD_{thermal,y}$ = Quantity of methane destroyed for the generation of thermal energy (tCH_4), for the proposed Project this is equal to 0
$MD_{PL,y}$ = Quantity of methane sent to the pipeline for feeding to the natural gas distribution network (tCH_4), for the proposed Project this is equal to 0

Right hand side of the equation (8) is sum over all the points of captured methane use: therefore in all the flares and all electricity generation source foreseen in this Project. The supply to each point of methane destruction, through flaring or use for energy generation, will be measured separately.

$$MD_{flared,y} = LFG_{flared,y} \cdot w_{CH4,y} \cdot D_{CH4} - \left(\frac{PE_{flare,y}}{GWP_{CH4}}\right) \qquad \textbf{(7)}$$

Where:

$LFG_{flare,y}$ = Quantity of landfill gas fed to the flare(s) during the year measured in cubic meters (m^3)

$w_{CH4,y}$ = Average methane fraction of the landfill gas as measured[1] during the year and expressed as a fraction (in $m^3{}_{CH4}$ / $m^3{}_{LFG}$)

D_{CH4} = Methane density expressed in tonnes of methane per cubic meter of methane ($t_{CH4}/m^3{}_{CH4}$)[2]

$PE_{flare,y}$ = Project emissions from flaring of the residual gas stream in year y (tCO2e) determined following the procedure described in the "*Tool to determine project emissions from flaring gases containing Methane*" for each flare

Application of "Tool to determine project emissions from flaring gases containing Methane"

This tool is applicable because for CTRS / BR.040 Project the following conditions are fulfilled:

- The residual gas stream to be flared contains no other combustible gases than methane, carbon monoxide and hydrogen;
- The residual gas stream to be flared is obtained from decomposition of organic material (through landfills).

For the Project **enclosed flares will be installed and continuous monitoring** of the flare efficiency will be made.

This tool involves the following seven steps:

STEP 1: Determination of the mass flow rate of the residual gas that is flared
STEP 2: Determination of the mass fraction of carbon, hydrogen, oxygen and nitrogen in the residual gas
STEP 3: Determination of the volumetric flow rate of the exhaust gas on a dry basis
STEP 4: Determination of methane mass flow rate of the exhaust gas on a dry basis
STEP 5: Determination of methane mass flow rate of the residual gas on a dry basis
STEP 6: Determination of the hourly flare efficiency
STEP 7: Calculation of annual project emissions from flaring based on measured hourly values or based on default flare efficiencies.

STEP 1

This step calculates the residual gas mass flow rate in each hour *h*, based on the volumetric flow rate and the density of the residual gas. The density of the residual gas is determined based on the volumetric fraction of all components in the gas.

$$FM_{RG,h} = \rho_{RG,n,h} \bullet FV_{RD,h} \qquad \textbf{(7.1)}$$

[1] Methane fraction of the landfill gas and LFG flow have to be measured on same basis (either wet or dry). since the "Tool to determine project emissions from flaring gases containing Methane" is used for this Project, it will be followed the standard approaches to convert the flow on wet basis to dry basis.

[2] 5 At standard temperature and pressure (0 degree Celsius and 1,013 bar) the density of methane is 0.0007168 $t_{CH4}/m^3{}_{CH4}$.

Where:

Variable	SI Unit	Description
$FM_{RG,h}$	kg/h	Mass flow rate of the residual gas in hour *h*
$\rho_{RG,n,h}$	kg/m3	Density of the residual gas at normal conditions in hour *h*
$FV_{RG,h}$	m3/h	Volumetric flow rate of the residual gas in dry basis at normal conditions in the hour *h*

Where:

$$\rho_{RG,n,h} = \frac{P_n}{\frac{R_u}{MM_{RG,h}} \bullet T_n} \quad \textbf{(7.2)}$$

Where:

Variable	SI Unit	Description
$\rho_{RG,n,h}$	kg/m3	Density of the residual gas at normal conditions in hour *h*
P_n	Pa	Atmospheric pressure at normal conditions (101 325)
R_u	Pa.m3/kmol.K	Universal ideal gas constant (8 314)
$MM_{RG,h}$	kg/kmol	Molecular mass of the residual gas in hour *h*
T_n	K	Temperature at normal conditions (273.15)

and:

$$MM_{RG,h} = \sum_i (fv_{i,h} \bullet MM_i) \quad \textbf{(7.3)}$$

Where:

Variable	SI Unit	Description
$MM_{RG,h}$	kg/kmol	Molecular mass of the residual gas in hour *h*
$Fv_{i,h}$	-	Volumetric fraction of component *i* in the residual gas in the hour *h*
MM_i	kg/kmol	Molecular mass of residual gas component *i*
I		The components CH_4, CO, CO_2, O_2,H_2, N_2

For this Project it has been chosen, as a simplified approach, to measure only the volumetric fraction of methane and consider the difference to 100% as being nitrogen (N_2).

STEP 2

Determine the mass fractions of carbon, hydrogen, oxygen and nitrogen in the residual gas, calculated from the volumetric fraction of each component *i* in the residual gas, as follows:

$$fm_{j,h} = \frac{\sum_i fv_{i,h} \bullet AM_j \bullet NA_{j,i}}{MM_{RG,h}} \quad \textbf{(7.4)}$$

Where:

Variable	SI Unit	Description
$Fm_{j,h}$	-	Mass fraction of element *j* in the residual gas in hour *h*
$Fv_{i,h}$	-	Volumetric fraction of component *i* in the residual gas in the hour *h*
AM_j	kg/kmol	Atomic mass of element *j*
$NA_{j,i}$	-	Number of atoms of element *j* in component *i*
$MM_{RG,h}$	kg/kmol	Molecular mass of the residual gas in hour *h*
j		The elements carbon, hydrogen, oxygen and nitrogen
i		The components CH_4, CO, CO_2, O_2,H_2, N_2

STEP 3
This step is applicable because for the Project the methane combustion efficiency of the flare(s) will be continuously monitored.
Determine the average volumetric flow rate of the exhaust gas in each hour *h* based on a stoichiometric calculation of the combustion process, which depends on the chemical composition of the residual gas, the amount of air supplied to combust it and the composition of the exhaust gas, as follows:

$$TV_{n,FG,h} = V_{n,FG,h} \bullet FM_{RG,h} \quad \textbf{(7.5)}$$

Where:

Variable	SI Unit	Description
$TV_{n,FG,h}$	m^3/h	Volumetric flow rate of the exhaust gas in dry basis at normal conditions in hour *h*
$V_{n,FG,h}$	m^3/kg residual gas	Volume of the exhaust gas of the flare in dry basis at normal conditions per kg of residual gas in hour *h*
$FM_{RG,h}$	kg residual gas/h	Mass flow rate of the residual gas in the hour *h*

$$V_{n,FG,h} = V_{n,CO2,h} + V_{n,O2,h} + V_{n,N2,h} \quad \textbf{(7.6)}$$

Where:

Variable	SI Unit	Description
$V_{n,FG,h}$	m^3/kg residual gas	Volume of the exhaust gas of the flare in dry basis at normal conditions per kg of residual gas in the hour *h*
$V_{n,CO2,h}$	m^3/kg residual gas	Quantity of CO_2 volume free in the exhaust gas of the flare at normal conditions per kg of residual gas in the hour *h*
$V_{n,N2,h}$	m^3/kg residual gas	Quantity of N_2 volume free in the exhaust gas of the flare at normal conditions per kg of residual gas in the hour *h*
$V_{n,O2,h}$	m^3/kg residual gas	Quantity of O_2 volume free in the exhaust gas of the flare at normal conditions per kg of residual gas in the hour h

$$V_{n,O2,h} = n_{O2,h} \bullet MV_n \quad \textbf{(7.7)}$$

Where:

Variable	SI Unit	Description
$V_{n,O2,h}$	m^3/kg residual gas	Quantity of O_2 volume free in the exhaust gas of the flare at normal conditions per kg of residual gas in the hour *h*
$n_{O2,h}$	kmol/kg residual gas	Quantity of moles O_2 in the exhaust gas of the flare per kg residual gas flared in hour *h h*
MV_n	m^3/kmol	Volume of one mole of any ideal gas at normal temperature and pressure (22.4 L/mol)

$$V_{n,N2,h} = MV_n \bullet \left\{ \frac{fm_{N,h}}{200 AM_N} + \left(\frac{1 - MF_{O2}}{MF_{O2}} \right) \bullet \left[F_h + n_{O2,h} \right] \right\} \quad \textbf{(7.8)}$$

Where:

Variable	SI Unit	Description
$V_{n,N2,h}$	m^3/kg residual gas	Quantity of N_2 volume free in the exhaust gas of the flare at normal conditions per kg of residual gas in the hour *h*
MV_n	m^3/kmol	Volume of one mole of any ideal gas at normal temperature and pressure (22.4 m^3/Kmol)
$fm_{N,h}$	-	Mass fraction of nitrogen in the residual gas in the hour *h*
AM_n	kg/kmol	Atomic mass of nitrogen
MF_{O2}	-	O_2 volumetric fraction of air
F_h	kmol/kg residual gas	Stochiometric quantity of moles of O_2 required for a complete oxidation of one kg residual gas in hour *h*
$n_{O2,h}$	kmol/kg residual gas	Quantity of moles O_2 in the exhaust gas of the flare per kg residual gas flared in hour *h*

$$V_{n,CO2,h} = \frac{fm_{C,h}}{AM_C} \bullet MV_n \quad \textbf{(7.9)}$$

Where:

Variable	SI Unit	Description
$V_{n,CO2,h}$	m^3/kg residual gas	Quantity of CO_2 volume free in the exhaust gas of the flare at normal conditions per kg of residual gas in the hour *h*
$fm_{C,h}$	-	Mass fraction of carbon in the residual gas in the hour *h*
AM_C	kg/kmol	Atomic mass of carbon
MV_n	m^3/kmol	Volume of one mole of any ideal gas at normal temperature and pressure (22.4 m^3/Kmol)

$$n_{O2,h} = \frac{t_{O2,h}}{[1-(t_{O2,h}/MF_{O2})]} \bullet \left[\frac{fm_{C,h}}{AM_C} + \frac{fm_{N,h}}{2AM_N} + \left(\frac{1-MF_{O2}}{MF_{O2}} \right) \bullet F_h \right] \quad \textbf{(7.10)}$$

Where:

Variable	SI Unit	Description
$n_{O2,h}$	kmol/kg residual gas	Quantity of moles O_2 in the exhaust gas of the flare per kg residual gas flared in hour *h*
$t_{O2,h}$	-	Volumetric fraction of O_2 in the exhaust gas in the hour *h*
MF_{O2}	-	Volumetric fraction of O_2 in the air (0.21)
F_h	kmol/kg residual gas	Stochiometric quantity of moles of O_2 required for a complete oxidation of one kg residual gas in hour *h*
$fm_{j,h}$	-	Mass fraction of element *j* in the residual gas in hour *h* (from equation 4)
AM_j	kg/kmol	Atomic mass of element *j*
j		The elements carbon (index C) and nitrogen (index N)

$$F_h = \frac{fm_{C,h}}{AM_C} + \frac{fm_{H,h}}{4AM_H} - \frac{fm_{O,h}}{2AM_O} \quad \textbf{(7.11)}$$

Where:

Variable	SI Unit	Description
F_h	kmol O_2/kg residual gas	Stoichiometric quantity of moles of O_2 required for a complete oxidation of one kg residual gas in hour *h*
$fm_{j,h}$	-	Mass fraction of element *j* in the residual gas in hour *h* (from equation 4)
AM_j	kg/kmol	Atomic mass of element *j*
j		The elements carbon (index C), hydrogen (index H) and oxygen (index O)

STEP 4

This step is applicable because for the Project the methane combustion efficiency of the flare(s) will be continuously monitored.

The mass flow of methane in the exhaust gas is based on the volumetric flow of the exhaust gas and the measured concentration of methane in the exhaust gas, as follows:

$$TM_{FG,h} = \frac{TV_{n,FG,h} \bullet fv_{CH4,FG,h}}{1000000} \quad \textbf{(7.12)}$$

Where:

Variable	SI Unit	Description
$TM_{FG,h}$	kg/h	Mass flow rate of methane in the exhaust gas of the flare in dry basis at normal conditions in the hour *h*
$TV_{n,FG,h}$	m^3/h exhaust gas	Volumetric flow rate of the exhaust gas in dry basis at normal conditions in hour *h*
$fv_{CH4,FG,h}$	mg/m^3	Concentration of methane in the exhaust gas of the flare in dry basis at normal conditions in hour *h*

STEP 5
The quantity of methane in the residual gas flowing into the flare is the product of the volumetric flow rate of the residual gas ($FV_{RG,h}$), the volumetric fraction of methane in the residual gas ($fv_{CH4,RG,h}$) and the density of methane (_$_{CH4,n,h}$) in the same reference conditions (normal conditions and dry or wet basis). It is necessary to refer both measurements (flow rate of the residual gas and volumetric fraction of methane in the residual gas) to the same reference condition that may be dry or wet basis.
The residual gas moisture wouldn't be significant in this Project because several treatment units are foreseen in order to reduce significantly the landfill gas moisture content; therefore the measured flow rate of the residual gas shouldn't be corrected to dry basis to be comparable with the measurement of methane that will be undertaken on a dry basis.

$$TM_{RG,h} = FV_{RG,h} \bullet fv_{CH4,RG,h} \bullet \rho_{CH4,n} \quad \textbf{(7.13)}$$

Where:

Variable	SI Unit	Description
$TM_{RG,h}$	kg/h	Mass flow rate of methane in the residual gas in the hour *h*
$FV_{RG,h}$	m3/h	Volumetric flow rate of the residual gas in dry basis at normal conditions in hour *h*
$fv_{CH4,RG,h}$	-	Volumetric fraction of methane in the residual gas on dry basis in hour *h* (NB: this corresponds to $fv_{i,RG,h}$ where *i* refers to methane).
_$_{CH4,n}$	kg/m3	Density of methane at normal conditions (0.716)

STEP 6
Since this Project forecast to install enclosed flares and do a continuous monitoring, the flare efficiency in the hour *h* ($\eta_{flare,h}$) is:

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

$$\eta_{flare,h} = 1 - \frac{TM_{FG,h}}{TM_{RG,h}} \quad \textbf{(7.14)}$$

Where:

Variable	SI Unit	Description
$\eta_{flare,h}$	-	Flare efficiency in the hour *h*
$TM_{FG,h}$	kg/h	Methane mass flow rate in exhaust gas averaged in a period of time t (hour, two months or year)
$TM_{RG,h}$	kg/h	Mass flow rate of methane in the residual gas in the hour *h*

STEP 7
Project emissions from flaring are calculated as the sum of emissions from each hour *h*, based on the methane flow rate in the residual gas ($TM_{RG,h}$) and the flare efficiency during each hour *h* ($\eta_{flare,h}$), as follows:

$$PE_{flare,y} = \sum_{h=1}^{8760} TM_{RG,h} \bullet (1-\eta_{flare,h}) \bullet \frac{GWPCH4}{1000} \qquad \textbf{(7.15)}$$

Where:

PE_{flare}. = Project emissions from flaring of the residual gas stream (tCO_{2e}/y)
$TM_{RG,h}$ = Mass flow rate of methane in the residual gas in the hour h (kg/h)
$\eta_{flare,h}$ = Flare efficiency in hour h
GWP_{CH4} = Global Warming Potential of methane valid for the commitment period (tCO_{2e}/tCH_4)

$$MD_{electricity,y} = LFG_{electricity} \bullet w_{CH4,\, y} \bullet D_{CH4} \qquad \textbf{(8)}$$

Where:

$MD_{electricity,y}$ = Quantity of methane destroyed by generation of electricity
$LFG_{electricity,y}$ = Quantity of landfill gas fed into electricity generator

Ex ante estimation of the the amount of methane that would have been destroyed/combusted during the year in tonnes of methane (*MDproject,y)*

The *ex ante* estimation of the amount of methane that would have been destroyed/combusted during the year, in tonnes of methane (MD project,y) has been done with the latest version of the approved "*Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site*", considering the following additional equation:

$$MD_{project,y} = \frac{BE_{CH4,\, SWDS,\, y}}{GWP_{CH4}} \qquad \textbf{(9)}$$

The efficiency of the degassing system which will be installed in the project activity has been taken into account while estimating the ex-ante estimation with a collection efficiency conservative value of 80%[1]. Therefore the final formula used to estimate the amount of methane that would have been destroyed/combusted during the year by the Project activity has been:

$$MD_{project,y} = 80\% \bullet \frac{BE_{CH4,\, SWDS,\, y}}{GWP_{CH4}} \qquad \textbf{(9.1)}$$

Where:

$BE_{CH4,SWDS,y}$ = Methane generation from the landfill in the absence of the project activity at year *y* (tCO2e), calculated as per the "*Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site*". As per:

$$BE_{CH4,\, SWDS,\, y} = \varphi \bullet (1-f) \bullet GWP_{CH4} \bullet (1-OX) \bullet \frac{16}{12} \bullet F \bullet DOC_f \bullet MCF \bullet \sum_{X=1}^{Y} \sum_{j} W_{j,\, x} \bullet DOC_j \bullet e^{-k_y(y-x)} \bullet \left(1-e^{-k_j}\right) \qquad \textbf{(10)}$$

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

Where:

φ =	Model correction factor to account for model uncertainties (0.9)
f =	Fraction of methane captured at the SWDS and flared, combusted or used in another manner, since AF has already been taken into account in equation (2), according to ACM0001 statement "f" in the tool have been assigned a value 0
GWP_{CH4} =	Global Warming Potential (GWP) of methane, 21 ton $_{CO2\ e}$/ton $_{CH4}$
OX =	Oxidation factor (reflecting the amount of methane from SWDS that is oxidised in the soil or other material covering the waste)
F =	Fraction of methane in the SWDS gas (volume fraction) (0.5)
DOC_f =	Fraction of degradable organic carbon (DOC) that can decompose
MCF =	Methane correction factor
$W_{j,x}$ =	Amount of organic waste type *j* prevented from disposal in the SWDS in the year *x* (tons)
DOC_j =	Fraction of degradable organic carbon (by weight) in the waste type *j*
k_j =	Decay rate for the waste type *j*
j =	Waste type category (index)
x =	Year during the crediting period: x runs from the first year of the first crediting period (x = 1) to the year y for which avoided emissions are calculated (x = y), according to ACM001 x refers to the year since the landfill started receiving wastes.
y =	Year for which methane emissions are calculated

Determination of $CEF_{elec,BL,y}$ *in equation* ***(1)*** *- Application of "Tool to calculate the emission factor for an electricity system"*

Since the baseline is electricity generated by plants connected to the grid the emission factor have been calculated according to "*Tool to calculate the emission factor for an electricity system*" Version 01.1 The data used to calculate the grid emission factor was taken from the Brazilian DNA. The factor will be updated every month, using dispatch data from the ONS from 2007:

Table B.6.1.1 Emission Factor Calculations

COMBINED MARGIN EMISSION FACTOR - 2007													
$EF_{CM} = (EF_{OM} \times W_{OM}) + (EF_{BM} \times W_{BM})$													
EMISSION FACTOR (tCO2/MWh)													
Month ->	***Jan***	***Feb***	***March***	***April***	***May***	***June***	***July***	***Aug***	***Sept***	***Oct***	***Nov***	***Dec***	***FINAL***
EF_{OM}	0.2292	0.1954	0.1948	0.1965	0.1606	0.2559	0.3096	0.3240	0.3550	0.3774	0.4059	0.4865	*0.2909*
EF_{BM}	0.0775	0.0775	0.0775	0.0775	0.0775	0.0775	0.0775	0.0775	0.0775	0.0775	0.0775	0.0775	*0.0775*
W_{OM}	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	*0.50*
W_{BM}	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
EF	**0.1533**	**0.1364**	**0.1361**	**0.1370**	**0.1190**	**0.1667**	**0.1935**	**0.2007**	**0.2163**	**0.2274**	**0.2417**	**0.2820**	***0.1842***

Source of data: http://www.mct.gov.br/index.php/content/view/74691.html

The Combined Margin (CM) for the Project is calculated as the weighted average of the Build Margin (BM) and Operating Margin (OM), as follows:

$CM_{2007} = 0.5 \times (OM_{2007} \times BM_{2007})$ = **0,1842 tCO2/MWh** **(11)**

Project Emissions

As per the latest version of ACM0001 Project Emissions have to be evaluated with the following formula:

$$PE_y = PE_{EC,y} + PE_{FC,y} \quad \textbf{(12)}$$

Where:

$PE_{EC,y}$ = Emissions from consumption of electricity in the project case. The project emissions from electricity consumption ($PE_{EC,y}$) Has been calculated following the latest version of "*Tool to calculate baseline, project and/or leakage emissions from electricity consumption*". In the baseline nof LFG is captured.

$PE_{FC,j,y}$ = Emissions from consumption of heat in the project case. For this Project is equal to 0 since no heat will be consumed.

Determination of $PE_{EC,y}$ *in equation* ***(12)*** *- Application of "Tool to calculate baseline, project and/or leakage emissions from electricity consumption"*

The tool is applicable because the "Scenario A: Electricity consumption from the grid." applies to the sources of electricity for this Project and no baseline or leakage emissions have to be evaluated for this Project since no electricity is consumed in the baseline and no leakage have to be taken into account.

The general formula is:

$$PE_{EC,y} = \sum_{y} EC_{PJ,j,y} \bullet EF_{EL,j,y} \bullet (1 + TDL_y) \quad \textbf{(12.1)}$$

Where:

$PE_{EC,y}$ = Project emissions from electricity consumption in year *y* (tCO_2/yr)

$EC_{PJ,j,y}$ = Quantity of electricity consumed by the project electricity consumption source *j* in year *y* (MWh/yr)

$EF_{EL,j,y}$ = Emission factor for electricity generation for source *j* in year *y* (tCO_2/MWh)

$TDL_{j,y}$ = Average technical transmission and distribution losses for providing electricity to source *j* in year *y*, for the Project the 20% default value has been used.

j = Sources of electricity consumption in the project, in this case is only the National grid.

For the calculation of the EF Option A1:. "Calculate the combined margin emission factor of the applicable electricity system, using the procedures in the latest approved version of the "Tool to calculate the emission factor for an electricity system" ($EF_{EL,j/k/l,y} = EF_{grid,CM,y}$)" applies. Therefore, according to the previous calculations **(15)**:

$$EF_{EL,j/k/l,y} = EF_{grid,CM,y} = 0.1842 \quad \textbf{(12.2)}$$

Leakage calculation

No leakage effects need to be accounted under ACM0001 methodology.

Emission Reduction

Emission reductions are calculated as follows:

$$ER_y = BE_y - PE_y \quad \textbf{(13)}$$

Where:

ER_y = Emission reductions in year y (tCO_2e/yr)
BE_y = Baseline emissions in year y (tCO2e/yr)
PE_y = Project emissions in year y (tCO_2/yr)

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

(Copy this table for each data and parameter

Data / Parameter:	Regulatory requirements relating to landfill gas
Data unit:	
Description:	Regulatory requirements relating to landfill gas
Source of data used:	Publicly available information of the Brazilian's regulatory requirements relating to landfill gas. The DNA has been contacted to provide information.
Value applied:	Brazilian government does not mandate to flare or collect the LFG emitted from landfills (communication *Oficio n° 058/2008/CIMG*)
Justification of the choice of data or description of measurement methods and procedures actually applied :	The information though recorded annually, wouldn't be used for changes to the adjustment factor (AF) or directly $MD_{BL,y}$ at renewal of the credit period because for this Project it has been chosen a fixed Crediting Period.
Any comment:	

Data / Parameter:	**CE**
Data unit:	%
Description:	Collection efficiency of the degassing system
Source of data used:	**USEPA**; *Turning a Liability into an Asset: A Landfill Gas-to-Energy Project Development Handbook*; September 1996
Value applied:	80%
Justification of the choice of data or description of measurement methods and procedures actually applied :	According to EPA Handbook : "Landfill Gas Flow is the net quantity of landfill gas per day that is captured by the collection system, processed, and delivered to the power generation equipment (usually 75% to 85% of the total gas produced in the landfill)"; the value of 80%, in the middle of the range, has been conservatively adopted for this Project.
Any comment:	

Data / Parameter:	η_{PV}
Data unit:	%
Description:	Capture efficiency of the baseline passive venting system
Source of data used:	http://www.mnp.nl/ipcc/Archive/AR4FOD/ExpRevFOD/FODrev/FOD_AChapter10.doc - IPCC Fourth Assessment Report *Expert Review of the First-Order Draft*
Value applied:	37%
Justification of the choice of data or description of measurement methods and procedures actually applied :	As per measurements made in 11 Dutch landfills, in the closed unlined period, Oonk and Boom (1995) measures efficiencies in between 10 and 80%,, the average being 37%
Any comment:	

Data / Parameter:	η_{LFGF}
Data unit:	%
Description:	LFG Flaring efficiency of the passive venting system's connected wells
Source of data used:	"Tool to determine project emissions from flaring gases containing methane"
Value applied:	50%
Justification of the choice of data or description of measurement methods and procedures actually applied :	It can be considered that lighted wells can burn methane less efficiently than an open flare, in the "Tool to determine project emissions from flaring gases containing methane" open flares are defined as devices where the residual gas is burned in an open air tip with or without any auxiliary fluid assistance, therefore it is conservative to adopt for these wells the open flare efficiency value which is equal to 50%.
Any comment:	

Data / Parameter:	N_{fw}
Data unit:	
Description:	Number of wells lighted on in the baseline
Source of data used:	Survey data, see Annex III "Baseline information" for the Survey Report
Value applied:	25
Justification of the choice of data or description of measurement methods and procedures actually applied :	It has been measured that the average number of wells lighted on in the CTRS / BR.040 landfill in the survey period is 23; in the calculation it has been assumed a value of 25 to be more conservative. Moreover the ignited wells are conservatively considered to remain lighted all day long, for the whole year , not taking into account seasonal rains, windy days and the frequent quenching attested from the survey in order to act in the most conservative way. No other data source was available
Any comment:	

Data / Parameter:	N_{vw}
Data unit:	
Description:	Total number of wells present on site that can be ignited
Source of data used:	Survey data, see Annex III "Baseline information" for the Survey Report
Value applied:	123
Justification of the choice of data or description of measurement methods and procedures actually applied :	Attested from the Survey, see attached Report with picture and drawings, no other data source was available.
Any comment:	

Data / Parameter:	$BE_{CH4,SWDS,y}$
Data unit:	tCO_{2e}
Description:	
Source of data used:	Calculated as per the *"Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site"*
Value applied:	
Justification of the choice of data or description of measurement methods and procedures actually applied :	As per the *"Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site"*
Any comment:	Used for ex-ante estimation of the amount of methane that would have been destroyed/combusted during the year

Data / Parameter:	**OX**
Data unit:	
Description:	Oxidation factor (reflecting the amount of methane from SWDS that is oxidized in the soil or other material covering the waste)
Source of data used:	2006 IPCC Guidelines for National Greenhouse Gas Inventories for the CTRS / BR.040 Landfill cover
Value applied:	0
Justification of the choice of data or description of measurement methods and procedures actually applied :	The CTRS /.040 landfill is covered with a compacted clay layer. As this kind of cover is not considered an oxidising material, OX used for calculations is equal to 0
Any comment:	

Data / Parameter:	MCF
Data unit:	
Description:	Methane correction factor
Source of data used:	IPCC 2006 Guidelines for National Greenhouse Gas Inventories
Value applied:	1
Justification of the choice of data or description of measurement methods and procedures actually applied :	According with the 2006 IPCC Guidelines, the CTRS / BR.040 landfill meets the criteria of managed SWDS because has had controlled placement of waste (i.e., waste directed to specific deposition areas, a degree of control of scavenging and a degree of control of fires) with: (i) cover material; (ii) mechanical compacting; (iii) levelling of the waste..
Any comment:	The methane correction factor (MCF) accounts for the fact that unmanaged SWDS produce less methane from a given amount of waste than managed SWDS, because a larger fraction of waste decomposes aerobically in the top layers of unmanaged SWDS.

<table>
<tr><td>Data / Parameter:</td><td>DOCj</td></tr>
<tr><td>Data unit:</td><td>%</td></tr>
<tr><td>Description:</td><td>Fraction of degradable organic carbon (by weight) in the waste type j</td></tr>
<tr><td>Source of data used:</td><td>IPCC 2006 Guidelines for National Greenhouse Gas Inventories</td></tr>
<tr><td>Value applied:</td><td>DOCj percentages for wet wastes:
<table>
<tr><th><u>Waste type j</u></th><th><u>DOCj
(% wet waste)</u></th></tr>
<tr><td>Wood and wood products</td><td>43.00%</td></tr>
<tr><td>Pulp, paper and cardboard (other than sludge)</td><td>40.00%</td></tr>
<tr><td>Food, food waste, beverages and tobacco (other than sludge)</td><td>15.00%</td></tr>
<tr><td>Textiles</td><td>24.00%</td></tr>
<tr><td>Garden, yard and park waste</td><td>20.00%</td></tr>
<tr><td>Glass, plastic, metal, other inert waste</td><td>0.00%</td></tr>
</table></td></tr>
<tr><td>Justification of the choice of data or description of measurement methods and procedures actually applied :</td><td>Since waste type can not clearly be attributed to neither wet or dry type, for this Project has been chosen wet waste because is the waste type where the values of DOCj and kj result in a conservative estimate (lowest emissions),</td></tr>
<tr><td>Any comment:</td><td></td></tr>
</table>

<table>
<tr><td>Data / Parameter:</td><td>kj</td></tr>
<tr><td>Data unit:</td><td></td></tr>
<tr><td>Description:</td><td>Decay rate for the waste type j</td></tr>
<tr><td>Source of data used:</td><td>IPCC 2006 Guidelines for National Greenhouse Gas Inventories</td></tr>
<tr><td>Value applied:</td><td>
<table>
<tr><td colspan="2" rowspan="2">Waste type j</td><td>Tropical (MAT>20°C)</td></tr>
<tr><td>Wet (MAP>1000mm)</td></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>0.04</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, beverages and tobacco (other than sludge)</td><td>0.40</td></tr>
</table>
</td></tr>
<tr><td>Justification of the choice of data or description of measurement methods and procedures actually applied :</td><td>Those values were adopted considering the following Belo Horizonte climate data:
- MAT = 21.1 °C
- MAP = 1,460 mm/y
- PET = 1,243mm/y</td></tr>
<tr><td>Any comment:</td><td>Reference: http://www.fao.org/nr/water/aquastat/gis/index3.stm
Coordinates: 19°44' S; 44°00' W</td></tr>
</table>

Data / Parameter:	f
Data unit:	
Description:	Fraction of methane captured at the SWDS and flared, combusted or used in another manner
Source of data used:	Baseline information
Value applied:	0
Justification of the choice of data or description of measurement methods and procedures actually applied :	According to ACM0001, since the ann adjustment factor AF is already accounted for in equation to determine MD_{BL}, “f” in the tool shall be assigned a value 0.
Any comment:	

Data / Parameter:	W_x
Data unit:	tons
Description:	Total amount of organic waste prevented from disposal in year *x* (tons)
Source of data used:	Official data from public bid N° 183/2007 documents
Value applied:	see table below
Justification of the choice of data or description of measurement methods and procedures actually applied :	
Any comment:	

Years	Waste to Landfill [t/y]	Years	Waste to Landfill [t/y]	Years	Waste to Landfill [t/y]
1983	232,733	1994	699,247	2005	1,071,357
1984	199,949	1995	665,103	2006	930,521
1985	239,155	1996	712,187	2007	624,649
1986	278,925	1997	762,755		
1987	295,180	1998	793,131		
1988	306,736	1999	1,170,436		
1989	325,736	2000	1,204,280		
1990	393,158	2001	1,264,380		
1991	461,977	2002	1,249,585		
1992	521,847	2003	1,165,362		
1993	553,339	2004	1,138,909		

Data / Parameter:	$p_{n,j,x}$
Data unit:	%
Description:	Weight fraction of the waste type *j*
Source of data used:	Official data from public bid N° 183/2007 documents
Value applied:	see table below
Justification of the choice of data or description of measurement methods and procedures actually applied :	
Any comment:	

Waste type j	Waste composition (%)
Wood and wood products	0.00%
Pulp, paper and cardboard (other than sludge)	8.43%
Food, food waste, beverages and tobacco (other than sludge)	52.54%
Textiles	4.04%
Garden, yard and park waste	9.05%
Glass, plastic, metal, other inert waste	25.94%
TOTAL	**100.00%**

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

LFG Generation

Applying the "*Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site*", the following table resumes the calculation made over the 10 years Crediting Period:

Table B.6.3.1. Ex-ante estimation of LFG generated in CTRS / BR.040 landfill

Year	LFG generated by tool [Nm^3LFG/y]
2009 (4 months)	17,609,199
2010	42,074,424
2011	34,278,429
2012	28,525,930
2013	24,196,964
2014	20,869,493
2015	18,255,026
2016	16,155,349
2017	14,433,400
2018	12,993,661
2019 (8 months)	7,845,954

The collection efficiency factor (80%) has than been taken into account to evaluate LFG that can be captured by the designed capture system and used to produce electricity or, if exceeding the engine's requirements, to be flared in the high temperature flaring section.

Following tables resume the calculations made according to the methodologies and tools as presented in the above section B.6.1. Explanation of methodological choices:

Table B.6.3.2. Project Emissions from flaring

$PE_{flare,y} = \Sigma TM_{RG,h} * (1 - \eta_{flare,h}) * GWP_{CH4} / 1000$ (T.15)		2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
$PE_{flare,y}$	Project emissions from flaring of the residual gas stream (tCO_2e) determined following the procedure described in the "Tool to determine project emissions from flaring gases containing methane"	970	869	414	196	166	143	125	111	99	89	54
$\Sigma TM_{RG,h}$	Total mass flow rate in the residual gas (kg)	4,619	4,140	1,971	934	792	683	597	529	472	425	257
$\eta_{flare,h}$	Flare combustion efficiency	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
GWP_{CH4}	Global Warming Potential value for methane for the first commitment period (tCO_2e/tCH_4)	21	21	21	21	21	21	21	21	21	21	21

Table B.6.3.3. Methane Destroyed by Flaring

$MD_{flared,y} = (LFG_{flare,y} * w_{CH4,y} * D_{CH4}) - (PE_{flare,y}/GWP_{CH4})$ (4)		2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
$LFG_{flare,y}$	Quantity of landfill gas fed to the flare during the year (m^3)	12,887,423	11,551,421	5,499,735	2,605,108	2,209,768	1,905,890	1,667,126	1,475,374	1,318,119	1,186,636	716,526
$w_{CH4,y}$	Average methane fraction of the landfill gas as measured during the year y and expressed as a fraction (m^3 CH_4 / m^3 LFG)	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
D_{CH4}	Methane density (tCH_4/m^3CH_4)	0.0007168	0.0007168	0.0007168	0.0007168	0.0007168	0.0007168	0.0007168	0.0007168	0.0007168	0.0007168	0.0007168
$PE_{flare,y}$ / GWP_{CH4}	Project emissions from flaring of the residual gas stream (tCO_2e) determined following the procedure described in the "Tool to determine project emissions from flaring gases containing methane"	748	3,542	3,542	3,542	3,542	3,542	3,542	3,542	3,542	3,542	2,361
GWP_{CH4}	Global Warming Potential value for methane for the first commitment period (tCO_2e/tCH_4)	21	21	21	21	21	21	21	21	21	21	21

Table B.6.3.4. Methane Destroyed by Electricity production

$MD_{electricity,y} = (LFG_{electricity,y} * w_{CH4,y} * D_{CH4})$		2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
$MD_{electricity,y}$	Quantity of methane destroyed by generation of electricity (tCH_4)	280	7565	7565	7003	5940	5123	4481	3966	3543	3190	1926
$LFG_{electricity,y}$	Quantity of landfill gas fed into the electricity generator (m^3)	781,818	21,109,091	21,109,091	19,538,308	16,573,263	14,294,173	12,503,443	11,065,308	9,885,891	8,899,768	5,373,941
$w_{CH4,y}$	Average methane fraction of the landfill gas as measured during the year y and expressed as a fraction (m^3 CH_4 / m^3 LFG)	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
D_{CH4}	Methane density (tCH_4/m^3CH_4)	0.0007168	0.0007168	0.0007168	0.0007168	0.0007168	0.0007168	0.0007168	0.0007168	0.0007168	0.0007168	0.0007168

Table B.6.3.5. Methane Destroyed in the project activity

$MD_{project,y} = MD_{flared,y} + MD_{electricity,y}$		2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
$MD_{project,y}$	Amount of methane that would have been destroyed/combusted during the year y (tCH_4)	4853	11664	9517	7927	6724	5799	5073	4489	4011	3611	2180
$MD_{flared,y}$	Methane destroyed by flaring (tCH_4)	4573	4099	1951	924	784	676	592	523	468	421	254
$MD_{electricity,y}$	Methane destroyed by electricity generation (tCH_4)	280	7565	7565	7003	5940	5123	4481	3966	3543	3190	1926

Table B.6.3.6. Methane Destroyed in the Baseline

$MD_{BL,y,}=MD_{reg,y} = MD_{project,y} * AF$		2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
$MD_{reg,y}$	Amount of methane that World have been destroyed/combusted during the year y in the absence of the Project (tCH_4)	237	567	462	384	326	281	246	218	195	175	106
$MD_{project,y}$	Amount of methane that would have been destroyed/combusted during the year y (tCH_4)	4,853	11,664	9,517	7,927	6,724	5,799	5,073	4,489	4,011	3,611	2,180
AF_y	Adjustment factor	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05

Table B.6.3.7. Ex.ante Esimation of Emission Reductions

$ER_y = (MD_{project,y} - MD_{reg,y}) * GWP_{CH4} + EL_{LFG,y} * CEF_{elec,BL,y} - EL_{PR,y} * CEF_{elec,PR,y}$		2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
ER_y	Emissions reduction (tCO_2e)	96,275	234,565	191,679	159,500	134,678	115,598	100,606	88,566	78,693	70,437
$MD_{project,y}$	Amount of methane that would have been destroyed/combusted during the year y (tCH_4)	4,853	11,664	9,517	7,927	6,724	5,799	5,073	4,489	4,011	3,611
$MD_{reg,y}$	Amount of methane that would have been destroyed/combusted during the year y in the absence of the project (tCH_4)	237	567	462	384	326	281	246	218	195	175
GWP_{CH4}	Global Warming Potential value for methane for the first commitment period (tCO_2e/tCH_4)	21	21	21	21	21	21	21	21	21	21
$EL_{LFG,y}$	Net quantity of electricity produced using LFG, which in the absence of the project activity would have been produced by power plants connected to an on-site/off-site fossil fuel based captive power the grid or by generation, during year y (MWh)	520	27,510	27,510	25,250	20,983	17,704	15,127	13,057	11,360	9,941
$CEF_{elec,BL}$	CO_2 emissions intensity of the baseline source of electricity displaced (tCO_2e/MWh)	0.1842	0.1842	0.1842	0.1842	0.1842	0.1842	0.1842	0.1842	0.1842	0.1842
$EL_{PR,y}$	Amount of electricity generated in an on-site fossil fuel fired power plant or imported from the grid as a result of the project activity, measured using electricity meter (MWh)	605	2,865	2,865	2,865	2,865	2,865	2,865	2,865	2,865	2,865
$CEF_{elec,PR,y}$	Carbon emission factor for electricity generation in the project activity (tCO_2e/MWh)	0.1842	0.1842	0.1842	0.1842	0.1842	0.1842	0.1842	0.1842	0.1842	0.1842

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

Tab. B. 6.4.1: Total emission reductions

Year	Estimation of project activity emissions (tCO2e)	Estimation of baseline emissions (tCO2e)	Estimation of Leakage (tCO2e)	Estimation of overall emission reductions (tCO2e)
2009 (4 months)	748	97,023	0	96,275
2010 (full year)	3,542	238,107	0	234,565
2011 (full year)	3,542	195,221	0	191,679
2012 (full year)	3,542	163,042	0	159,500
2013 (full year)	3,542	138,220	0	134,678
2014 (full year)	3,542	119,140	0	115,598
2015 (full year)	3,542	104,148	0	100,606
2016 (full year)	3,542	92,108	0	88,566
2017 (full year)	3,542	82,235	0	78,693
2018 (full year)	3,542	73,979		70,437
2019 (8 months)	2,361	44,637	0	42,276
Total (tCO2e)	**34,987**	**1,347,859**	**0**	**1,312,872**

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

B.7.1 Data and parameters monitored:

The monitoring methodology is based on direct measurement of the amount of landfill gas captured and destroyed by flaring and used in the engines in order to generate electricity to be sold to the National Grid. Data will be recorded and archived electronically during the crediting period and two years after

Data / Parameter:	$LFG_{total,y}$
Data unit:	Nm^3
Description:	Total amount of landfill gas captured at Normal Temperature and Pressure
Source of data to be used:	Flow meter
Value of data applied for the purpose of calculating expected emission reductions in section B.5	The parameter is calculated ex-ante using the "*Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site*" using the equations shown in section B.
Description of measurement methods and procedures to be applied:	Instant flow will be measured by a flow meter, normalized according to landfill gas temperature and pressure, automatic measurement of temperature and pressure will be made by probes connected to the flowmeter – these data will be used to convert the gas-flow to Nm^3. This unit will measure directly Nm^3 of LFG being delivered to the plant. The flow will be measured continuously in Nm^3/h and data will be aggregated hourly to summarize Nm^3 of LFG being delivered to the plant, then monthly and yearly for reporting.
QA/QC procedures to be applied:	Data with low level of uncertainty. QA/QC procedures are planned for these data. Flow meters will be subject to regular maintenance and testing regime to ensure accuracy according to manufacturer's specifications.
Any comment:	Data will be archived electronically during the crediting period and two years after.

Data / Parameter:	$LFG_{flare,y}$
Data unit:	Nm^3
Description:	Amount of landfill gas flared
Source of data to be used:	Flow meter
Value of data applied for the purpose of calculating expected emission reductions in section B.5	The parameter is calculated *ex ante* considering that all LFG captured and not used to produce electricity (as for engine maintenance stops)will be sent to the high temperature enclosed flares, as shown in the calculations made in section B
Description of measurement methods and procedures to be applied:	Instant flow will be measured by a flow meter, one for each flare's feeding pipeline, normalized according to landfill gas temperature and pressure, automatic measurement of temperature and pressure will be made by probes connected to the flow meter – these data will be used to convert the gas-flow to Nm^3. This unit will measure directly Nm^3 of LFG being delivered to the plant.

	The flow will be measured continuously in Nm^3/h and data will be aggregated hourly to summarize Nm^3 of LFG being delivered to the flaring section, then monthly and yearly for reporting.
QA/QC procedures to be applied:	Data with low level of uncertainty. QA/QC procedures are planned for these data. Flow meters will be subject to regular maintenance and testing regime to ensure accuracy according to manufacturer's specifications
Any comment:	Data will be archived electronically during the crediting period and two years after

Data / Parameter:	$LFG_{electricity,y}$
Data unit:	Nm^3
Description:	Amount of landfill gas combusted in power plant
Source of data to be used:	Flow meter
Value of data applied for the purpose of calculating expected emission reductions in section B.5	The parameter is calculated ex ante as the LFG captured and used year by year to produce electricity by the installed engines, as shown in the calculations made in section B
Description of measurement methods and procedures to be applied:	Instant flow will be measured by a flow meter, normalized according to landfill gas temperature and pressure, automatic measurement of temperature and pressure will be made by probes connected to the flow meter – these data will be used to convert the gas-flow to Nm^3. This unit will measure directly Nm^3 of LFG being delivered to the plant. The flow will be measured continuously in Nm^3/h and data will be aggregated hourly to summarize Nm^3 of LFG being delivered to the power plant, then monthly and yearly for reporting.
QA/QC procedures to be applied:	Data with low level of uncertainty. QA/QC procedures are planned for these data. Flow meters will be subject to regular maintenance and testing regime to ensure accuracy according to manufacturer's specifications
Any comment:	Data will be archived electronically during the crediting period and two years after

Data / Parameter:	$w_{CH4,y}$
Data unit:	$m^3 CH_4 / m^3 LFG$
Description:	Methane fraction in the landfill gas
Source of data to be used:	Continuous methane analyser
Value of data applied for the purpose of calculating expected emission reductions in section B.5	50%
Description of measurement methods and procedures to be applied:	Measured directly and continuously with a gas analyser on dry basis, and aggregated hourly, monthly and yearly.

QA/QC procedures to be applied:	QA/QC procedures are planned for these data. The gas analyzer is subject to regular maintenance and testing regime to ensure accuracy according to manufacturer's specifications and accuracy will be checked at list every six month during then plant normal operation .
Any comment:	Data will be archived electronically during the crediting period and two years after.

Data / Parameter:	Operation of the energy plant
Data unit:	hours
Description:	Operation of the energy plant
Source of data to be used:	Engine's working hours counter meters
Value of data applied for the purpose of calculating expected emission reductions in section B.5	7,500 h/year (conservative)
Description of measurement methods and procedures to be applied:	Measured by hours counter meters, aggregated at list yearly.
QA/QC procedures to be applied:	According to the engine manufacturer specifications
Any comment:	This is monitored to ensure methane destruction is claimed for methane used in electricity plant when it is operational.

Data / Parameter:	EL_{LFG}
Data unit:	MWh
Description:	Net amount of electricity generated using landfill gas
Source of data to be used:	Electricity meter
Value of data applied for the purpose of calculating expected emission reductions in section B.5	The values calculated for each year for the Project are shown in section B.
Description of measurement methods and procedures to be applied:	Required to estimate the emission reductions from electricity generated from LFG and exported out of the Project boundary. Data will be measured continuously with an electricity meter
QA/QC procedures to be applied:	Electricity meter will be subject to regular (in accordance with stipulation of the meter supplier) maintenance and testing to ensure accurancy. Double check by receipt of sales.
Any comment:	Data will be archived electronically during the crediting period and two years after

Data / Parameter:	EL_{PR}
Data unit:	MWh
Description:	Total amount of electricity imported to meet the requirements of the Project
Source of data to be used:	Electricity meter
Value of data applied for the purpose of calculating expected emission reductions in section B.5	The value calculated for each year is shown in section B.
Description of measurement methods and procedures to be applied:	Required to evaluate CO_2 emissions due to the power consumption of the project activity imported from the National Grid. Data will be measured continuously with an electricity meter.
QA/QC procedures to be applied:	Electricity meter will be subject to regular(in accordance with stipulation of the meter supplier) maintenance and testing to ensure accuracy. .Double check by receipt of sales.
Any comment:	Data will be archived electronically during the crediting period and two years after

Data / Parameter:	$CEF_{elecy,BL,y}$
Data unit:	tCO_2/MWh
Description:	Carbon Emission Factor for electricity
Source of data to be used:	Official data from DNA
Value of data applied for the purpose of calculating expected emission reductions in section B.5	Since baseline source of electricity is the grid, EF has been estimated using the "*Tool to calculate the emission Factor for an electricity system*" and calculated to be equal to $CEF_{elecy,BL,y}$ =$EF_{CM,2007}$=0.1842
Description of measurement methods and procedures to be applied:	Required to evaluate CO_2 emissions due to the power consumption of the project activity imported from the National Grid; for this Project emissions factor to be updated annually during monitorin
QA/QC procedures to be applied:	g
Any comment:	

Tool to calculate the Emission Factor for an electricity system

Data / Parameter:	$EF_{CM,y}$
Data unit:	tCO_2/MWh
Description:	Combined margin emissions factor required to evaluate CO_2 emissions due to the power consumption of the project activity imported from the National Grid
Source of data to be used:	The data used to calculate the grid emission factor was taken from the Brazilian DNA. The factor will be updated every year, using dispatch data from the ONS from 2007
Value of data applied for the purpose of calculating expected emission reductions in section B.5	$EF_{CM,2007}$=0.1842
Description of measurement methods and procedures to be applied:	Since “ex post” option has been chosen in the Operating Margin calculations applying the “*Tool to calculate the emission factor for an electricity system*”, the year in which the project activity displaces grid electricity, requiring the emissions factor to be updated annually during monitoring. If the data required to calculate the emission factor for year y is usually only available later than six months after the end of year y, alternatively the emission factor of the previous year (y-1) may be used. If the data is usually only available 18 months after the end of year y, the emission factor of the year proceeding the previous year (y-2) may be used. The same data vintage (y, y-1 or y-2) will be used throughout all crediting periods.
QA/QC procedures to be applied:	
Any comment:	

Tool to determine project emissions from flaring gases containing Methane

Data / Parameter:	$fv_{i,h}$
Data unit:	
Description:	Volumetric fraction of component *i* in the residual gas in the hour *h* where *i* = CH_4, CO, CO_2, O_2,H_2, N_2
Source of data to be used:	Continuous gas analyser
Value of data applied for the purpose of calculating expected emission reductions in section B.5	As a simplified approach, in this Project it is only measured the methane content of the residual gas and considered the remaining part as N_2.
Description of measurement methods and procedures to be applied:	Measured directly and continuously with a gas analyser on dry basis, and aggregated hourly, monthly and yearly.
QA/QC procedures to be applied:	QA/QC procedures are planned for these data. The gas analyzer is subject to regular maintenance and testing regime to ensure accuracy according to

	manufacturer's specifications and accuracy will be checked at list every six month during then plant normal operation
Any comment:	Data will be archived electronically during the crediting period and two years after.

Data / Parameter:	$t_{O2,h}$
Data unit:	
Description:	Volumetric fraction of O_2 in the exhaust gas of the flare in the hour *h* (only in case the flare efficiency is continuously monitored)
Source of data to be used:	Continuous gas extractive sampling analyzer with water and particulates removal devices
Value of data applied for the purpose of calculating expected emission reductions in section B.5	For the purpose of calculating expected emission reductions in section B.5 Flare efficiency has been considered equal to 99%
Description of measurement methods and procedures to be applied:	The point of measurement (sampling point) will be in the upper section of the flare (80% of total flare height). Sampling will be conducted with appropriate sampling probes adequate to high temperatures level. An excessively high temperature at the sampling point (above 700 ºC) may be an indication that the flare is not being adequately operated or that its capacity is not adequate to the actual flow.
QA/QC procedures to be applied:	Analysers will be periodically calibrated according to the manufacturer's recommendation. A zero check and a typical value check should be performed by comparison with a standard gas.
Any comment:	Monitoring of this parameter is applicable because in this Project enclosed flares and continuous monitoring of the flare efficiency.has been foreseen. Data will be recorded and archived electronically during the crediting period and two years after

Data / Parameter:	$fv_{CH4,FG,h}$
Data unit:	mg/m^3
Description:	Concentration of methane in the exhaust gas of the flare in dry basis at normal conditions in the hour *h* (only in the case the flare efficiency is continuously monitored)
Source of data to be used:	Continuous gas extractive sampling analyzer with water and particulates removal devices
Value of data applied for the purpose of calculating expected emission reductions in section B.5	For the purpose of calculating expected emission reductions in section B.5 Flare efficiency has been considered equal to 99%

Description of measurement methods and procedures to be applied:	The sampling point will be in the upper section of the flare (80% of total flare height). Sampling will be conducted with appropriate sampling probes adequate to high temperatures level. Cyclically samples will be collected and used to calculate the averaged hourly value.
QA/QC procedures to be applied:	Analysers will be periodically calibrated according to the manufacturer's recommendation. A zero check and a typical value check should be performed by comparison with a standard gas.
Any comment:	Monitoring of this parameter is applicable because in this Project enclosed flares and continuous monitoring of the flare efficiency.has been foreseen. Data will be recorded and archived electronically during the crediting period and two years after. Measurement instruments may read ppmv or % values. To convert from ppmv to mg/m3 simply multiply by 0.716. 1% equals 10 000 ppmv.

Data / Parameter:	T_{flare}
Data unit:	°C
Description:	Temperature in the exhaust gas of the enclosed flare
Source of data to be used:	Type N thermocouple
Value of data applied for the purpose of calculating expected emission reductions in section B.5	T > 500 °C
Description of measurement methods and procedures to be applied:	Tthe temperature of the exhaust gas stream will be continuously measured in the flare by a Type N thermocouple. A temperature above 500 ºC indicates that a significant amount of gases are still being burnt and that the flare is operating.
QA/QC procedures to be applied:	Thermocouples will be calibrated every year using a reference thermocouple, in case of failure in calibration the thermocouples will be replaced.
Any comment:	

B.7.2. Description of the monitoring plan:

According to ACM0001, direct monitoring will be conducted on the LFG captured, destroyed by flare and used for power generation. The monitoring procedures will measure:

- Landfill gas collected from project wells
- Landfill gas flow into flare.
- Landfill gas flow into power plant.
- Methane content in the landfill gas.
- Temperature of exhaust gas from flaring
- Methane and oxygen content in the exhaust gas from flaring
- Electricity imported from the power grid.
- Electricity exported to the power grid.
- Power plant working hours.
- Emissions from flaring.

- Local and national regulatory framework
- Emission Factor
- $MD_{project,y}$ = Amount of methane destroyed by the project activity during the year y of the project activity (tCH4)

The monitoring of the operation parameters during the operation of the plant will be carryed out according to the monitoring plan on Annex 4.

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

Detailed baseline information is provided in Annex III to this PDD.
The baseline study was completed on 24/11/2008 and prepared by *Aria.biz S.A.* (Project Participant) and *Aria Engineering S.r.l* . (not a Project Participant); the contact info are the following:

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SECTION C. Duration of the project activity / crediting period

C.1. Duration of the project activity:

C.1.1. Starting date of the project activity:

07/08/2008.

This date is the date when the concession contract between Municipality of Belo Horizonte and Consòrcio Horizonte Asja for the right to exploit the landfill gas arising from wastes CTRS / BR.040 landfill was signed.

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

10 years

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

C.2.1. Renewable crediting period:

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

Not Applicable

C.2.1.2. Length of the first crediting period:

Not Applicable

C.2.2. Fixed crediting period:

C.2.2.1. Starting date:

01/09/2009

C.2.2.2. Length:

10 years, equal to 120 months

SECTION D. Environmental impacts

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

In Minas Gerais State the attributions of environmental regularization are performed by the Conselho Estadual de Política Ambiental (State Cabinet of Environmental Politics), respected the projects of federal interest, through the Câmaras Especializadas (Specialized Councils), the Unidades Regionais Colegiadas (Member Regional Units body), the Superintendências Regionais de Meio Ambiente e Desenvolvimento Sustentável (Regional Superintendence for Environment and Sustainable Development), the Fundação Estadual do Meio Ambiente (State Foundation for Environment), the Instituto Mineiro de Gestão das Águas (Minas Gerais Institute for Waters Management) and the Instituto Estadual de Florestas (State Institute for Forests), in accordance with Art. 1º of State Decree nº 44.844/08. However, the State can delegate its licensing functions to the city if it is considered necessary

(Articles 4º to 7º of the Resolution nº 237/97); in Belo Horizonte, such is performed by the Conselho Municipal de Meio Ambiente - COMAM (City Council for Environment).

CTRS/BR.040 Landfill, on which the present Project Activity will be undertaken, was properly licensed before its implantation (licensing nº 01.138348.05.55), permitting the current project to be simply regularized. According to COMAM it was interpreted as established in Subsection IV of Art. 4º from COMAM Normative Deliberation nº 48/03, i.e. it is a modification of already environmentally licensed enterprise, since it does not modify the repercussion of the activity in the urban ambient, only requiring the obtaining of the Licença de Operação – LO (Operational License).

A detailed inventory and analysis of the landfill and surrounding areas had been realized and compiled in the Relatório de Controle Ambiental - RCA (Environmental Control Report) delivered to COMAM with respective Plano de Controle Ambiental – PCA (Environmental Control Plan), where prevention, controlling and relieving of the identified negative environmental impacts methodology is described. The notes made in RCA and PCA are:

- RCA:
    - Likely sources of contamination
        - Noise
        - Liquid effluents
        - Atmospheric effluents
        - Solid waste
        - Sanitary sewer
    - Diagnosis of enterprise influence area
        - Physic environment
            - Geologic-morphologic aspects
            - Hydrologic aspects
        - Biotic environment
            - Flora
            - Fauna
- PCA:
    - Capture wells analysis and control
    - Aspirators control
    - Torch manage and control
    - Supervision and control system
    - Efficiency analysis of torch combustion
    - Biogas combustion torches gas emissions
    - Verification by DOE (Designated Operational Entity) and by UNFCCC

Moreover, additional to the required by the regularizing agency, n° 01.146231/02-04 Audience was promoted on 2008, November 5th, in the capital of state, with the goal of maximize the participation of the population in the project, through the explanation of the foreseen activities and stimulating them to tell us their opinion.

Concluding, the project, beyond contributing to the improvement of environmental and social quality of the region, will generate jobs, qualify professionals, promote local technological development and will bring foreign currency to the city, collaborating for the sustainable development of Belo Horizonte. Thus, LO was obtained with the following characteristics:

- LO nº 1823/08;
- Emission date: 14/11/2008; and
- Validity: 5 years.

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

None of the identified environmental impacts was considered of magnitude that made the continuation of the project impracticable. All the COMAM orientations and requirements had been obeyed and the environmental regularization was concluded successfully, being the measures foreseen in PCA considered satisfactory, according to the official LO nº 1823/08 issued on November the 14th 2008.

SECTION E. Stakeholders' comments

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

The Brazilian DNA Interministerial Commission on Global Climate Change (Comissão Interministerial de Mudança Global do Clima) regulates the local stakeholder consultation process through the following official documents:

- Resolution nº 1 of September 11, 2003;
- Resolution nº 2 of August 10, 2005;
- Resolution nº 3 of March 24, 2006;
- Resolution nº 4 of December 6, 2006;
- Resolution nº 5 of April 5, 2007;
- Resolution nº 6 of June 6, 2007;
- Resolution nº 7 of march 5, 2008;
- Resolution nº 8 of May 26, 2008; and
- Manual for Submitting CDM Projects Activities (version 2), of July 2, 2008.

All of them establish rules and procedures in order to obtain the letter of approval of the project.
In accordance to these procedures, CONSÓRCIO HORIZONTE ASJA performed the stakeholder consultation process in the following manner:
STEP 1: Invitation letters - on 28 October 2008, letters were sent by mail with return receipt in order to invite the following persons to submit comments on the Project :

Table E.1-1: Invitees for local stakeholder consultation process

Name	Position	Company/Institution
Fernando Damata Pimentel	Mayor	City Hall of Belo Horizonte
Murilo de Campos Valadares	Municipal Secretary	SMURBE - Secretaria Municipal de Políticas Urbanas
Sinara Inácio Meireles Chenna	Superintendent of Urban Sanitation	SLU – Superintendence of Urban Sanitation
Totó Teixeira	Town Council President	City Council of Belo Horizonte
Guilherme Silvino	Environmental Sanitation Manager	FEAM – State Foundation of Environment (State environmental body)
Flávia Mourão Parreira do Amaral	Municipal Secretary	SMAMA – Environment Municipal Assistant Secretary
Esther Neuhaus	Executive Manager	FBOMS – Brazilian NGO Forum and Social Movements for the Environment and Development
Rafael Afonso Silva	Vice president	Association of Residents and Friends of Nossa Senhora da Glória District
Odilon Araújo	President	AMOPIA - Association of Pindorama District and Neighbourhoods
Sebastião Mhen Ambrósio	Manager	Association COMFORÇA
Geralda Maria Vieira	President	Community Association Conjunto Jardim Filadélfia
Rafael Afonso Silva	Leader	Sportive Association of Bertioga
Marilu Coelho Moreira	President	Association of Conjunto Jardim Califórna 2 Residents
José Veríssimo Pinto	Leader	Association Vila da Paz
Ronaldo Adriano da Silva	Leader	Carroceiros
Rafael Afonso Silva	Leader	Local Comission for Health of Pindorama District
João de Almeida Castro	President	GCAM - Community Guild Alípio de Melo
Luiz Arnaldo de Castro	President	Activity Muda Aterro
Rafael Afonso Silva	Leader	Palmeirense Soccer Club
Paulo Amaro Laporte	President	ORBIS Conjunto Califórnia Club
Daniela Almeida	General Coordination	Rede (NGO) – Alternative Tecnologies Exchange Net
Luciana Cristina Giannasi	Prosecutor	State Attorney General of Minas Gerais
Carlos Frederico Santos	General Secretary	Federal Attorney General

This list of entities are in part pre-established in Article 3º of Resolution nº 7; the not pre-established stakeholders, were defined in partnership with the municipal Departure of Social Politics and Mobilization, the municipal environmental body of Belo Horizonte (SMAMA) and community leaders. Within the letter, support material was attached, as follows:

- Cover letter with basic explanation, indication of web and mail addresses where Project PDD and Anexo III documents are available for public consultation and invitation to comments;

- Questionnaire;

According with Brazilian DNA Guidelines, PDD's last version, the "Questionnaire" form and "Anexo III" document, which contains explanation on how he Project will contribute to local sustainable development, are available for public consultation and downloadable in the web-page http://www.ariabiz.com.ar/belohorizonte.html until the end of the Validation process.

E.2. Summary of the comments received:

During the public consultation period the following stakeholder made comments about the Project:

- *Fórum Brasileiro de ONGs e Movimentos Sociais para o Meio Ambiente e o Desenvolvimento – FBOMS (Brazilian NGO Forum)*- by e-mail to Contact Person on November the 13th 2008

The FBOMS declared that they are waiting for Comissão Interministerial de Mudança Global do Clima – CIMGC (Interministerial Committee for Global Climate Change) declaration, as Federal Government, about how the comments and analysis eventually made by FBOMS about CDM projects will be considered in the final decision of CIMGC. Furthermore, they suggest the adoption of additional criteria for the social activity programs, such as the Gold Standard.

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

Project participants appreciated the comments and can only state that the CDM projects Brazilian regulation says stakeholders consultation process is open until the request for registration of the project activity, not being limited to a 30-day length. Regarding the Gold Standard criteria, project participants answered that verification process of the CERs already takes into account sustainability criteria, as hiring and training of personnel and compliance with the environmental license. However Consórcio Horizonte Asja will analyze the possibility of the GS criteria adoption.

Annex 1

CONTACT INFORMATION ON PARTICIPANTS IN THE PROJECT ACTIVITY

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Annex 2

INFORMATION REGARDING PUBLIC FUNDING

There is no public funding involved in the development of the "Exploitation of the biogas from Controlled Landfill in Solid Waste Management Central – CTRS / BR.040" Project.

Annex 3

BASELINE INFORMATION

BASELINE SURVEY

The baseline scenario, as identified in section "B.4 Description of how the baseline scenario is identified and description of the identified baseline scenario", is the same as the scenario existing prior to the start of implementation of the Project: BAU Business As Usual scenario.
The LFG arising from CTRS / BR.040 landfill at present is vented for safety reasons thanks to passive venting wells built to discharge LFG as the dumped wastes height increased over the landfill's operational years.
The existing practice is to light occasionally some of the total 123 vents: the daily average number of lighted wells can be conservatively overestimated to be equal to 25.
No equipment or machinery are installed nor any other system is in operation at the CTRS / BR.040 Landfill.

Consider as a part of this section the following documents provided in attachment:

- Attachment A – Reference design PLN001h;
- Attachment B – Baseline Survey – Passive Vents
- Attachment C - Baseline Survey – Survey Results

ADDITIONALITY INFORMATION

Table 1 – LFG Projects registered in Brazil

APPROVED PROJECTS ACCORDING TO RESOLUTION Nº 1			
Setorial Scope: WASTE		Type: LANDFILL	
NUMBER	PROJECT TITLE	MUNICIPALITIES ATTENDED	TYPE OF PROJECT
1/2004	NovaGerar Landfill Gas to Energy Project	Nova Iguaçu	LFG Flare Electricity Generation
2/2004	Salvador da Bahia Landfill Gas Management Project	Salvador	LFG Flare
4/2004	Brazil MARCA Landfill Gas to Energy Project	Cariacica Domingos Martins Marechal Floriano Santa Leopoldina Santa Teresa Serra Venda Nova do Imigrante Viana Vitória	LFG Flare Electricity Generation

APPROVED PROJECTS ACCORDING TO RESOLUTION Nº 1			
Setorial Scope: WASTE		Type: LANDFILL	
NUMBER	PROJECT TITLE	MUNICIPALITIES ATTENDED	TYPE OF PROJECT
5/2005	Landfill Gas to Energy Project at Lara landfill, Maua, Brazil	Diadema Mauá Praia Grande Ribeirão Pires Rio Grande da Serra S. Bernardo do Campo S. Caetano do Sul São Vicente	LFG Flare Electricity Generation
6/2005	Onyx Gas Recovery Project - Temembé, Brazil	Caçapava Ilhabela Monteiro Lobato Sto Antônio do Pinhal S. J. do Barreiro S. Bento do Sapucaí S. Sebastião	LFG Flare
10/2005	ESTRE'S Paulínia Landfill Gas Project (EPLGP)	Americana Artur Nogueira Capivari Cesário Lange Hortolândia Jaguariúna Louveira Mogi-Mirim Nazaré Paulista Nova Odessa Paulínia Pereiras Piracicaba Porangaba Santo Antônio de Posse Sumaré Tietê Valinhos Vinhedo	LFG Flare
11/2005	Caieiras Landfill Gas Emission Reduction	Caieiras Cajamar Campo Limpo Paulista Franco da Rocha São Paulo Taboão da Serra Várzea Paulista	LFG Flare
13/2005	Bandeirantes Landfill Gas to Energy Project (BLFGE)	São Paulo	LFG Flare Electricity Generation

APPROVED PROJECTS ACCORDING TO RESOLUTION Nº 1			
Setorial Scope: WASTE		Type: LANDFILL	
NUMBER	PROJECT TITLE	MUNICIPALITIES ATTENDED	TYPE OF PROJECT
16/2005	Project Anaconda	Bom Jesus dos Perdões Campos do Jordão Caraguatatuba Jandira Nazaré Paulista Santa Isabel	LFG Flare
21/2005	São João Landfill Gas to Energy Project (SJ)	São Paulo	LFG Flare Electricity Generation
76/2006	Canabrava Landfill Gas Project	Salvador	LFG Flare
80/2006	Aurá Landfill Gas Project	Belém	LFG Flare
89/2006	Embralixo/Araúna - Bragança Landfill Gas Project (EABLGP)	Bragança Paulista	LFG Flare
93/2006	SIL Landfill Gas Project (PROGAS)	Minas do Leão	LFG Flare
105/2006	Manaus Landfill Gas Project	Manaus	LFG Flare
109/2006	Alto-Tiete Landfill Gas Capture Project	Arujá Carapicuíba Cunha Ferraz de Vasconcelos Itaquaquecetuba Mairiporã Mogi das Cruzes Poá Suzano	LFG Flare
114/2006	Terrestre Ambiental Landfill Gás Project	Bertioga Cubatão Guarujá Santos	LFG Flare
115/2006	ESTRE Itapevi Landfill Gas Project (EILGP)	Cotia Itapevi Jandira São Roque Vargem Grande Paulista	LFG Flare
116/2006	Quitauna Landfill Gas Project	Guarulhos	LFG Flare
138/2006	CDR Pedreira Landfill Gas Project (PROGAEP)	São Paulo	LFG Flare
158/2007	SANTECH - Saneamento & Tecnologia Ambiental Ltda. - SANTEC Resíduos Landfill Gas Emission Reduction Project Activity	Içara	LFG Flare

APPROVED PROJECTS ACCORDING TO RESOLUTION Nº 1			
Setorial Scope: WASTE		Type: LANDFILL	
NUMBER	PROJECT TITLE	MUNICIPALITIES ATTENDED	TYPE OF PROJECT
162/2007	Probiogas - JP - João Pessoa Landfill Gas Project	Bayeux Cabedelo Conde João Pessoa Santa Rita	LFG Flare
180/2007	Proactiva Tijuquinhas Landfill Gas Capture and Flaring Project	Biguaçu Bombinhas Florianópolis Gov. Celso Ramos Porto Belo Tijuquinhas	LFG Flare
182/2007	URBAM/ARAUNA - Landfill Gas Project (UALGP)	Paraibuna S. J. dos Campos	LFG Flare
198/2007	CTRVV Landfill Emission Reduction Gas Project	Vilha Velha	LFG Flare
202/2007	Feira de Santana Landfill Gas Project.	Feira de Santana	LFG Flare Electricity Generation

Source: http://www.mct.gov.br/index.php/content/view/57967.html (Consulted on: 2008, November, 17th).

Table 2 – Districts with waste collection services, by final waste destination unit, according with the Geographical Regions and Federation Units – 2000.

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

Source: IBGE, Diretoria de Pesquisas de População e Indicadores Sociais, Pesquisa Nacional de Saneamento Básico 2000 (Consulted on 2008, November 17th).

Note 1: One same district might have more than one final destination of waste collected.

Note 2: This table was adapted from the original table from PNSB.

Table 3 – Distribution of project activities in Brazil by type of project

Validation/Approving Projects	Number of projects	Annual emission reduction	Number of projects	Annual emission reduction
Renewable energy	150	16,431,099	47%	39%
Pig culture	55	2,737,322	17%	6%
Sanitary landfill	29	10,036,702	9%	24%
Energy industries	7	832,946	2%	2%
Energetic efficency	21	1,490,288	7%	4%
Waste	10	1,160,797	3%	3%
N_2O reduction	5	6,373,896	2%	15%
Change of fossil fuel	39	2,907,977	12%	7%
Fugitive emissions	1	34,685	0%	0%
Reforestation	1	262,352	0%	1%

Source: http://www.mct.gov.br/upd_blob/0026/26985.pdf (Consulted on 2008, November 17th).
Note: This table was adapted from the original table in MCT website.

Table 4 – Energy Mix of Brazilian national Grid

OPERATING ENTERPRISES							
Type		**Installed Capacity**		**%**	**Total**		**%**
		N.° of Power Units	**(kW)**		**N.° of Power Units**	**(kW)**	
Hydro		707	77,525,822	70.24	707	77,525,822	70.24
Gas	Natural	85	10,588,402	9.59	114	11,769,430	10.66
	Process	29	1,181,028	1.07			
Oil	Diesel	596	3,316,596	3.01	617	4,613,790	4.18
	Residual Oil	21	1,297,194	1.18			
Biomass	Sugar cane Bagasse	252	3,376,063	3.06	302	4,553,595	4.13
	Black Liqueur	13	859,217	0.78			
	Wood	30	255,517	0.23			
	Biogas	3	41,590	0.04			
	Casca de Arroz	4	21,208	0.02			
Nuclear		2	2,007,000	1.82	2	2,007,000	1.82
Mineral Coal	Mineral Coal	8	1,455,104	1.32	8	1,455,104	1.32
Eolic		17	272,650	0.25	17	272,650	0.25
Imports	Paraguay		5,650,000	5.46		8,170,000	7.4
	Argentina		2,250,000	2.17			
	Venezuela		200,000	0.19			
	Uruguay		70,000	0.07			
Total		**1,767**	**110,367,391**	**100**	**1,767**	**110,367,391**	**100**

Source: http://www.aneel.gov.br/aplicacoes/capacidadebrasil/OperacaoCapacidadeBrasil.asp

Annex 4

MONITORING INFORMATION

Introduction

According to ACM0001, direct monitoring will be conducted on the LFG captured, destroyed by flare and used for power generation.

An operative manual of the project will be available. This Management Manual will have the applicative documents of the monitoring plan (description of the project and responsibilities, operative procedures for measurements and handlings of data and details about internal audits, etc.)
Attached to this PDD there's the first Management Manual draft: "Attachment D – Management Manual"

Operators will collect necessary data for the monitoring plan and a Project Manager will verify the correct application of the operative procedures written in the manual.

The monitoring plan is described below:

(1 DATA MONITORED

The monitoring procedures will include:

- Landfill gas collected from project wells.
- Landfill gas flow into flare.
- Landfill gas flow into power plant.
- Methane content in the landfill gas.
- Temperature of exhaust gas from flaring
- Methane and oxygen content in the exhaust gas from flaring
- Electricity imported from the power grid.
- Electricity exported to the power grid.
- Power plant working hours.
- Emissions from flaring.
- Local and national regulatory framework.
- Emission Factor
- $MD_{project,y}$ = Amount of methane destroyed by the project activity during the year y of the project activity (tCH4)

All the equipments of the plant will be connected through a Programmable Logic Control (PLC) that permit the operator quick check of the main working parameters through a user-friendly interface.

(2 DATA COLLECTED, FREQUENCY AND QUALITY CONTROL

Landfill gas flow:

- **collected from the landfill**
- **fed to the flares**
- **fed to the electricity generation devices**

Landfill gas flow will be measured by means of a flow meter. One flow meter will be installed for each LFG destroying device and on the main pipeline. For reporting purposes, this parameter is generally required to be normalized to 0°C and 1.01325bar. In order to normalize the flow measured by the flow meter to standard temperature and pressure, the temperature and pressure of LFG will be measured by temperature and pressure sensors preferably already included in the flow meter equipment.
To limit the time of operation with no flow signal in case of failure, the flow meter will be exchanged as soon as possible.
Despite this quick exchange the plant can operate for a short time without continuous flow signal; to determine the flow during this time span, the average flow of the last 7 days will be used and so will be possible calculate the quantity of CO_2 reduced. Flow measurement equipments are reliable and flow meters failures unusual.

Methane content in the landfill gas

Methane content in the landfill gas will be measured by a gas analyzer with an infrared ray system analysis (or any measurement system with the same precision and reliability), with a scale range of 0-100 %Vol.
The CH_4 analyzer will be calibrated according to its calibration protocol.
To limit the time of operation with no gas analyzer in case of failure, this analyzer will be replaced with another analyzer as soon as possible.
Despite this quick exchange, the plant can operate for a short time without CH_4 signal.
To determine the CH_4 content during this time span the average CH_4 content of the last 7 days will be used.

Emissions from flaring:

- **temperature of exhaust gas.**
- **methane and oxygen content in the exhaust gas**

Project owners will monitor and measure with a gas analyzer the quantity of CH_4 and O_2 emitted by the flare and will measure and control the temperature of the exhaust gas with a K-type thermocouple in order to determine the efficiency of the flare.
The sampling point for these parameters will be installed in the upper section of the flare, at 80% of the lare's height.
The analysis station will be equipped with a sampling probe for the collection of CH_4 and O_2 samples in the exhaust gas (that will resist high temperatures). The transport line of the sampling probe of the gas will have a thermal self-regulation.
A gas analyser, whose methane and oxygen measurement cell's measure are based on the selective absorption of infrared rays by the methane and oxygen, will measure in a continuous and dry basis, the CH_4 in the exhaust gases.
In case there are no records available of the CH_4, O_2 and temperature of the exhaust gas, for each parameter an average value of the last 7 days will be used in order to proceed with the calculations.

The gas analyser will be subject to a regular maintenance (based on the maintenance manual) and testing regime to ensure accuracy. Calibration records will be kept by the Project Owner and will be available for consulting at the time of verification.
Not only the equipment of the analysing station but also the system equipments of the entire plant will be connected through a Programmable Logic Control (PLC) that let the operator quickly check the unit's main variables through a user-friendly interface.
The amount of CH_4 and O_2 in the exhaust gas, together with the exhaust's flow rate, the amount of O_2 and of CH_4 in the residual LFG fed to the flare, will be sent to the PLC that will implement the flare efficiency calculations with formula given in the "*tool to determine project emissions from flaring gases containing methane"* as described in Section B of PDD.
All formulae contained in the tool will be programmed in the software of the PLC that will calculate by itself (using all the parameters measured by the station and fixed input data), the efficiency of the flare in a continuous basis.
The value of flare efficiency will be correlated with the value of temperature of the exhaust gas and will just be considered valid to be used in the formula when the value of the latter is higher that 500°C for more than 40 minutes during the hour considered.
The value of flare efficiency calculated will be used by the same software in order to calculate the PE_{flare}.

Electricity imported from and exported to power grid
Electricity imported and exported by power grid will be measured by power meters. Since electricity meters belong and are managed by the Power Supply Co. the amounts of electricity will be attested thanks to the official electricity bills.

Local and national regulatory framework
As stated on the Management Manual available on-site, the local and national regulatory framework (related to the project) will be monitored on an annual basis in order to verify that the project complies with the local and national regulation.

Emission Factor
Since "ex post" option has been chosen in the Operating Margin calculations applying the "*Tool to calculate the emission factor for an electricity system*", the year in which the project activity displaces grid electricity, requiring the emissions factor to be updated annually during monitoring. If the data required to calculate the emission factor for year y is usually only available later than six months after the end of year y, alternatively the emission factor of the previous year (y-1) may be used. If the data is usually only available 18 months after the end of year y, the emission factor of the year proceeding the previous year (y-2) may be used. The same data vintage (y, y-1 or y-2) will be used throughout all crediting periods.

$MD_{project,}$
Since option 2 of step 2 in ACM0001 calculation for the AF_y has been chosen, the destruction efficiency of the system used in the project activity is estimated every year with equation (5) in B.6.1 Section of the PDD
The methane destroyed by the project activity ($MD_{project,y}$) during a year is determined by monitoring the quantity of methane actually flared and gas used to generate electricity and the total quantity of methane captured and calculated with equation (8) in B.6.1 Section of the PDD.The supply to each point of methane destruction, through flaring or use for energy generation, will be measured separately.

Possible failure: No electrical power

When there is no electrical power the blower of the biogas plant cannot operate, so no landfill gas stream is available.

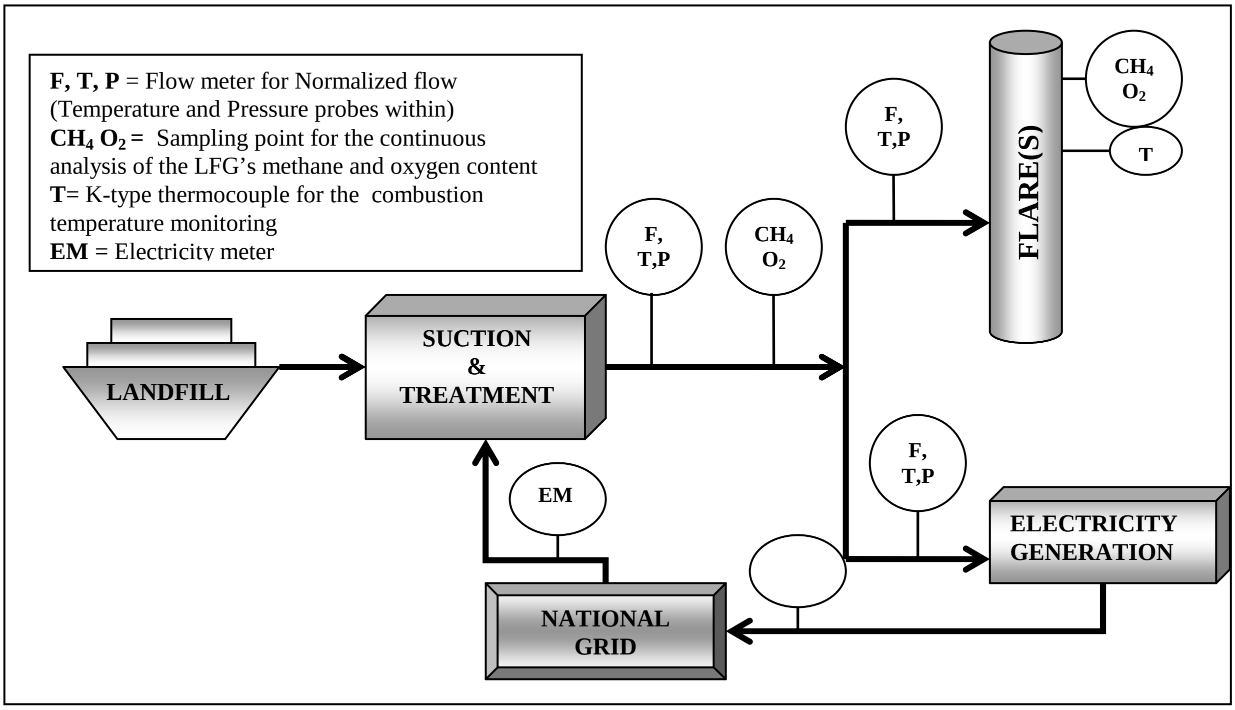
The flow meter detects no landfill gas stream and does not count any CO_{2eq}. No special actions are possible to avoid this.

(3 MONITORING EQUIPMENTS AND INSTALLATION

All measurements equipments are maintained and managed on general technical standards. The Management Manual will determine the quality control regime for each key that includes regular maintenance and calibration. The measurement and recording will be done in an accurate and transparent manner.

In order to determine the quantity of ERs generated during the project activity the following equipments will be installed.

Fig. 1: Monitoring points



(4 CALCULATION OF THE AMOUNT OF ERs

The greenhouse gas emission reduction achieved by the project activity during a given year "*y*" (ER_y) is calculated by using the formula as given in methodology ACM0001 and in the related tools and showed in PDD's Section B

(5 MONITORING ORGANIZATION

To assure a correct monitoring, the personnel will be trained on the following subjects:

- General knowledge about the equipment used in the landfill.
- Reading and recording data.
- Calibration methodology.

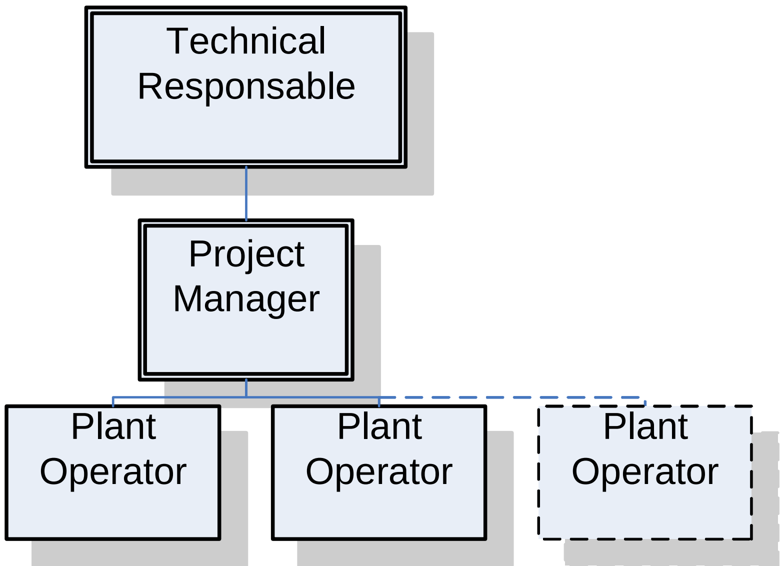
- Emergency situation

Chosen trainees will have a good understanding of the processes and installation of the technology for the landfill gas extraction.
The personnel will be trained before the plant enters into operation.
A guidebook about landfill gas extraction and utilization in English and Portuguese will also be available.

The guidebook will have:

- Operating manual.
- Maintenance instructions.
- Description of the main parts of the equipments.

Fig. 2: Organization Chart.



(6 CALIBRATION

All measurement instruments will be subject to regular calibration. The calibration procedures in the "Management Manual" define the management, checks and calibration intervals of the equipment used for process control.

PM will be responsible for the management of the pieces of equipment needing regular calibration for the biogas installations.

The regular check and calibration will be entrusted to the operators. The PM will be responsible for checking the equipment's proper working order, as well as checking and storing up the calibration certificates and records. Calibration documents will be kept for all the equipments until two years after the end of the crediting period.

(7 DATA MANAGEMENT SYSTEM

The PLC will receive continuously the value of the parameters monitored on-site and automatically generate spreadsheets that will be archived. The information archived will be aggregated hourly, monthly and yearly in a standard format for reporting purposes.

The quality control system will ensure that all the necessary documents (such as operation manual, drawings, maintenance and calibration instructions, etc.) are available and stored in a proper manner. Monitored data and Monitoring Sheets will be copied to magnetic media every 6 months and stored in appropriate archives.

All data, including calibration records and Monitoring Reports will be kept until 2 years after the end of the crediting period.

(8 AUDIT REVIEW

Internal audits will be performed by an auditor not involved in the daily operation of the biogas plant in order to assess the implementation of the Monitoring Plan and to prepare the Monitoring Report.

All the audit findings, including corrective actions, will be recorded and will be available on-site at the time of verification.