Project design document form for CDM project activities

(Version 05.0)

Complete this form in accordance with the Attachment "Instructions for filling out the project design document form for CDM project activities" at the end of this form.

PROJECT DESIGN DOCUMENT (PDD)	
Title of the project activity	Uberlândia landfills I and II
Version number of the PDD	Version 03
Completion date of the PDD	21/10/2014
Project participant(s)	• Energas Geracao de Energia Ltda. (Brazilian Private Entity) • Limpebrás Resíduos Ltda. (Brazilian Private Entity) • Asja Brasil Serviços para o Meio Ambiente Ltda. (Brazilian Private Entity)
Host Party	Brazil
Sectoral scope and selected methodology(ies), and where applicable, selected standardized baseline(s)	*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. Uberlândia landfills I and II applies the following methodology and tools: • Version 12.0.0 of ACM0001 – *"Flaring or use of landfill gas"*; • Version 4.0.0 of the *"Combined tool to identify the baseline scenario and demonstrate additionality"*; • Version 6.0.1 of the *"Emissions from solid waste disposal sites"*; • Version 01 of the *"Tool to calculate baseline, project and/or leakage emissions from electricity consumption"*; • Version 01 of the *"Tool to determine project emissions from flaring gases containing methane"*; • Version 2.0.0 of the *"Tool to determine the mass flow of a greenhouse gas in a gaseous stream"*. In accordance with the *Tool to calculate baseline, project and/or leakage emissions from electricity consumption,* the following tool is applied: • Version 2.2.1 of the "*Tool for calculation of emission factor for an electricity system".*
Estimated amount of annual average GHG emission reductions	**100,522**

SECTION A. Description of project activity

A.1. Purpose and general description of project activity

The objective of the Uberlândia landfills I and II is to collect the landfill gas produced in the Uberlândia Landfill and use it to generate electricity. A total capacity of 2.852 MW will be installed, composed by 2 engines with individual capacity of 1.426 MW each. The project is expected to export 421,071 MWh during its lifetime.

The Project will start operating its LFG collection, flaring and electricity generation in March 2012, and the production of emission reductions is estimated to start in September 2012, when the Project is expected to be registered as a CDM project activity.

Uberlândia Landfill comprises two adjoining solid waste disposal sites (SWDS), named Landfill I and Landfill II, both owned and operated by Limpebrás Resíduos Ltda. (Project Participant). The Landfill I started operating in July of 1995 and stopped receiving waste in September 2010. During the 15 years of lifetime, Landfill I received around 2,100,000 tonnes of domestic waste, disposed in 150,000 m^2 of a total area of 300,000 m^2, being operated under the most strict environmental care, for which the landfill was awarded with the Borboleta de Ouro prize, given by the state environment entity, Fundação Estadual do Meio Ambiente – FEAM, as the best landfill of Minas Gerais state.

The Landfill II started operating in October 2010 with the same environmental care applied to the previous disposal site and counts on a qualified and multidisciplinary team of technicians. The landfill has a total area of 300,000 m^2, with 200,000 m^2 dedicated to disposal of waste, being able to receive till 4,500,000 m^3 of solid waste for an approximately 18 years of lifetime. All the area was sealed with a membrane of High Density Polyethylene (HDPE) and compacted clay in order to protect the phreatic layer from contamination.

The leachate generated in each landfill is given a different treatment. For Landfill I the leachate is treated at an ascendant flow anaerobic reactor followed by an anaerobic filter and then sent to the Uberabinha's sewage treatment station (ETE Uberabinha) through municipal canalization. The leachate from Landfill II, after being analysed by the Municipal Department of Water and Sewage (Departamento Municipal de Água e Esgoto – DMAE), was authorized to be directly sent to the ETE Uberabinha without previous treatment.

In this Project the Landfill I and the Landfill II were considered as a sole SDWS, since the area surrounding the two sites, including them, is owned and operated by Limpebrás Resíduos Ltda. and they are physically near enough to permit the joint operation. In fact, only a 27 m width road used exclusively for the landfilling operation separates the two sites, and the gas station and power plant of the proposed project activity are planned to be installed on the roadside between the Landfill I and Landfill II. Therefore, the estimative of emissions of methane from SWDS considered the two sites as one single SWDS.

The scenario existing prior to the implementation of the Uberlândia landfills I and II project activity at the Uberlândia Landfill is the operation of the landfill with uncontrolled emission of the LFG (landfill gas) generated to the atmosphere, i.e. the LFG generated due to the decomposition of the organic matter is vented through the vertical wells installed at the landfill's area. At the top of some wells, the LFG is partially burned to address safety and odour issues. As will be demonstrated ahead, the existing scenario and the baseline scenario are the same.

Emissions associated with the baseline scenario are the CH_4 emissions due to the atmospheric release of the LFG and CO_2 emissions due to the power generation from fossil-fuel power-plants. With the implementation of the project, the LFG previously released will be collected through the installation of pipelines and emission reduction will be achieved through the destruction of the gas collected in a flaring system and in the power plant. Additionally, the project will export renewable electricity to the grid, avoiding the dispatch of the same amount of electricity from fossil-fuel based power plants in the Brazilian National Grid.

The project will bring benefits to sustainable development, as follows:

- *Increase of local environmental quality:* the project will contribute not only through the avoidance of GHG emissions to the atmosphere, but also by displacing the fossil fuel consumption from power plants connected to the Brazilian Electric Grid. The project might also be seen as a good practice of correct solid waste final disposal;

- *Labour capaciting / Income generation:* the project will need qualified operators to maintain the gas collection wells and pipeline and to operate the degassing station and the power plant. A team composed by engineers and technicians will be created and trained by international consultants and manufacturers. The revenues of these personnel will be above the market, as the technology employed is new in the Uberlândia region;

- *Integration with different sectors:* using LFG to generate electricity is relatively new in Brazil – some projects were developed only under the CDM and only a few of them are indeed generating electricity (like the Bandeirantes Landfill Gas to Energy Project, São João Landfill Gas to Energy Project and Exploitation of the biogas from Controlled Landfill in Solid Waste Management Central – CTRS / BR.040). Therefore, the project will have an enormous contribution over the integration with the electric sectors.

A.2. Location of project activity

A.2.1. Host Party

Brazil.

A.2.2. Region/State/Province etc.

State of Minas Gerais.

A.2.3. City/Town/Community etc.

Uberlândia.

A.2.4. Physical/Geographical location

The geographical coordinates of the Uberlândia Landfill are:

- S 18.878361°
- W 48.318583°

The picture below presents the detailed location of the landfill:

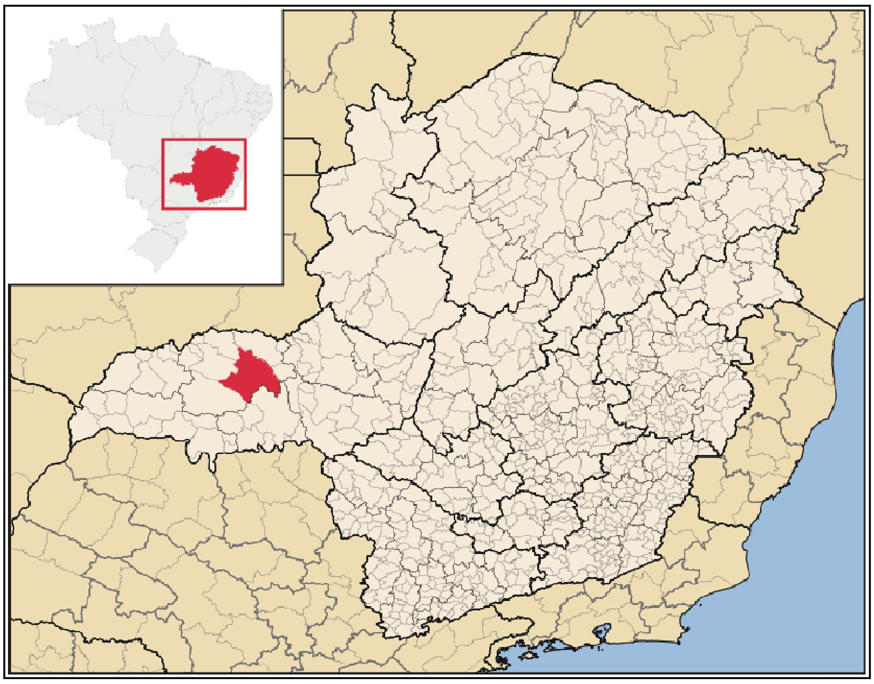

Figure 1: Location of Minas Gerais State and Uberlândia.

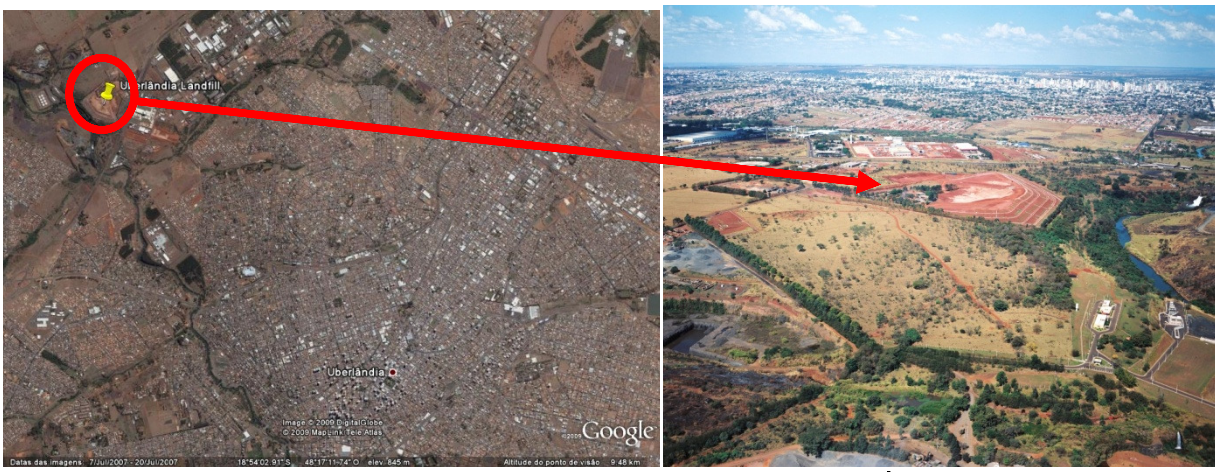

Figure 2: Location of the Landfill inside Uberlândia.

A.3. Technologies and/or measures

As described in section A.1., the scenario existing prior to the implementation of the Uberlândia landfills I and II at the Uberlândia Landfill is the operation of the landfill with uncontrolled emission of the LFG generated to the atmosphere, i.e. the LFG generated due to the decomposition of the organic matter is vented through the vertical wells installed at the landfill's area. At the top of some wells the LFG is partially burned to address safety and odour issues.

Emissions associated with the baseline scenario are the CH_4 emissions due to the atmospheric release of the LFG and CO_2 emissions due to the power generation from fossil-fuel power-plants. With the implementation of the project, the LFG previously released will be collected through the installation of pipelines and emission reductions will be achieved through the destruction of the gas collected in a flaring system and in the power plant. Additionally, the project will export renewable electricity to the grid, avoiding the dispatch of the same amount of electricity from fossil-fuel based power plants in the Brazilian National Grid. Therefore, none of the equipment installed in the project activity exist in the baseline scenario.

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

- a collection system;
- a transmission pipeline network;
- a gas station, composed by condensate separators, pipe bundle heat exchanger, chiller, blowers and flaring system; and
- a dry filter (moisture and contaminant removal) and a power plant.

Figure 3 presents a lay-out of such kind of installation.

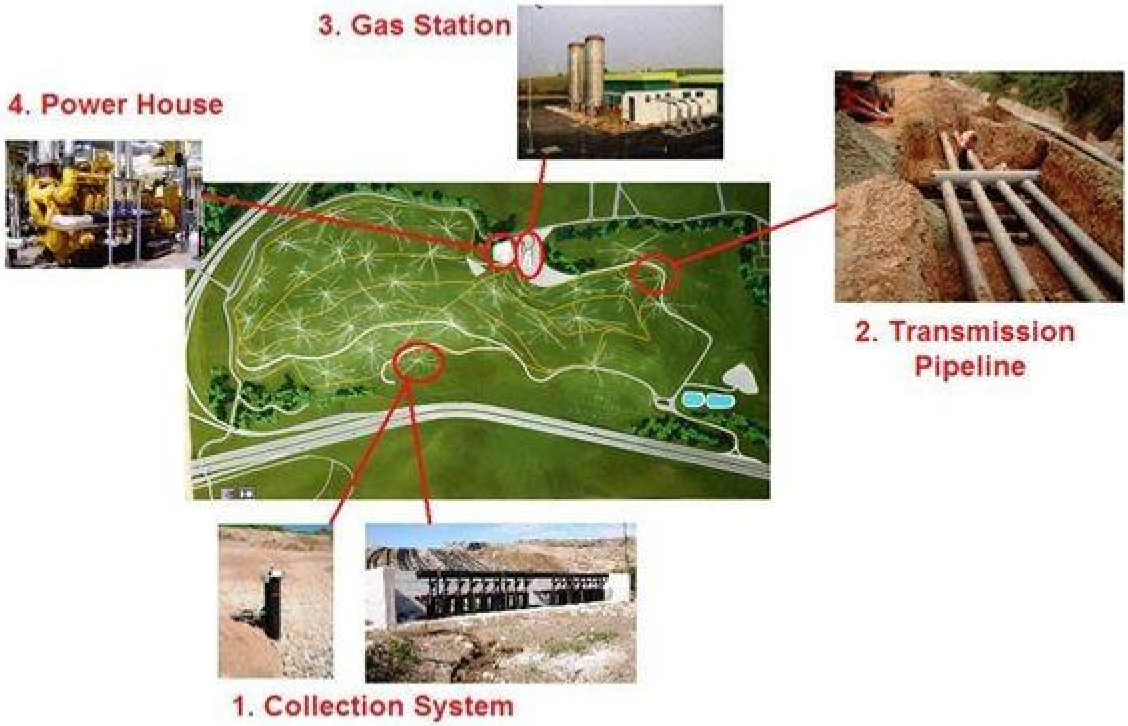

Figure 3: Schematic situation of a landfill with active gas recovery.

The proposed system will be installed to absorb a maximum of 3,000 Nm^3/h of landfill gas, based on estimative of biogas generation.

1. Collection System

Having in mind the dimensions of the Uberlândia Landfill, when considering the LFG collection the infra-structure was defined based on vertical wells. These elements will be connected to a collection pipeline which will transport the gas to the regulation stations – used to control the load loss in the wells. Some horizontal wells might also be constructed, if necessary.

Project Proponents will install vertical wells all over the landfill in an approximately 25 meter grid. Each well will be equipped with wellheads consisting of a carbon steel pipe, complete with a flanged side section bearing a butterfly type valve that enables the well to be connected or cut out from the vacuum system. This is an important element because it will connect the well with the collection pipeline, avoiding directly emission of LFG to the atmosphere.

The wellhead is 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 the 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 wellhead 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.

These pipelines will consist on HDPE (High Density Polyethylene) pipes and will transport the LFG collected from the wells to the gas regulation stations, which role is to control and monitor the characteristics of the LFG extracted. Each regulation station will be done in carbon steel pipe equipped with an additional condensate knock-out and regulation valves and will be able to receive the connection of many wells, beyond transferring the LFG collected to the transmission network.

2. Transmission pipeline network

From the regulation stations the LFG will be transferred to lines manifolds constructed in carbon steel and then to the gas station through a HDPE transmission pipeline. Lines manifolds are responsible for receiving the LFG from many regulation stations and grouping then into a single line towards the gas station.

3. Gas Station

The gas station comprises the LFG pre-treatment system, the suction system and the flares.

The pre-treatment system consists in a series gas/water & glycol tube nest heat exchangers that can cool down the LFG to a temperature lower than 10 °C, by means of a set of chillers through which the biogas passes as it arrives at the gas station. Such cooling aims to force the moisture in the LFG to condensate, so it can be easily removed from the flow through a coalescer filter situated just after the heat exchangers. This considerably reduces impurities that would damage the equipment.

Following the coalescer filters, LFG flows to the suction system responsible for applying the appropriate pressure to the each well, guaranteeing the effectiveness of gas collection. The system will be composed by two centrifugal multi-stage blowers in parallel (one in standby) connected with the LFG collection and conveying system. The pressuring of the system will depend on the pressure needed by the flares and generators.

The dimensioning of the components is straight connected to the gas production from Uberlândia Landfill; Project Proponents foresee the installation of 2 blowers with 3,000 Nm^3/h capacity each – one main and another standby unit. However, the capacity of standby blower can be reviewed in order to better suit the project.

The gas station will also count with a gas flaring system, which will be equipped with enough high temperature enclosed flares to ensure the total LFG captured to be completely and safely destroyed. Each flare installed will be assembled with all equipment needed to continuously monitor of flare's compliance with manufacturer's specifications, according to the "*Tool to determine project emissions from flaring gases containing methane*", i.e. flow meter on the inlet pipeline and a thermocouple installed at 80% of flare's height.

4. Power Plant

A power plant will also be installed in order to generate electricity with the LFG captured. It will be composed by dry filters which consist in barrels made in carbon steel fitted with polyester filters designed to remove solid impurities from the stream (as well as a share of the micro-contaminants that would be harmful to the electric energy generating sets) and internal combustion engine generating sets.

This is a well known and high reliable technology for biogas utilization. Furthermore, internal combustion engine generating sets have modular design and are available in many different sizes permitting the installation of power plant step by step as the LFG flow increases. High performance and reliability are guaranteed for the equipment.

The number of engines to be installed will depend on the amount of LFG collected, but Project Proponents foresee to install in two phases a total capacity of 2.852 MW.

The LFG stream will be preferably sent to the power plant and the LFG amount exceeding its assimilation capacity will be diverged to the enclosed flares, guaranteeing the destruction of all methane captured. Therefore, flares will be used to combust the LFG exceeding the power plant capacity or to burn all the LFG captured, in case of generation sets maintenance.

A.4. Parties and project participants

Party involved (host) indicates host Party	Private and/or public entity(ies) project participants (as applicable)	Indicate if the Party involved wishes to be considered as project participant (Yes/No)
Brazil (host)	• Energas Geracao de Energia Ltda. (Brazilian Private Entity) • Limpebrás Resíduos Ltda. (Brazilian Private Entity) • Asja Brasil Serviços para o Meio Ambiente Ltda. (Brazilian Private Entity)	No

A.5. Public funding of project activity

There is no public funding involved in the development of the Project Uberlândia landfills I and II.

SECTION B. Application of selected approved baseline and monitoring methodology and standardized baseline

B.1. Reference of methodology and standardized baseline

Uberlândia landfills I and II applies the following methodology and tools:

- Version 12.0.0 of ACM0001 – *“Flaring or use of landfill gas”*;
- Version 4.0.0 of the *“Combined tool to identify the baseline scenario and demonstrate additionality”*;
- Version 6.0.1 of the *“Emissions from solid waste disposal sites”*;
- Version 01 of the *“Tool to calculate baseline, project and/or leakage emissions from electricity consumption”*;
- Version 01 of the *“Tool to determine project emissions from flaring gases containing methane”*;
- Version 2.0.0 of the *“Tool to determine the mass flow of a greenhouse gas in a gaseous stream”*.

In accordance with the *Tool to calculate baseline, project and/or leakage emissions from electricity consumption,* the following tool is applied:

- Version 2.2.1 of the “*Tool for calculation of emission factor for an electricity system”.*

B.2. Applicability of methodology and standardized baseline

a) ACM0001

Applicability conditions:

The methodology is applicable to project activities which:

METHODOLOGY	PROJECT
(a) *Install a new LFG capture system in a new or existing SWDS;* (b) *Make an investment into an existing LFG capture system to increase the recovery rate or change the use of the captured LFG, provided that:* (*i*) *The captured LFG was only vented or flared and not used prior to the implementation of the project activity;* (*ii*) *In the case of an existing active LFG capture system for which the amount of LFG cannot be collected separately from the project system after the implementation of the project activity and its efficiency is not impacted on by the project system: historical data on the amount of LFG capture and flared is available.*	The conditions (a) and (b – item (*i*)) are applicable. The main objective of the project is to capture the LFG produced in the Uberlândia Landfills, turning it into an active system. As demonstrated on item B.4, the baseline scenario is the continuation of the landfill's operation, with total emission of the landfill gas generated to the atmosphere (passive system). So, the project will make an investment installing a new LFG capture system in an existing SWDS.
(c) *Flare the LFG and/or use the captured LFG in any (combination) of the following ways:* (*i*) *Generating electricity;* (*ii*) *Generating heat in a boiler, air heater or kiln (brick firing only);and/or* (*iii*) *Supplying the LFG to consumers through a natural gas distribution network.*	This condition is applicable (c -item (*i*)). The main objective of the project is to collect the LFG generated in the Uberlândia Landfill and use it to generate electricity. The project will install flare(s) to destroy the surplus LFG collected, after the power plant comes into operation.
(d) *Do not reduce the amount of organic waste that would be recycled in the absence of the project activity.*	As the landfill I is already closed and landfill II will not imply any change in the waste received, therefore this condition is not applicable.

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

METHODOLOGY	PROJECT
(a) *Partial or total release of the LFG from the SWDS;* (b) *In the case that the LFG is used in the project activity for generating electricity and/or generating heat in boiler, air heat or kiln;* (*i*) *For electricity generation: that electricity would be generated in the grid or in captive fossil fuel fired power plants; and/or* (*ii*) *For heat generation: that heat would be generated using fossil fuels in on-site equipment.*	As shown in the section B.4, the baseline scenario is the total release of the LFG from the SWDS and the electricity generation by the national grid, so the methodology ACM0001 is applicable, according to item (a).

The methodology is not applicable:

METHODOLOGY	PROJECT
(a) *In combination with other approved methodologies. For instance, ACM0001 cannot be used to claim emission reductions for the displacement of fossil fuels in a kiln, where the purpose of the CDM project activity is to implement energy efficiency measures at the*	This project only applies the methodology *ACM0001* and is not in combination with other approved methodologies.

kiln;	
(b) *If the management of the SWDS in the project activity is deliberately changed in order to increase methane generation compared to the situation prior to the implementation of the project activity (e.g. other to meet a technical or regulatory requirement). For example, this may apply to the addition of liquids to a SWDS, pretreating waste to seed it with bacteria for the purpose of increasing the anaerobic degradation environment of the SWDS or changing the shape of the SWDS to increase the Methane Correction Factor.*	The management of the SWDS in the project activity will not be deliberately changed in order to increase methane generation. So the *ACM0001* is applicable.

B.3. Project boundary

	Source	GHGs	Included?	Justification/Explanation
Baseline scenario	Emissions from electricity generation	***CO_2***	***Yes***	***Major emission source, since power generation is included in the project activity.***
		CH_4	No	Excluded for simplification. This is conservative.
		N_2O	No	Excluded for simplification. This is conservative.
	Emissions from heat generation	CO_2	No	This emission source was neglected because the project activity will not consume/generate thermal energy
		CH_4	No	Excluded for simplification. This is conservative.
		N_2O	No	Excluded for simplification. This is conservative.
	Emissions from decomposition of waste at the SWDS site	CO_2	No	CO_2 emissions from the decomposition of organic waste are not accounted since the CO_2 is also released under the project activity.
		CH_4	***Yes***	***The major source of emissions in the baseline.***
		N_2O	No	N_2O emissions are small compared to CH_4 emissions from SWDS. Exclusion of this gas is conservative.
	Emissions from the use of natural gas	CO_2	No	Excluded for simplification. This is conservative.
		CH_4	No	This emission source was neglected because the project activity will not consume/generate natural gas.
		N_2O	No	Excluded for simplification. This is conservative.
Project scenario	Emissions from fossil fuel consumption for purposes other than electricity generation or transportation due to the project activity	CO_2	No	This source of project emissions was neglected as no fossil fuel will be used on-site.
		CH_4	No	Excluded for simplification. This emission source is assumed to be very small.
		N_2O	No	Excluded for simplification. This emission source is assumed to be very small.
	Emissions from electricity consumption due to the project activity	***CO_2***	***Yes***	***CO_2 emissions will be accounted for electricity consumed from the grid.***
		CH_4	No	Excluded for simplification. This emission source is assumed to be very small.
		N_2O	No	Excluded for simplification. This emission source is assumed to be very small.

Project Boundary

The project boundary comprises:

- Boundary 1: the landfill, the degassing station (including the flare) and the power house, i.e. *"site of the project activity where the gas is captured and destroyed/used"*
- Boundary 2: all power plants connected to the Brazilian National Electric Grid, i.e. *"all the power generation sources connected to the grid to which the project activity is connected"*;

The Figure 4 below illustrates the project boundary.

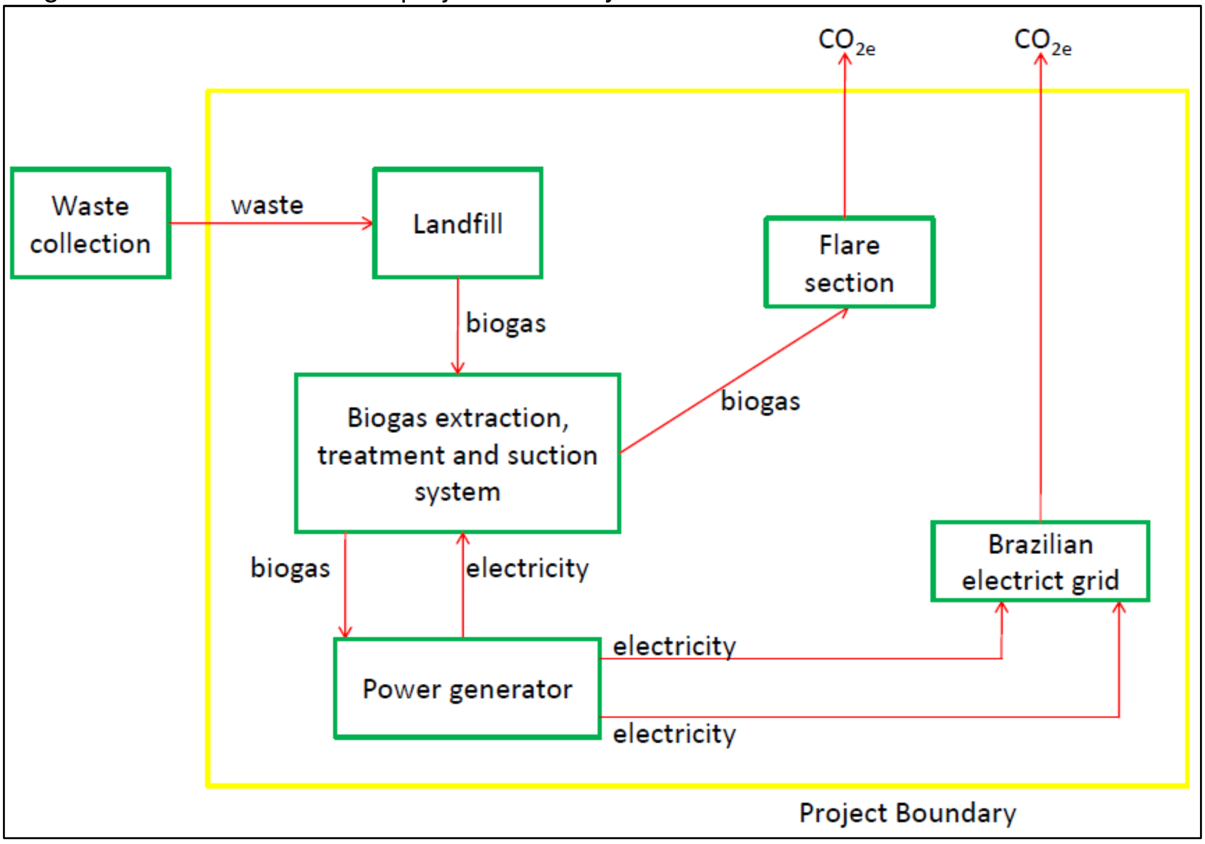

Figure 4: Flow diagram of the project boundary.

B.4. Establishment and description of baseline scenario

Procedure for estimating the end of the remaining lifetime of existing equipment

According to the methodology *ACM0001*, *"this procedure applies if LFG is used in equipment that was in operation prior to the implementation of the project activity"*.

Therefore, it is not applicable since no landfill gas was used prior to the implementation of the project activity and no equipment was in place for such a use.

Procedure for the selection of the most plausible baseline scenario

According to the methodology, the baseline scenario needs to be identified, following the *Version 4.0.0 of the "Combined tool to identify the baseline scenario and demonstrate additionality"* and requirements from *ACM0001*.

The tool is only applicable to methodologies for which the potential alternative scenarios to the proposed project activity available to project participants cannot be implemented in parallel to the proposed project activity. Therefore, it is applicable.

Application of the "Combined tool to identify the baseline scenario and demonstrate additionality".

This tool is used to identify all realistic and credible alternatives by following the Steps 0, 1a and 1b presented below:

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

For the measures listed in the definitions section of the tool, a proposed project activity is the First-of-its-kind in the applicable geographical area if:

(a) The project is the first in the applicable geographical area that applies a technology that is different from all other technologies that are able to deliver the same output and that have started commercial operation in the applicable geographical area before the start date of the project; and
This condition is fulfilled, since other project activities which use the same technology and deliver the same output are registered under CDM and are not to be regarded.

(b) Project participants selected a crediting period for the project activity that is "a maximum of 10 years with no option of renewal"
This condition is not fulfilled, since the project participants decided to adopt a 21 years of crediting period, being the first period equal to 7 years.

<u>*Outcome of Step 0:*</u> The proposed project activity is not the first-of-its-kind.

Step 1: Identification of alternative scenarios

Step 1a: Define alternatives to the proposed CDM project activity
The following realistic and credible alternatives for solid waste disposal and power generation are identified to the project:

ALTERNATIVES FOR THE DISPOSAL/TREATMENT OF THE WASTE	
LFG1	The project activity implemented without being registered as a CDM project activity (i.e. capture and flaring or use of LFG);
LFG2	Atmospheric release of the landfill gas or partial capture of landfill gas and destruction to comply with regulations or contractual requirements, or to address safety and odour concerns – Business As Usual (BAU);
LFG3	LFG is partially not generated because part of the organic fraction of the solid waste is recycled and not disposed in the SWDS; **(Since the project does not involve the separation of organic waste neither for recycling nor for other type of treatment and such separation is not considered in the concession contract which rules the baseline activity, this scenario does not apply.)**
LFG4	LFG is partially not generated because part of the organic fraction of the solid waste is treated aerobically and not disposed in the SWDS; **(Since the project does not involve the separation of organic waste neither for recycling nor for other type of treatment and such separation is not considered in the concession contract which rules the baseline activity, this scenario does not apply.)**
LFG5	LFG is partially not generated because part of the organic fraction of the solid waste is incinerated and not disposed in the SWDS; **(Since the project does not involve the separation of organic waste neither for recycling nor for other type of treatment and such separation is not considered in the concession contract which rules the baseline activity, this scenario does not apply.)**

So, alternatives for disposal/treatment of the waste to be considered are LFG1 and LFG2.

ALTERNATIVES FOR POWER GENERATION	
E1	Electricity generation from LFG, undertaken without being registered as CDM project activity;

E2	Electricity generation in existing or new on-site or off-site renewable based captive power plant; **(As the project activity will be installed in Brazil and regarding that electricity is largely available in the country, there are no specific needs to produce this amount of electricity from a fuel which is not directly available locally. Also, the operation of the landfill site does not consume a large amount of electricity that would require the construction of a new off-site power plant. In addition, electricity is readily available on site through the national grid; therefore this scenario does not apply.)**
E3	Electricity generation in existing and/or new grid-connected power plants.

Alternatives for heat generation will not be assessed once the project does not forecast the use of the LFG for heat generation.

According to the tool, *"realistic combinations of these should be considered as possible alternative scenarios to the proposed project activity"*. Regarding this information, the alternatives LFG1 and E1 were comprised, since they represent the same scenario. The same was done with alternatives LFG2 and E3, regarding that they represent the continuation of the current situation. Therefore, only LFG1 and LFG2 scenarios will be analyzed hereinafter.

So, the identified realistic and credible scenarios to the project activity are:
LFG1. The project activity implemented without being registered as a CDM project activity (i.e. capture and flaring or use of LFG);

LFG2. Atmospheric release of the landfill gas or partial capture of landfill gas and destruction to comply with regulations or contractual requirements, or to address safety and odour concerns; and electricity generation in existing and/or new grid-connected power plants.

Outcome of Step 1a: The credible alternatives to the project activity are LFG1 and LFG2.

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 neither 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.

In 2010, the *Política Nacional de Resíduos Sólidos* (National Solid Waste Policy), under discussion since 2000, was approved. One of the scopes of this policy is to enforce the adequate environmental final destination of the solid waste. However, the Policy does not foresee neither obligation on landfill gas destruction and the promotion of the landfill gas use such as those for the production of renewable energy, nor those that promote the processing of organic waste[1].

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

For the alternatives raised, the conclusions are:

WASTE TREATMENT/DISPOSAL

ALTERNATIVES	OBSERVATIONS	CONCLUSION
LFG1	• There are no laws which obligate the	OK, alternative in

[1] "Política Nacional de Resíduos Sólidos"; Available at http://www.planalto.gov.br/ccivil_03/_ato2007-2010/2010/lei/l12305.htm, accessed on 08/09/2011.

	destruction of the LFG produced; • There are no laws which obligate or forbid the use of the LFG for Power generation; • There are no incentive policies to promote the use of the LFG to electricity generation.	compliance with the mandatory applicable legal and regulatory requirements.
LFG2	• Uberlândia landfill has an Operational License, emitted from the environmental authority; • There are no obligations in the Operational License to partially capture and destroy the LFG, in order to accomplish with mandatory applicable legal and regulatory requirements. • There are no laws which obligates or forbid the power generation through existing and/or construction of new grid-connected power plants; • There are no incentive policies to promote the power generation through existing and/or construction of new grid-connected power plants.	OK, alternative in compliance with the mandatory applicable legal and regulatory requirements.

<u>Outcome of Step 1b:</u> Alternatives LFG1 and LFG2 are consistent with mandatory and regulatory requirements.

Outcome of the procedure for the selection of the most plausible baseline scenario
As shown in the Section B.5 below, the scenario LFG1 is not a realistic and credible alternative, because it is clearly economically unattractive. Therefore, the only plausible scenario is the scenario LFG2.

B.5. Demonstration of additionality

According to the methodology, the additionality is demonstrated and assessed following the *Version 4.0.0 of the "Combined tool to identify the baseline scenario and demonstrate additionality".*

<u>Application of the "Combined tool to identify the baseline scenario and demonstrate additionality".</u>
Step 1. Identification of alternative scenarios
As shown in the section B.4, the realistic and credible alternative scenarios to the project activity which are consistent with mandatory laws and regulations are:

LFG1. The project activity implemented without being registered as a CDM project activity (i.e. capture and flaring or use of LFG);

LFG2. Atmospheric release of the landfill gas or partial capture of landfill gas and destruction to comply with regulations or contractual requirements, or to address safety and odour concerns; and electricity generation in existing and/or new grid-connected power plants.

Step 2. Barrier Analysis
As per the *"Combined tool to identify the baseline scenario and demonstrate additionality*" and the version 01 of the "*Guidelines for objective demonstration and assessment of barriers*".

Step 2a. Identify barriers that would prevent the implementation of alternative scenarios:
None of the alternative scenarios face barriers that would prevent their implementation.

Step 2b. Eliminate alternative scenarios which are prevented by the identified barriers
According to the tool, those alternative scenarios which are prevented by at least one of the barriers listed in *Step 2a* shall be eliminated from further consideration.
For this Project, none of the alternative scenarios would be prevented by any barrier.

<u>*Outcome of Step 2:*</u> As both alternative scenarios LFG1 and LFG2 a not prevented by any barrier and the proposed project activity is not the First-of-its-kind, according to the *"Combined tool to identify the baseline scenario and demonstrate additionality"* there is a need to explain how the registration of the CDM project activity will alleviate the barriers that prevent the proposed project activity from occurring in the absence of the CDM. This explanation can be seen through the investment analysis, in the *Step 3* below.

Step 3: Investment analysis
The objective of this step is to compare the economic or financial attractiveness of the alternative scenarios of the Step 2 by conducting an investment analysis, and to confirm the choice of the most plausible baseline scenario. The "*Combined tool to identify the baseline scenario and demonstrate additionality*" and the Version 5.0 of the "*Guidelines on the assessment of investment analysis*" were used as guidance.

Selection of financial benchmark
According to the tool, the financial indicator most suitable for the project type and decision-making context needs to be identified. If one of the alternative scenarios corresponds to the situation that does not involve any investment costs, either NPV or IRR can be used as the financial indicator. Project participants do not undertake an investment, IRR will be used as the financial indicator.

For the alternative LFG2, since it does not involve investment cost, the IRR to be used shall be the financial benchmark, as stated in the "*Combined tool to identify the baseline scenario and demonstrate additionality*", and determined through the options (a) to (e). In the case of LFG2, the financial benchmark is derived from:

(b) Estimates of the cost of financing and required return on capital (e.g. commercial lending rates and guarantees required for the country and the type of project activity concerned), based on banker's views and private equity investor/fund's required return on comparable projects.

The reference rate for investments in Brazil is the SELIC (Sistema Especial de Liquidação e de Custódia) rate, which is the market indicator for the government securities of Tesouro Nacional and of Banco Central do Brasil. Therefore, the benchmark value considered for the alternative LFG2 is **11.55%**, which corresponds to the average of SELIC rates fixed in COPOM (Comitê de Política Monetária do Banco Central do Brasil) meetings held in the last 5 years, from April 19^{th} 2006 to April 20^{th} 2011.

For the calculation of the IRR for the LFG1 alternative scenario (The project activity undertaken without being registered as a CDM project activity), some assumptions were made:

- The operational lifetime of this Project is considered to be 21 years, as the operational lifetime of the Landfill II is estimated to finish in 2028 and the landfill gas production is expected to quickly decrease after the stop in receiving waste, according to the experience of Asja Group with similar projects located in tropical areas. Therefore the Project Proponents estimate the lifetime of this Project to end in December of 2032.
  As per the *Version 5 of Guidelines on the assessment of investment analysis* a minimum period of 10 years of assessment is required. For this Project the period of assessment considered in the investment analysis is the project lifetime, then 21 years.
- For IRR calculation the input number are the revenue, variable costs, depreciation, income tax and investment.

Project revenues considered are the ones from electricity sale: "*Annual average output (MWh)*" is calculated as the simple average of the estimated annual electricity production and "*Total*

Electricity delivered to the grid (MWh)" is calculated as the sum of the quantities of electricity estimated to be sold during the lifetime of the project.

Total investment and project costs, "*Total investment (Euro)*", "*Annual operation cost on flaring production (Euro/year)*", "*Annual operation cost on energy generation (Euro/year)*" and "*General and administrative expenses (Euro/year)*", are estimated from previous similar projects implemented by Asja Group around the world.

Investment costs include the construction of a new LFG collection, conveying, suction, treatment, analysis, flare combustion and electricity generation systems, all civil works to build the infrastructure necessary to the equipment and personnel, connection of power plant to the power grid, the revamping cost of the engines, etc.; such costs are based on commercial proposals and detail on the main values is described in the Table 1 below. Those cost values, when necessary, included an inflation value, according to the time interval between the time of the investment decision (May 3rd 2011, when Energas Geração de Energia Ltda. was created) and the time when the budget was made by the producer. Operational costs and general expenses are estimated based on Asja's experience in similar projects already built. The forecast is realistic and conservative; from a market survey it can be gathered that real cost will actually be higher than the ones foreseen.

No expense related to the baseline systems is considered in this analysis, neither related to the implementation costs of LFG passive venting system and leachate collection and treatment system, nor to their operation, as it is exclusive responsibility of landfill's manager. Only the costs from the additional LFG and leachate collection systems (active LFG collection and leachate removal through pumps) are considered in the input costs being analyzed.

The depreciation rate considers the amortization of equipment by the end of a 10 years period, which is an internal company depreciation period; it means that in ten years we should have an amortization of 100% of investment. For this Project it is foreseen an investment in the year 2027 due to the revamping of the engines which will not be able to be totally amortized until the end of the project lifetime (December of 2032), so the remaining value not depreciated was considered to be the fair value of the equipment. Therefore the average depreciation of project is 4.38%.

The operation cost on flaring production is estimated from real and recent (from 2011 January to July) costs of a similar project implemented by Asja Group in Brazil, and include maintenance expenses with acquisition of materials and payment of employees, costs with electricity and water consumption and telecommunication services, as internet connection and telephone, besides private security, consultancy services from external entities, travels of personnel and other minor operational costs.

The operation cost on energy generation is estimated from real cost of a similar project implemented by Asja Group in the year 2008. Such cost was considered to remain constant through that year to the time of investment decision; therefore no inflation rate was applied. This is considered to be conservative.

General and administrative expenses refer to expenditure with financial, controlling, administrative, legal, information technology, communication, technical and commercial departments which, although not being directly involved with the operation of flaring and/or electricity generation systems, are necessary to the correct and organized management of the operational plant. The cost considered for this Project is based in real expenses of a similar project implemented by Asja Group in the country and includes expenses with payment of employees, acquisition of services and materials and consumption of electricity and water and use of internet and telephone connections by the mentioned departments.

Table 1: Description of main values of the total investment cost

Description of cost		Cost without inflation (EUR/y)							Source of cost
		2011	2012	2014	2016	2018	2019	2027	
LFG Collection System	Drilling of wells	149,565.22	82,608.70	132,173.91	132,173.91	132,173.91	-	-	Signed contract
	HDPE piping for the wells	35,349.81	24,678.88	37,018.32	37,018.32	37,018.32	-	-	Commercial invoice
	Well heads	31,801.02	15,221.00	22,831.50	22,831.50	22,831.50	-	-	Commercial offer
LFG Conveying System	HDPE piping for LFG transport	48,079.11	35,644.46	43,194.74	43,194.74	43,194.74	-	-	Commercial offer
	Substation of regulation	40,291.09	40,291.09	40,291.09	40,291.09	40,291.09	-	-	Commercial offer
Gas Station	Heat exchangers	40,058.74	-	-	-	-	-	-	Commercial offer
	Chillers	54,347.83	-	-	-	-	-	-	Commercial offer
	Blowers	114,482.61	-	-	-	-	-	-	Commercial offer
	PLC controlling panel	224,151.75	-	-	-	-	-	-	Commercial offer
	Enclosed flare	134,834.73	-	-	-	-	-	-	Commercial offer
Power plant	Generation engines	1,394,219.49	1,394,219.49	-	-	-	-	-	Commercial offer
	Revamping of engines	-	-	-	-	-	2,171,363.36	2,171,363.36	Supplier statement
	Electrical substations	156,754.35	156,754.35	-	-	-	-	-	Commercial offer
Civil Works	Foundation of electrical substations	19,316.70	-	-	-	-	-	-	Commercial offer
	Other foundations and administrative office	75,789.13	15,877.44	-	-	-	-	-	Commercial offer
Others	Connection to the local grid	22,956.52	-	-	-	-	-	-	Commercial offer
	Incidental expenses (5% of total cost)	147,114.19	95,473.39	19,637.78	19,637.78	19,637.78	-	-	N/A

The Brazilian taxes applied in the financial analysis, based on presumed profit, were COFINS (Contribuição para o Financiamento da Seguridade Social - *Contribution to the Financing of Social Security*)[2], PIS (Programa de Integração Social - *Social Integration Program*)[3], IRPJ (Imposto de Renda para Pessoa Jurídica - *Income Tax for Corporations*)[4] and CSLL (Contribuição Social sobre o Lucro Líquido - *Social Contribution on Net Income*)[5], in accordance with local regulations.

The electricity price chosen for this project has been taken from the results of the 2º Leilão de Fontes Alternativas (Second Renewable Sources Auction) held in 2010, exclusive for auctioning small hydro power plant and other renewable sources' energies (source: http://www.ccee.org.br/cceeinterdsm/v/index.jsp?contentType=RESULTADO_LEILAO&vgnextoid=ed7c645eb56ba210VgnVCM1000005e01010aRCRD&qryRESULTADO-LEILAO-CD-RESULTADO-LEILAO=5710645eb56ba210VgnVCM1000005e01010a &x=11&y=5, accessed in 09/06/2011).

The financial analysis inputs and results, for the alternative LFG1, are provided in the following tables:

Table 2: Main financial data in the project scenario LFG1.

Financial parameters	
Annual average output (CERs)	100,011
Annual average output (MWh)	20,051
Total CERs to trade during lifetime of project (CERs)	2,100,236
Total electricity delivered to the grid (MWh)	421,071
Expected electricity sale (Euro/MWh)	64.76
Average installed capacity (MW)	2.80
Annual Engines' working hours (h)	8,100
Total investment (Euro)	10,843,903
Life time of this project (years)	21 years of production + 1 year for construction
Crediting period (years)	21
Depreciation rate (average)	4.38%
Annual operation cost on flaring production (Euro/year)	177,600
Annual operation cost on energy generation (Euro/MWh)	25
General and administrative expenses (Euro/year)	100,000

Table 3: Financial analysis result.

Revenue Analysis	Project Activity without CDM	Business As Usual
Total investment IRR	1.0%	11.5%

The project IRR in the scenario LFG 1 (the project undertaken without carbon credits revenues) results quite lower than the benchmark, and the NPV by the end of project lifetime is € (2,966,179), negative. Therefore, comparing both alternative scenarios, it is clear that the scenario LFG2 (Business As Usual) is the most attractive scenario.

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2 http://www.receita.fazenda.gov.br/pessoajuridica/pispasepcofins/regincidencia.htm (accessed in 10/04/2012).

3 http://www.receita.fazenda.gov.br/pessoajuridica/pispasepcofins/regincidencia.htm (accessed in 10/04/2012).

4 http://www.receita.fazenda.gov.br/legislacao/rir/L2Parte3.htm (accessed in 10/04/2012) and http://www.planalto.gov.br/ccivil_03/leis/L9249.htm (accessed in 10/04/2012).

5 http://www.planalto.gov.br/ccivil_03/leis/L7689.htm (accessed in 10/04/2012).

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 calculated project IRR will be used to be comparable with the benchmark.

The most suitable financial indicators in the LFG1 alternative scenario are the total investment, the electricity revenue and the operation costs, included general expenses; total investment and operation costs represent, respectively, 40% and 42% of overall cost of the project, and the electricity selling is the only revenue of the project excepting CDM benefits, as shown at the table below. To maintain a conservative approach, these parameters are supposed to increase and decrease about 5% - 20%.

Table 4: Financial indicators for scenario LFG1.

Representativeness of financial indicators	Without CERs
Total costs of the project	€ 26,790,833
O&M on Total costs (>= 20%)	42%
Total investment on Total costs (>= 20%)	40%
Electricity revenues on Total revenues (>= 20%)	100%

The table below shows how these parameters should vary in order to reach the benchmark.

Table 5: Sensitivity analysis.

Total investment IRR sensitivity analysis								
	-20%	**-10%**	**-5%**	**0%**	**5%**	**10%**	**20%**	**on benchmark = 11.55%**
Floating total investment	4.8%	2.7%	1.8%	1.0%	0.2%	-0.5%	-1.8%	**-43.0%**
Electricity price	-7.4%	-2.9%	-0.9%	1.0%	2.8%	4.4%	7.5%	**33.7%**
Operation cost (O&M)	4.2%	2.6%	1.8%	1.0%	0.1%	-0.8%	-2.6%	**-72.0%**

As it can be seen, the LFG1 project IRR remains lower than the benchmark (scenario LFG2) even in the case where these parameters change in favor of the project.

Another analysis was made in the column "on benchmark = 11.55%", 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 an 11.55% IRR in the alternative scenario LFG1. The results show that the project investment needs to decrease by 43% and the O&M costs by 72% in order to achieve the expected IRR. Based on the experience of Project Proponents such variations are not likely to happen 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. Moreover, the cap inflation rate applied to the investment forecasts is 2.5%, too conservative when compared to the historic of the IGP-M (Índice Geral de Preços do Mercado) inflation rate, which accumulated value from 2006 May to 2011 May (investment decision date) is 38.53% (https://www3.bcb.gov.br/CALCIDADAO/publico/corrigirPorIndice.do?method=corrigirPorIndice, consulted in 18/01/2012), with an annual average of 7.71%.

The IGP-M rate is monthly calculated based on the price variation of different activities as Industry, Construction, Agriculture, Retailer Commerce and Services and their many distinct stages of production, and is largely used in Brazil as a reference of a macroeconomic index (http://portalibre.fgv.br/main.jsp?lumChannelId=402880811D8E34B9011D92B6B6420E96, accessed in 18/01/2012).

It's also unlikely that renewable energy price would increase 33.7% from its current value. Considering the Brazilian hydroelectric energy descending trend of prices, which respond for more than half of national energetic matrix, and the abundance of renewable sources in Brazil, we can expect the same trend to be the one for the price of every kind of renewable energy. Therefore such an electricity price variation is not realistic and it can be actually demonstrated that the scenario LFG1 (project activity without extra revenue from CDM) is not financially attractive.

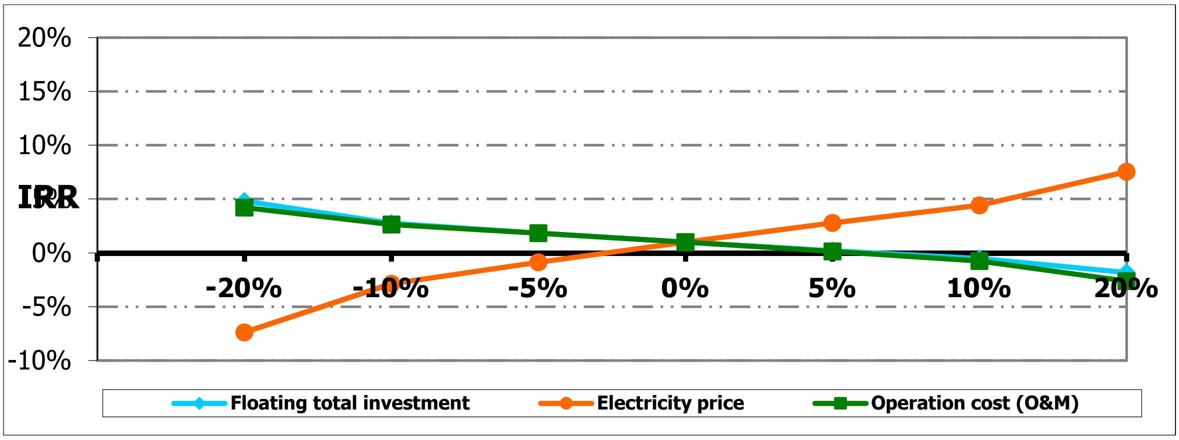

Figure 5: The impact from changes of floating total investment, electricity revenue and operation cost on IRR of the LFG1 alternative scenario.

Outcome of Step 3:
The variations obtained for the alternative scenario LFG1 are not realistic scenarios. Only in the situations of very favorable scenarios (but hardly realistic) it would be possible to reach an 11.55% benchmark. The IRR is quite lower than the benchmark (stated as the IRR of the alternative scenario LFG2) based on realistic assumptions, therefore alternative LFG1 cannot be considered as financially feasible 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 it has been clearly demonstrated that LFG revenues (electricity) are not enough 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.

According to the "*Combined tool to identify the baseline scenario and demonstrate additionality*", if the sensitivity analysis confirms the result of the investment analysis comparison, then the most economically or financially attractive alternative scenario is considered as baseline scenario. Therefore, **the identified baseline scenario is the alternative LFG2** (*Atmospheric release of the landfill gas or partial capture of landfill gas and destruction to comply with regulations or contractual requirements, or to address safety and odour concerns; and electricity generation in existing and/or new grid-connected power plants*), confirming the choice from the Step 2.

STEP 4. Common practice analysis
According to the *"Combined tool to identify the baseline scenario and demonstrate additionality"* and the Version 1.0 of the "*Guidelines on common practice*", as the project activity is not the First-of-its-kind, the previous Steps shall be complemented with an analysis of the extent to which the proposed project type has already diffused in the relevant sector and applicable geographical area.

According to the latest official statistics on urban solid waste in Brazil the "*Pesquisa Nacional de Saneamento Básico 2008*"[6] (National Research of Basic Sanitation), from a total of 5,562 districts with waste management service only 1,540 or 27.69% of them are attended by sanitary landfills, as presented in the Figure 6 below, also presented in the original form in Table 18 in Appendix 3 - Baseline Information. Most part of waste produced in the country is sent to open dumps which are generally areas without any sort of proper infrastructure to avoid environmental hazards. Therefore, even the disposal of waste in landfills is not a common practice in the country yet.

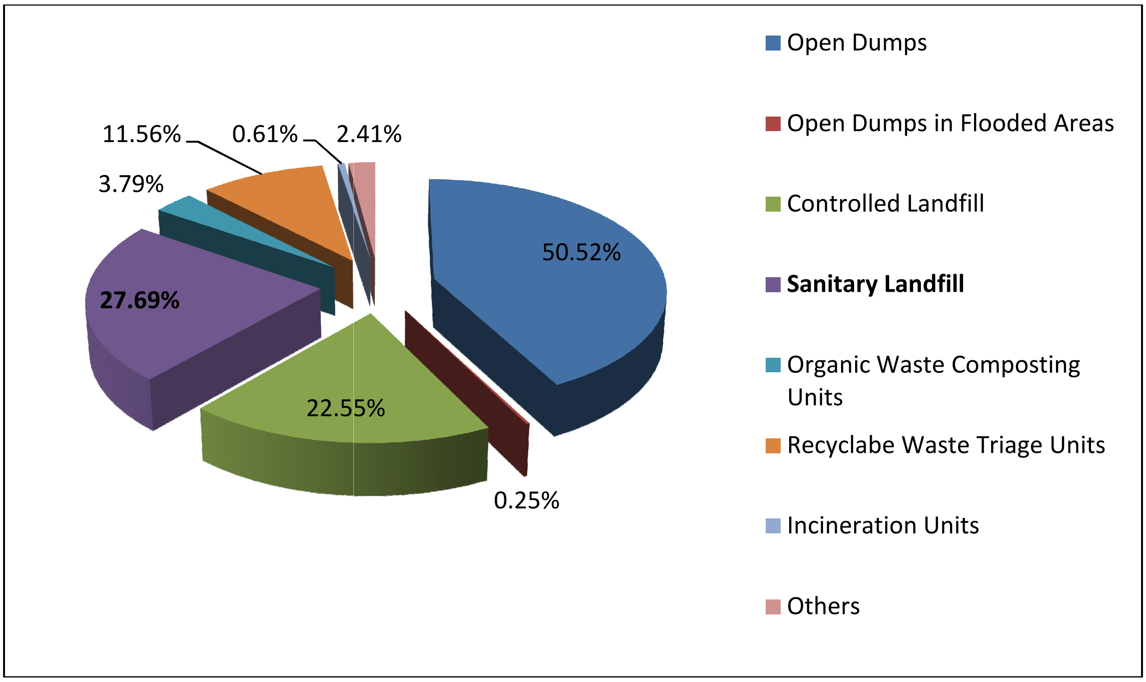

Figure 6: Districts with waste management service (total of 5,562), by final waste destination - 2008.

Other research, published by "*Sistema Nacional de Informações sobre Saneamento*" (National System of Information about Sanitation) for the year 2006[7], shows that from a total of 211 solid waste disposal sites (SWDS) in Brazil, only 17 affirm to have installed a "Gas Final Use" project. The majority release the gas directly in the atmosphere, without any previous treatment, since it is not a regulatory requirement in Brazil.

From the 17 SWDS presented in the study which have a project for the landfill gas, 10 are registered as CDM project, according to the information available at Brazilian DNA website[8]. They are located at (city/state): Cariacica/ES, Nova Iguaçu/RJ, Paulínia/SP, Salvador/BA (2 landfills), Santos/SP, São José dos Campos/SP, São Paulo/SP (2 landfills) and Tremembé/SP. Therefore, from the total, only 7 landfills affirm to have a gas final use without being CDM projects.

These landfills are the following:

Name and Location	Type and discussion about of project implemented
Sanitary Landfill of Cuiabá (MT)	*Actual status:* LFG utilization system not implemented. The landfill drains the gas and destroys part in the top of the wells (phone call confirmation).

[6] Brazilian National Research of Basic Sanitation 2008, Table 92; Available at http://www.ibge.gov.br/home/estatistica/populacao/condicaodevida/pnsb2008/defaulttabzip_man_res_sol.shtm; accessed in 09/06/2011.

[7] 2006 SNIS, Table Up03; Available at http://www.snis.gov.br/PaginaCarrega.php?EWRErterterTERTer=16; acessed in 10/06/2011.

[8] www.mct.gov.br; accessed in 12/03/2012.

Controlled Landfills of Juína (MT)	*Actual status:* LFG utilization system not implemented. The landfill does not even have a gas draining system (phone call confirmation).
a. CTR – Rio de Janeiro (RJ)	*Actual status:* LFG utilization system not implemented. The landfill does not exist and the project was never approved to receive the Environmental Permission[9]. However, the project encompasses the installation of a degassing unit, with a LFG flaring system.
Sanitary Landfill of Santa Bárbara d'Oeste (SP)	*Actual status:* LFG utilization system not implemented. The landfill drains the gas and destroys part in the top of the wells (internet search confirmation[10]).
Sanitary Landfill of São Leopoldo (RS)	*Actual status:* LFG utilization system not implemented. The landfill has leachate evaporation and incineration system, only (phone call confirmation).
Sanitary Landfill of Goiânia (GO)	*Actual status:* LFG utilization system implemented, but not operating. Enclosed flare voluntarily not operating (phone call confirmation).
Sanitary Landfill of Cascavel (PR)	*Actual status:* Power generation for lightning – pilot-scale (phone call confirmation).

Regarding the above described landfills and the definition in the *"Combined tool to identify the baseline scenario and demonstrate additionality",* similar activities to the proposed project activity are not observed and commonly carried out, since the project activity involves the landfill gas flaring and electricity generation to the grid. Although, according to the tool, if the proposed CDM project activity applies a measure that is listed in the definitions section and for further conduct the common practice analysis, it is needed to follow the *Step 4a.*

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

The proposed project activity is foreseen to have an installed electricity capacity of 2.852 MW. Therefore, the applicable output range is 1.426 MW – 4.278 MW.

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

According to a list published by ANEEL (*Agência Nacional de Energia Elétrica*[11]), informing the projects in Brazil which generate electricity, there are 547 with an installed capacity of 1.426 MW – 4.278 MW currently in operation.

Among these, 4 are registered as CDM projects, as per data published by CD4CDM – *Capacity Development for the Clean Development Mechanism*[12], and should not be included in this analysis, according to the tool.

Therefore, the identified plants that deliver the same output or capacity, within the applicable output range calculated in the *Step 4a(1),* represent N_{all} = 543.

[9] http://www.inea.rj.gov.br/downloads/ata_audit_public_ctr.pdf; accessed in 10/06/2011.

[10] http://www.santabarbara.sp.gov.br/v3/index.php?pag=pag_noticia&dir=noticias&id=27715; accessed in 10/06/2011.

[11] http://www.aneel.gov.br/aplicacoes/capacidadebrasil/UsinaListaSelecao.asp; accessed in 23/03/2012.

[12] http://www.cd4cdm.org/CDMJIpipeline.htm (accessed in 10/04/2012).

Sub-step 4a(3): Within the plants identified in Step 2, identify those that apply technologies different than the technology applied in the proposed project activity. Note their number N_{diff}.
According to the tool, different technologies, in the context of common practice, are defined as technologies that deliver the same output and differ by at least one: energy source/fuel; feed stock; size of installation; investment climate in the date of the investment decision; other features.

Among the 543 plants identified, all of them are identified to use "different technologies" to deliver the same output as the proposed project activity, because they utilize different energy source/fuel as hydroelectric, fossil fuels etc. The LFG to electricity generation is a strictly use, nowadays, for projects under the CDM.

Therefore, $N_{diff} = 543$.

Sub-step 4a(4): Calculate factor $F = 1-N_{diff}/N_{all}$ representing the share of plants using technology similar to the technology used in the proposed project activity in all plants that deliver the same output or capacity as the proposed project activity.
Regarding $N_{all} = N_{diff} = 543$, therefore:

$F = 1 - N_{diff}/N_{all} = 1 – 543/543 = \mathbf{0}$

According to the *"Combined tool to identify the baseline scenario and demonstrate additionality"*, the proposed project activity is regarded as a "common practice" within a sector in the applicable geographical area if both of the following conditions are fulfilled:

(a) The factor F is greater than 0.2; and
(b) $N_{all} – N_{diff}$ is greater than 3.

As shown in the calculation above, the proposed project activity has F = 0 (not greater than 0.2) and $N_{all} - N_{diff} = 0$ (not greater than 3). Therefore, it is clear that electricity generation using LFG is not a common practice in the host country.

<u>Outcome of Step 4:</u> This project is one of the fewest proposed to use the LFG to generate electricity, and other LFG capturing projects were developed strictly only under the CDM; similar activities are not observed or commonly carried out, being restricted into pilot-scale systems.
Thus, the proposed project activity is not regarded as "common practice" and **it is additional.**

Timeline and starting date of the project:
CDM revenues were seriously considered in the decision to proceed with the project activity as the following timeline of events demonstrates:

1. In April 12th 2010, Limpebrás Resíduos Ltda. communicated to Brazilian DNA the intention to develop a project activity and to seek CDM status.
2. In April 13th 2010, Limpebrás Resíduos Ltda. communicated to UNFCCC the intention to develop a project activity and to seek CDM status.
3. In June 10th 2010, Limpebrás Resíduos Ltda. sent letters inviting all local stakeholders of the project activity to know and comment about the proposed project activity.
4. In May 3rd 2011, Limpebrás Resíduos Ltda. and Asja Brasil Serviços para o Meio Ambiente Ltda. signed contract to create Energas Geração de Energia Ltda. (the three are Project Participants of the Project), compromising themselves to invest money and efforts to implement a CDM project activity based on LFG collection, flare combustion and electricity generation, therefore the Project; this has been assumed to be the Project's starting date hereinafter in section C.1.1.
5. In June 23rd 2011, the PDD was published in the UNFCCC website for global stakeholder consultation. This is considered the start of validation process.

From the last event on, real action of a program of activities began aiming to obtain the CDM status and implement the Project. Implementation timeline foreseen is:

1. May to June 2011: earth-moving activities;

2. July to December 2011: constructions works;
3. July to December 2011: wells drilling and LFG collection system assembly;
4. August to December 2011: gas station's equipment installation works and power plant assembling;
5. 26 January 2012: start of flaring;
6. 19 February 2012: power plant commissioning (1 engine of 1.426 MW);
7. 01 March 2012: start of electricity production;
8. 09 October 2012: installation of the second engine (1.426 MW) for electricity generation; and
9. October to December 2013: wells drilling in the landfill II.

B.6. Emission reductions

B.6.1. Explanation of methodological choices

The baseline emissions, project emissions, leakage and emission reductions are calculated according to the methodology *ACM0001* and the referred tools.

Baseline Emissions

Version 12 of *ACM0001* states that greenhouse gas baseline emissions during a given year "y" (BE_y) are estimated according with the equation **(1)** below and comprises the following sources:

(A) Methane emissions from the SWDS in the absence of the project activity;
(B) Electricity generation using fossil fuels or supplied by the grid in the absence of the project activity;
(C) Heat generation using fossil fuels in absence of the project activity; and
(D) Natural gas used from the natural gas network in the absence of the project activity.

$$BE_y = BE_{CH4,y} + BE_{EC,y} + BE_{HG,y} + BE_{NG,y} \quad \textbf{(1)}$$

Where:

BE_y	=	Baseline emissions in year *y* (tCO_2e/yr)
$BE_{CH4,y}$	=	Baseline emissions of methane from the SWDS in year *y* (tCO_2e/yr)
$BE_{EC,y}$	=	Baseline emissions associated with electricity generation in year y (tCO_2/yr)
$BE_{HG,y}$	=	Baseline emissions associated with heat generation in year *y* (tCO_2/yr)
$BE_{NG,y}$	=	Baseline emissions associated with natural gas use in year *y* (tCO_2/yr)

As the Uberlândia landfills I and II does not include heat generation ($BE_{HG,y}$=0) and/or natural gas use ($BE_{NG,y}$=0), the equation is updated to:

$$BE_y = BE_{CH4,y} + BE_{EC,y} \quad \textbf{(2)}$$

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

Baseline emissions of methane from the SWDS are determined as follows, based on the amount of methane that is captured under the project activity and the amount that would be captured and destroyed in the baseline. In addition, the effect of methane oxidation that is present in the baseline and absent in the project is taken into account:

$$BE_{CH4,y} = (1 - OX_{top\_layer}) * (F_{CH4,PJ,y} - F_{CH4,BL,y}) * GWP_{CH4} \quad \textbf{(3)}$$

Where:

$BE_{CH4,y}$	=	Baseline emissions of methane from the SWDS in year *y* (tCO_2e/yr)
OX_{top_layer}	=	Fraction of methane in the LFG that would be oxidized in the top layer of the SWDS in the baseline (dimensionless); for this Project it is considered to be 0 (zero), as per the *ACM0001* in most circumstances where the LFG is

		captured and used this effect is considered to be very small, as the operators of the SWDS have in most cases an incentive to main a high methane concentration in the LFG, therefore the effect is neglected as a conservative assumption
$F_{CH4,PJ,y}$	=	Amount of methane in the LFG which is flared and/or used in the project activity in year *y* (tCH_4/yr)
$F_{CH4,BL,y}$	=	Amount of methane in the LFG that would be flared in the baseline in year *y* (tCH_4/yr)
GWP_{CH4}	=	Global Warming Potential of CH_4 (tCO_2/tCH_4)

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

According to the methodology *ACM0001*, during the crediting period, $F_{CH4,PJ,y}$ is determined as the sum of the quantities of methane flared and used in power plant(s), boiler(s), air heater(s), kiln(s) and natural gas distribution network, as follows:

$$F_{CH4,PJ,y} = F_{CH4,flared,y} + F_{CH4,EL,y} + F_{CH4,HG,y} + F_{CH4,NG,y} \quad \textbf{(4)}$$

Where:

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

As the project will not have heat generation ($F_{CH4,HG,y} = 0$), neither will send LFG to the natural gas distribution network ($F_{CH4,NG,y} = 0$), the equation (4) is updated to:

$$F_{CH4,PJ,y} = F_{CH4,flared,y} + F_{CH4,EL,y} \quad \textbf{(5)}$$

The working hours of the power plant will be monitored and no emission reduction will be claimed for methane destruction during non-working hours.

Amount of methane used for electricity generation ($F_{CH4,EL,y}$)

$F_{CH4,EL,y}$ is determined using the *"Tool to determine the mass flow of a greenhouse gas in a gaseous stream"*. The following requirements apply:

- The gaseous stream the tool shall be applied to is the LFG delivery pipeline to each item of electricity generation equipment. $F_{CH4,EL,y}$ is then calculated as the sum of mass flows to each item of electricity generation equipment;
- CH_4 is the greenhouse gases for which the mass flow should be determined;
- The flow of the gaseous stream should be measured on continuous basis;
- The simplification offered for calculation the molecular mass of the gaseous stream is valid (equation 3 and 17 in the tool); and
- The mass flow should be summed to a yearly unit basis (t CH_4/yr).

<u>*Application of "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" (for determination of $F_{CH4,EL,y}$*)</u>

The option chosen for the calculation of the $F_{CH4,EL,y}$, according to the Table 1 of the tool, is the **Option A**, since the measurement of both flow of gaseous stream and volumetric fraction will be on **dry basis**.

Therefore, it is necessary to demonstrate that the gaseous stream is dry to use this option. There are two ways to do this:

a) Measure the moisture content of the gaseous stream ($C_{H2O,t,db,n}$) and demonstrate that this is less or equal to 0.05 kg H2O/m^3 dry gas; or

b) Demonstrate that the temperature of the gaseous stream (T_t) is less than 60ºC (333.15 K) at the flow measurement point.

For this project activity, the option (b) applies, as for security purposes the project participants will install a temperature probe at the hotter point of the LFG pipeline, just after the blowers, in order to continuously monitor this parameter. If the temperature reaches $T_t = 60ºC$ the plant operation will stop. No emission reductions will be claimed when the plant is stopped.

According to the *"Tool to determine the mass flow of a greenhouse gas in a gaseous stream"*, the mass flow of greenhouse gas *i* ($F_{i,t}$) is determined as follows:

$$F_{i,t} = V_{i,t,db} * v_{i,t,db} * \rho_{i,t} \quad \textbf{(6)}$$

With

$$\rho_{i,t} = \frac{P_t \times MM_i}{R_u \times T_t} \quad \textbf{(7)}$$

Where:

$F_{i,t}$	=	Mass flow of greenhouse gas *i* (CO_2, CH_4, N_2O, SF_6 or a PFC) in the gaseous stream in time interval *t* (kg gas/h)
$V_{t,db}$	=	Volumetric flow of the gaseous stream in time interval *t* on a dry basis (m³ dry gas/h)
$v_{i,t,db}$	=	Volumetric fraction of the gaseous gas *i* in the stream in a time interval *t* on a dry basis (m³ gas CH_4/m³ dry gas)
$\rho_{i,t}$	=	Density of the gaseous gas *i* in the stream in time interval *t* (kg CH_4/m³ CH_4)
P_t	=	Absolute pressure of the gaseous stream in time interval *t* (Pa)
MM_i	=	Molecular mass of greenhouse gas *i* (kg/kmol)
R_u	=	Universal ideal gases constant (Pa.m^3/kmol.K)
T_t	=	Temperature of the gaseous stream in time interval *t* (K)

As described above, CH_4 is the greenhouse gas for which the mass flow shall be determined.

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

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

$$F_{CH4,flared,y} = F_{CH4,sent\_flare,y} - (PE_{flare,y} / GWP_{CH4}) \quad \textbf{(8)}$$

Where:

$F_{CH4,flared,y}$	=	Amount of methane in the LFG which is destroyed by flaring in year *y* (tCH_4/yr)
$F_{CH4,sent\_flare,y}$	=	Amount of methane in the LFG which is sent to the flare in the year *y* (tCH_4/yr)
$PE_{flare,y}$	=	Project emissions from flaring of the residual gas stream in year *y* (tCO_2e/yr)
GWP_{CH4}	=	Global warming potential of CH4 (tCO_2e/ tCH_4)

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

The same options applied in the calculation of $F_{CH4,EL,y}$ are made for $F_{CH4,sent\_flare,y}$, as the measurement of both flow of gaseous stream and volumetric fraction will be at **dry basis** and a temperature probe installed at the hotter point of the LFG pipeline, just after the blowers, in order to continuously monitor this parameter, so the plant operation will stop in case the temperature reaches T_t = 60℃. Therefore, the amount of methane sent to the flare(s) will be calculated as per formulae **(6)** and **(8)**.

$PE_{flare,y}$ is determined using the *"Tool to determine project emissions from flaring gases containing methane"*. If LFG is flared through more than one flare, then $PE_{flare,y}$ is the sum of the emissions for each flare determined separately.

<u>Application of "*Tool to determine project emissions from flaring gases containing methane" (for determination of* $PE_{flare,y}$)</u>
Since in this Project **enclosed flares** will be installed, the temperature in the exhaust gas of the flare will be measured to determine whether the flare is operating or not.

According to the tool, for enclosed flares, either of the following two options can be used to determine the flare efficiency:

- To use a 90% default value. Continuous monitoring of compliance with manufacturer's specification of flare (temperature, flow rate of residual gas at the inlet of the flare) must be performed. If in a specific hour any of the parameters are out of the limit of manufacturer's specifications, a 50% default value for the flare efficiency should be used for the calculations for this specific hour.

- Continuous monitoring of the methane destruction efficiency of the flare (flare efficiency).

For the Project, a **90% default value for the flare efficiency** will be used.

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: Determination of the mass flow rate of the residual gas that is flared
Step not applicable, since the methane combustion efficiency of the flare will not be continuously monitored.

Step 2: Determination of the mass fraction of carbon, hydrogen, oxygen and nitrogen in the residual gas
Step not applicable, since the methane combustion efficiency of the flare will not be continuously monitored

STEP 3: Determination of the volumetric flow rate of the exhaust gas on a dry basis
Step not applicable, since the methane combustion efficiency of the flare will not be continuously monitored.

STEP 4: Determination of methane mass flow rate in the exhaust gas on a dry basis
Step not applicable, since the methane combustion efficiency of the flare will not be continuously monitored

STEP 5: Determination of methane mass flow rate in the residual gas on a dry basis
The residual gas moisture would not 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.

$$TM_{RG,\,h} = FV_{RG,\,h} \times fv_{CH_4,\,RG,\,h} \times \rho_{CH_4,\,n} \quad \textbf{(9)}$$

Where:

$TM_{RG,\,h}$	=	Mass flow rate of methane in the residual gas in the hour *h* (kg/h)
$FV_{RG,\,h}$	=	Volumetric flow rate of the residual gas in dry basis at normal conditions in hour *h* (m^3/h)
$fv_{CH4,\,RG,\,h}$	=	Volumetric fraction of methane in the residual gas on dry basis in hour *h*
$\rho_{CH4,\,n}$	=	Density of methane at normal conditions (0.716 kg/m^3)

STEP 6: Determination of the hourly flare efficiency
Following the methodology allowed options, the Project Proponents decided to adopt a default value for the flare efficiency.
Therefore, the flare efficiency in the hour h ($\eta_{flare,h}$) is:

- 0% if the temperature in the exhaust gas of the flare (T_{flare}) is below 500 °C for more than 20 minutes during the hour h.
- 50% if the temperature in the exhaust gas of the flare (T_{flare}) is above 500 °C for more than 40 minutes during the hour h, but the manufacturer's specifications on proper operation of the flare are not met at any point in time during the hour h.
- 90% if the temperature in the exhaust gas of the flare (T_{flare}) is above 500 °C for more than 40 minutes during the hour h and the manufacturer's specifications on proper operation of the flare are met continuously during the hour h.

Continuous monitoring of compliance with manufacturer's specification of flare (temperature, flow rate of residual gas at the inlet of the flare) will be performed. In case of parameters out of the limit of manufacturer's specifications in a specific hour, a 50% default value for the flare efficiency will be used for the calculations for this specific hour.

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

$$PE_{flare,\,y} = \sum_{h=1}^{8760} TM_{RG,\,h} \times \left(1 - \eta_{Flare,\,h}\right) \times \frac{GWP_{CH_4}}{1000} \quad \textbf{(10)}$$

Where:

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

If LFG is flared through more than one flare, then $PE_{flare,y}$will be the sum of the emissions for each flare determined separately.

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

According to the methodology *ACM0001*, an *ex ante* estimation of $F_{CH4,PJ,y}$ is required to estimate baseline emission of methane from the SWDS, in order to estimate the emission reductions of the proposed project activity in the CDM-PDD. This is estimated according to the equation below:

$$F_{CH4,PJ,y} = \eta_{PJ} * BE_{CH4,SWDS,y} / GWP_{CH4} \tag{11}$$

Where:

$F_{CH4,PJ,y}$	=	Amount of methane in the LFG which is flared and/or used in the project activity in year *y* (tCH_4/yr)
$BE_{CH4,SWDS,y}$	=	Amount of methane in the LFG that is generated from the SWDS in the baseline scenario in year *y* (tCO_2e/yr)
η_{PJ}	=	Efficiency of the LFG capture system that will be installed in the project
GWP_{CH4}	=	Global Warming Potential of CH_4 (tCO_2e/ tCH_4)

$BE_{CH4,SWDS,y}$ is determined using the methodological tool *"Emissions from solid waste disposal sites"*, following the instructions for the **Application A (The CDM project activity mitigates methane emissions from a specific existing SWDS)**. This application is referred to in the tool for determining parameters.

Since it was chosen a yearly basis for the calculations, the emissions are determined as follows:

$$BE_{CH4,SWDS,y} = \varphi \times (1-f) \times GWP_{CH_4} \times (1-OX) \times \frac{16}{12} \times F \times DOC_f \times MCF \times \sum_{x=1}^{y} \sum_{j} W_{j,x} \times DOC_j \times e^{-k_j(y-x)} \times \left(1-e^{-k_j}\right) \tag{12}$$

Where:

$BE_{CH4,SWDS,y}$	=	Baseline emissions occurring in the year *y* generated from waste disposal at a SWDS during a time period ending in the year *y* (t CO_2e/yr)
x	=	Years in the time period in which waste is disposed at the SWDS, extending from the first year in the time period (*x* = 1) to year *y* (*x* = *y*)
y	=	Year of the crediting period for which methane emissions are calculated (*y* is a consecutive period of 12 months)
$DOC_{f,y}$	=	Fraction of degradable organic carbon (DOC) that decomposes under the specific conditions occurring in the SWDS for year *y* (weight fraction)
$W_{j,x}$	=	Amount of solid waste type *j* disposed in the SWDS in the year *x* (t)
φ_y	=	Model correction factor to account for model uncertainties for year *y*
f_y	=	Fraction of methane captured at the SWDS and flared, combusted or used in another manner that prevents the emissions of methane to the atmosphere in year *y* (as per methodology ACM0001, for this parameter will be assigned a value of 0 because the amount of LFG that would have been captured and destroyed is already accounted for in equation 3of this project)
OX	=	Oxidation factor (reflecting the amount of methane from SWDS that is oxidized in the soil or other material covering the waste)
F	=	Fraction of methane in the SWDS gas (volume fraction)
MCF_y	=	Methane correction factor for year *y*
DOC_j	=	Fraction of degradable organic carbon in the waste type j (weight fraction)
k_j	=	Decay rate for the waste type *j* (1 / yr)
j	=	Type of residual waste or types of waste in the MSW

According with USEPA[13], collection efficiency for energy recovery between 75% and 85% sounds reasonable *"because each cubic foot of gas will have a monetary value to the owner/operator".*

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

Having this statement in mind, a collection efficiency of 85% was adopted once each cubic meter of LFG will have monetary value to generate electricity. Thus equation **(11)** is updated to:

$$F_{CH4,y} = 85\% \times \frac{\varphi \times (1-f) \times GWP_{CH_4} \times (1-OX) \times \frac{16}{12} \times F \times DOC_f \times MCF \times \sum_{x=1}^{y} \sum_{j} W_{j,x} \times DOC_j \times e^{-k_j(y-x)} \times \left(1-e^{-k_j}\right)}{GWP_{CH_4}} \qquad \textbf{(13)}$$

Considerations about the parameters cited above, please see in the section B.6.2.

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

According to the methodology *ACM0001*, to determine the amount of methane that would have been captured and destroyed (by flaring) in the baseline due to regulatory or contractual requirements, or to address safety and odour concerns (collectively referred to as *requirement* in this step), the appropriate case should be identified and the corresponding instruction followed.

Table 6: Cases for determining methane captured and destroyed in the baseline

Situation at the start of the project activity	**Requirement to destroy methane**	**Existing LFG Capture system**
Case 1	No	No
Case 2	Yes	No
Case 3	No	Yes
Case 4	Yes	Yes

In the Uberlândia Landfills I and II methane is partially destroyed through lighting the top of some wells of passive venting system exclusively to address safety and odour concerns. There are no regulatory or contractual requirements related to the capture and/or destruction of methane generated in the landfill.

However, the Version 12 of *ACM0001* establishes that, when applying the *Step A.2*, the capture and destruction of methane in the baseline "*due to regulatory or contractual requirements, or to address safety and odour concerns*" should be "*collectively referred to as requirement*". Therefore, according to the methodology the purpose of the passive venting system used in the Project (addressing safety and odour concerns) is referred to as a requirement, for what the Case 3 is not applicable.

So, as the Uberlândia Landfills I and II has a LFG capture system (passive system) and partially destroy methane through lighting the top of some wells of the passive venting system to address safety and odour concerns, the **Case 4** is identified as the appropriate case and will be followed.

Case 4: Requirement to destroy methane exists and LFG capture system exists

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

Where:

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

According to the methodology, for the Case 4, $F_{CH4,BL,R,y}$ and $F_{CH4,BL,sys,y}$ shall be determined according to the respective procedures for Case 2 and Case 3.

According to Case 2 procedures:

- If the requirement does not specify the amount or percentage of LFG that should be destroyed but requires the installation of a capture system, without requiring the captured LFG to be flared then:

$$F_{CH4,BL,R,y} = 0 \quad \textbf{(15)}$$

According to Case 3 procedures:

- If there is no monitored data available, but there is historic data on the amount of methane that was captured in the year prior to the implementation of the project situation, then:

$$F_{CH4,BL,sys,y} = F_{CH4,hist,y} \quad \textbf{(16)}$$

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

$$F_{CH4,hist,y} = \frac{F_{CH4,BL,x-1}}{F_{CH4,x-1}} \cdot F_{CH4,PJ,y} \quad \textbf{(17)}$$

Where:

$F_{CH4,hist,y}$	=	Historical amount of methane in the LFG which is captured and destroyed (tCH_4/yr)
$F_{CH4,BL,x-1}$	=	Historical amount of methane in the LFG which is captured and destroyed in the year prior to the implementation of the project activity (tCH_4/yr)
$F_{CH4,x-1}$	=	Amount of methane in the LFG generated in the SWDS in the year prior to the implementation of the project activity, estimated using the actual amount of waste disposed in the landfill as per the Version 6.0.1 of the "*Emissions from solid waste disposal sites*" (tCH_4/yr)
$F_{CH4,PJ,y}$	=	Amount of methane in the LFG which is flared and/or used in the project activity in year y (tCH_4/yr)

$F_{CH4,BL,x-1}$ can be evaluated as a fraction of $F_{CH4,x-1}$, therefore:

$$F_{CH4,BL,x-1} = MD_{BL} \cdot F_{CH4,x-1} \quad \textbf{(18)}$$

Where:

$F_{CH4,BL,x-1}$	=	Historical amount of methane in the LFG which is captured and destroyed in the year prior to the implementation of the project activity (tCH_4/yr)
MD_{BL}	=	Methane destruction efficiency in the baseline (-)
$F_{CH4,x-1}$	=	Amount of methane in the LFG generated in the SWDS in the year prior to the implementation of the project activity, estimated using the actual amount of waste disposed in the landfill as per the Version 6.0.1 of the "*Emissions from solid waste disposal sites*" (tCH_4/yr)

According to the study "*Reducing the uncertainty of methane recovered (R) in GHG inventories from waste sector and of adjustment factor (AF) in landfill gas projects under CDM*"[14], 154 Brazilian municipal solid waste landfills were analyzed, and those which have available historic data (from reliable sources, as Brazilian Ministry of Cities, Brazilian Ministry of Environment and from landfill managers) had their methane destruction efficiency in the baseline (MD_{BL}) calculated, following the methodology *ACM0001*. Then, an average of this value was found among those landfills, in order to contribute for better estimating MD_{BL} in landfill gas destruction projects in Brazil, under the CDM. Project participants decided to use this study in order to contribute for better calculation of the $F_{CH4,hist,y}$ parameter.

[14] Article presented at the *3rd International Workshop on Uncertainty in Greenhouse Gas Inventories* http://ghg.org.ua/fileadmin/user_upload/book/Proceedengs_UncWork.pdf; accessed in 06/06/2011.

As per this study, a collection efficiency of 75% was attributed to the passive systems, what the authors acknowledge to be a conservative approach, not reflecting the reality of existent passive systems commonly used in Brazil, and the sampled average MD_{BL} for those projects was 0.0176 and weighted average MD_{BL} was 0.0040 or, respectively, 1.76% and 0.40% (Table 19, in Appendix 4). Regarding that the use of the sampled average MD_{BL} from the cited study is more conservative, for Uberlândia landfills I and II a methane destruction efficiency of 1.76% will be used for estimating the $F_{CH4,BL,x-1}$.

Therefore, the equation **(18)** is updated to:

$$F_{CH4,BL,x-1} = 1.76\% \cdot F_{CH4,x-1} \qquad \textbf{(19)}$$

The equation **(17)** is then updated to:

$$F_{CH4,hist,y} = \frac{1.76\% \cdot F_{CH4,x-1}}{F_{CH4,x-1}} \cdot F_{CH4,PJ,y} \qquad \textbf{(20)}$$

Or

$$F_{CH4,hist,y} = 1.76\% \cdot F_{CH4,PJ,y} \qquad \textbf{(21)}$$

Since the amount of methane in the LFG which is flared in the baseline ($F_{CH4,BL,y}$) shall be the major value, between those given in equations **15** (= 0) and **16** ($F_{CH4,BL,sys,y} = F_{CH4,hist,y}$), it is then determined that:

$$F_{CH4,BL,y} = 1.76\% \cdot F_{CH4,PJ,y} \qquad \textbf{(22)}$$

Step B: Baseline emissions associated with electricity generation ($BE_{EC,y}$)

According to the methodology, the baseline emissions associated with electricity generation in y ($BE_{EC,y}$) shall be calculated using the "*Tool to calculate baseline, project and/or leakage emissions from electricity consumption*".

Application of the tool "Tool to calculate baseline, project and/or leakage emissions from electricity consumption"(for determination of $BE_{EC,y}$)

The tool is applicable because the "Scenario A: Electricity consumption from the grid." applies to the sources of electricity for this Project and correspond to the sources of electricity generated identified in the selection of the most plausible baseline scenario. The general approach is used and the formula is:

$$BE_{EC,y} = \sum_{k} EC_{BL,k,y} \times EF_{EL,k,y} \times \left(1 + TDL_{k,y}\right) \qquad \textbf{(23)}$$

Where:

$BE_{EC,y}$	=	Baseline emissions associated with electricity generation in the project activity in year *y* (tCO_2/yr)
$EC_{BL,k,y}$	=	Net amount of electricity generated using LFG in the project activity in year *y* (MWh/yr)
$EF_{EL,k,y}$	=	Emission factor for electricity generation for source *k* in year *y* (tCO_2/MWh)
$TDL_{k,y}$	=	Average technical transmission and distribution losses for providing electricity to source *k* in year *y.* A 20% default value has been used.
k	=	Sources of electricity generated identified in the baseline

The **Option A1** was chosen for the calculation of the $EF_{EL,k,y}$.

Option A1: Calculate the combined margin emission factor of the applicable electricity system, using the procedures in the approved version 2.2.1 of the "*Tool to calculate the emission factor for an electricity system*" ($EF_{EL,k,y} = EF_{grid,CM,y}$).

*Determination of $EF_{EL,k,y}$ in equation **(23)** - Application of "Tool to calculate the emission factor for an electricity system"*

$EF_{EL,k,y}$ will be calculated according with the *Version 2.2.1 of the Tool for calculation of emission factor for an electricity system* ($EF_{grid,CM,y}$ in the tool). The tool considers the determination of the emissions factor for the grid to which the project activity is connected as the core data to be determined in the baseline scenario.

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

The CM calculation must be based in data from an official source, preferable the dispatch authority. The capacity additions and the values generated from the power plants registered as CDM project activities must be excluded from the calculation. The calculation of the emission factor will be in charge of the CIMGC – Comissão Interministerial de Mudança Global do Clima (Brazilian DNA).

The OM values will be presented in an hourly basis and the values will be updated every month. The BM values will be updated every year.

According with the Tool, *"If the DNA of the host country has published a delineation of the project electricity system and connected electricity systems, these delineations should be used"*. The CIMGC published Resolução nº 8[15], which makes official the use of a single Electric Grid for CDM project activities applying the tool.

The steps 1 to 5: from the most recent version from the tool were applied by the CIMGC and the results were made available in their web-site (http://www.mct.gov.br/index.php/content/view/74689.html).

Step 6: Calculate the combined margin emissions factor

The combined margin emissions factor was based on the following choice of method, and will be calculated as follows:

(a) Weighted average CM

$$EF_{grid,CM,y} = EF_{grid,OM,y} * w_{OM} + EF_{grid,BM,y} * w_{BM} \quad \textbf{(24)}$$

Where:

$EF_{grid,CM,y}$	=	Emission factor for the Brazilian electric grid in year *y* (tCO_2/MWh)
$EF_{grid,OM,y}$	=	Operating margin CO_2 emission factor in year *y* (tCO_2/MWh)
$EF_{grid,BM,y}$	=	Build margin CO_2 emission factor in year *y* (tCO_2/MWh)
w_{OM}	=	Weighting of operating margin emissions factor (%)
w_{BM}	=	Weighting of build margin emissions factor (%)

[15] CIMGC – Comissão Interministerial de Mudança Global do Clima; "Resolução nº 8, de 26 de maio de 2009, que adota, para fins de atividade de projeto de MDL, um único sistema como definição de sistema elétrico do projeto no Sistema Interligado Nacional", available at http://www.mct.gov.br/; acessed in 08/09/2011.

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

Project Emissions
Project emissions are calculated as follows:

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

Where:

PE_y	=	Project emissions in year *y* (tCO_2/yr)
$PE_{EC,y}$	=	Emissions from consumption of electricity due to the project activity in year *y* (tCO_2/yr)
$PE_{FC,y}$	=	Emissions from consumption of fossil fuels due to the project activity, for purpose other than electricity generation, in year *y* (tCO_2/yr)

The project will not consume fossil fuels for purpose other than electricity generation, therefore $PE_{FC,y} = 0$.

PEEC,y is determined using the *"Tool to calculate baseline, project and/or leakage emissions from electricity consumption"*.

<u>*Application of the "Tool to calculate baseline, project and/or leakage emissions from electricity consumption" (for determination of $PE_{EC,y}$)*</u>
As the same of the $BE_{EC,y}$, the tool is applicable because the "Scenario A: Electricity consumption from the grid." applies to the sources of electricity for this Project.

The general formula is:

$$PE_{EC,y} = \sum_j EC_{PJ,j,y} \times EF_{EL,j,y} \times \left(1 + TDL_{j,y}\right) \quad \textbf{(26)}$$

Where:

$PE_{EC,y}$	=	Project emissions from electricity consumption in the 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)
$EF_{EJ,j,y}$	=	Emission factor for electricity generation for source *j* in year *y* (tCO_2/MWh)
$TDL_{j,y}$	=	Average technical transmission and distribution losses for providing electricity to source *j* in year *y*. A 20% default value has been used.
j	=	Sources of electricity consumption in the project activity.

For the calculation of the EF, Option A1: "Calculate the combined margin emission factor of the applicable electricity system, using the procedures in the approved version 2.2.1 of the "*Tool to calculate the emission factor for an electricity system*"" applies. The calculations and considerations done for the $EF_{EL,k,y}$ shall be considered, only regarding that, for project emissions from electricity consumption, $EF_{grid,CM,y} = EF_{EL,j,y}$.

Leakage
According with Version 12 of ACM0001, no leakage effects are accounted for under this methodology.

Emission Reductions
Emission Reductions will be calculated according with the equation below:

$$ER_y = BE_y - PE_y \quad \textbf{(27)}$$

Where:

ER_y = Emission reductions in year *y* (tCO_2e)
BE_y = Baseline emissions in year *y* (tCO_2e)
PE_y = Project emissions in year *y* (tCO_2e)

B.6.2. Data and parameters fixed ex ante

(Copy this table for each piece of data and parameter.)

Version 12 of *ACM0001*

Data / Parameter	**OX_{top_layer}**
Unit	Dimensionless
Description	Fraction of methane that would be oxidized in the top layer of the SWDS in the baseline
Source of data	Consistent with how oxidation is accounted for in the methodological tool *"Emission from solid waste disposal sites"*
Value(s) applied	0
Choice of data or Measurement methods and procedures	As per *ACM0001* version 12, in most circumstances where the LFG is captured and used this effect was considered to be very small, as the operators of the SWDS have in most cases an incentive to main a high methane concentration in the LFG. For this reason, this effect is neglected as a conservative assumption.
Purpose of data	Calculation of baseline emissions.
Additional comment	Applicable to Step A of *ACM0001* version 12.

Data / Parameter	**$F_{CH4,hist,y}$**
Unit	$t\ CH_4$ / yr
Description	Historical amount of methane in the LFG which is captured and destroyed
Source of data	According to the study "*Reducing the uncertainty of methane recovered (R) in GHG inventories from waste sector and of adjustment factor (AF) in landfill gas projects under CDM".*
Value(s) applied	**$F_{CH4,hist,y}$ = 1.76% * $F_{CH4,PJ,y}$** Calculations are shown in the section B. The $F_{CH4,hist,y}$ value for each year is shown in the table: **Year** – **$F_{CH4,hist,y}$ [t CH_4/yr]** **2012** – 24 **2013** – 76 **2014** – 79 **2015** – 81 **2016** – 83 **2017** – 85 **2018** – 87 **2019** – 60 OBS: 2012 refers to 4 months; 2019 refers to 8 months.
Choice of data or Measurement methods and procedures	Calculated as per the version 12 of *ACM0001* and described in the section B.6.1. $F_{CH4,hist,y}$ will be compared with the $F_{CH4,BL,R,y}$ as required by the version 12 of *ACM0001* in order to calculate the $F_{CH4,BL,y}$.
Purpose of data	Calculation of baseline emissions.
Additional comment	Applicable to Case 3 of Step A.2 of *ACM0001* version 12.

Data / Parameter	GWP_{CH4}
Unit	t CO_2e/t CH_4
Description	Global warming potential of CH_4
Source of data	IPCC
Value(s) applied	21
Choice of data or Measurement methods and procedures	21 for the first commitment period. Shall be updated according to any future COP/MOP decisions.
Purpose of data	Calculation of baseline and project emissions.
Additional comment	-

Data / Parameter	η_{PJ}
Unit	Dimensionless
Description	Efficiency of the LFG capture system that will be installed in the project activity
Source of data	USEPA[16]
Value(s) applied	85%
Choice of data or Measurement methods and procedures	According with USEPA, collection efficiency for energy recovery between 75% and 85% sounds reasonable *"because each cubic foot of gas will have a monetary value to the owner/operator".* Therefore, a collection efficiency of 85% was adopted once each cubic meter of LFG will have monetary value to generate electricity.
Purpose of data	Calculation of baseline emissions.
Additional comment	Applicable to Step A.1.1 of *ACM0001* version 12.

Data / Parameter	$BE_{CH4,SWDS,y}$
Unit	t CO_2e/yr
Description	Baseline emissions occurring in the year *y* generated from waste disposal at a SWDS during a time period ending in the year *y*
Source of data	Calculated as per the Version 6.0.1 of the methodological tool *Emissions from solid waste disposal site*
Value(s) applied	(see table below)

Year	$BE_{CH4,SWDS}$ [t CO_2e]
2012	107,084
2013	110,772
2014	114,335
2015	117,816
2016	121,243
2017	124,639
2018	128,020
2019	131,398

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

Choice of data or Measurement methods and procedures	As per the version 6.0.1 of the methodological tool *Emissions from solid waste disposal site*
Purpose of data	Calculation of baseline emissions.
Additional comment	Used for ex-ante estimation of the amount of methane that would have been destroyed/combusted during the year.

Version 02.0.0 of *Tool to determine the mass flow of a greenhouse gas in a gaseous stream*

Data / Parameter	$\mathbf{R_u}$
Unit	Pa.m^3/kmol.K
Description	Universal ideal gases constant
Source of data	"*Tool to determine the mass flow of a greenhouse gas in a gaseous stream"* version 02.0.0 and "*Tool to determine project emissions from flaring gases containing methane*" version 01
Value(s) applied	8,314.472
Choice of data or Measurement methods and procedures	Physical constant.
Purpose of data	Calculation of baseline emissions.
Additional comment	-

Data / Parameter	$\mathbf{MM_i}$
Unit	kg/kmol
Description	Molecular mass of greenhouse gas *i*
Source of data	"*Tool to determine the mass flow of a greenhouse gas in a gaseous stream*" version 02.0.0
Value(s) applied	(see table below)
Choice of data or Measurement methods and procedures	Physical constant.
Purpose of data	Calculation of baseline emissions.
Additional comment	For this Project, only CH_4 is analysed.

Compound (*i*)	Structure	Molecular mass (kg / kmol)
Carbon dioxide	CO_2	44.01
Methane	CH_4	16.04
Nitrous oxide	N_2O	44.02
Sulphur hexafluoride	SF_6	146.06
Perfluoromethane	CF_4	88.00
Perfluoroethane	C_2F_6	138.01
Perfluoropropane	C_3F_8	188.02
Perfluorobutane	C_4F_{10}	238.03
Perfluorocyclobutane	c-C_4F_8	200.03
Perfluoropentane	C_5F_{12}	288.03
perfluorohexano	C_6F_{14}	338.04

Version 01 of *Tool to determine project emissions from flaring gases containing methane*

Data / Parameter	$\boldsymbol{\rho_{CH4,n}}$
Unit	kg/m^3

Description	Density of methane gas at normal conditions
Source of data	*Tool to determine project emissions from flaring gases containing methane*
Value(s) applied	0.716
Choice of data or Measurement methods and procedures	Density of methane gas at 0°C and 1,013 bar.
Purpose of data	Calculation of baseline emissions.
Additional comment	-

Version 06.0.1 of methodological tool *Emission from solid waste disposal site*

Data / Parameter	$\varphi_{default}$
Unit	-
Description	Default value for the model correction factor to account for model uncertainties
Source of data	-
Value(s) applied	0.75
Choice of data or Measurement methods and procedures	As per the methodological tool, for baseline emission, the appropriate factor for application A of the tool and SWDS located in a humid climate area, a default value of 0.75 should be used.
Purpose of data	Calculation of baseline emissions.
Additional comment	Applicable to Option 1 in the procedure "Determining the model correction factor (φ_y)" of the tool.

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

Data / Parameter	**F**
Unit	-
Description	Fraction of methane in the SWDS gas (volume fraction)

Source of data	IPCC 2006 Guidelines for National Greenhouse Gas Inventories
Value(s) applied	0.5
Choice of data or Measurement methods and procedures	Default value as per the tool "*Emission from solid waste disposal site*".
Purpose of data	Calculation of baseline emissions.
Additional comment	Upon degradation, organic material is converted to a mixture of methane and carbon dioxide.

Data / Parameter	$\mathbf{DOC_{f,default}}$
Unit	Weight fraction
Description	Default value for the fraction of degradable organic carbon (DOC) in MSW that decomposes in the SWDS
Source of data	IPCC 2006 Guidelines for National Greenhouse Gas Inventories
Value(s) applied	0.5
Choice of data or Measurement methods and procedures	This factor reflects the fact that some degradable organic carbon does not degrade, or degrades very slowly, in the SWDS. This default value is recommended for Application A of the tool.
Purpose of data	Calculation of baseline emissions.
Additional comment	This factor reflects the fact that some degradable organic carbon does not degrade, or degrades very slowly, in the SWDS.

Data / Parameter	$\mathbf{MCF_{default}}$
Unit	-
Description	Methane correction factor
Source of data	2006 IPCC Guidelines for National Greenhouse Gas Inventories
Value(s) applied	1.0
Choice of data or Measurement methods and procedures	According to the tool, in case that the SWDS does not have a water table above the bottom of the SWDS and in case of application A, an applicable value can be selected. In the case of this project (application A) the applicable situation is: • 1.0 for **anaerobic managed solid waste disposal sites**.
Purpose of data	Calculation of baseline emissions.
Additional comment	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. In case of a water table above the bottom of the SWDS, a larger proportion of the SWDS is anaerobic and MCF shall be estimated.

Data / Parameter	$\mathbf{DOC_j}$
Unit	-
Description	Fraction of degradable organic carbon in the waste type *j* (weight fraction)
Source of data	IPCC 2006 Guidelines for National Greenhouse Gas Inventories (adapted from Volume 5, Tables 2.4 and 2.5)

Value(s) applied	<table><tr><th>DOC$_j$ (% wet waste)</th><th>Waste type *j*</th></tr><tr><td>43</td><td>Wood and wood products</td></tr><tr><td>40</td><td>Pulp, paper and cardboard (other than sludge)</td></tr><tr><td>15</td><td>Food, food waste, beverages and tobacco (other than sludge)</td></tr><tr><td>24</td><td>Textiles</td></tr><tr><td>20</td><td>Garden, yard and park waste</td></tr><tr><td>0</td><td>Glass, plastic, metal, other inert waste</td></tr></table>
Choice of data or Measurement methods and procedures	As per version 06.0.1 of methodological tool *Emission from solid waste disposal site*.
Purpose of data	Calculation of baseline emissions.
Additional comment	The procedure for the ignition loss test is described in *BS EN 15169:2007 Characterization of waste. Determination of loss on ignition in waste, sludge and sediments.* The percentages listed in Table are based on a wet waste basis which are concentrations in the waste as it is delivered to the SWDS. The IPCC Guidelines also specify DOC values on a dry waste basis, which are the concentrations after complete removal of all moist from the waste, which is not believed practical for this situation.

Data / Parameter	**k_j**
Unit	1/yr
Description	Decay rate for the waste type *j*
Source of data	2006 IPCC Guidelines for National Greenhouse Gas Inventories (adapted from Volume 5, Table 3.3)
Value(s) applied	<table><tr><th colspan="2">Waste type *j*</th><th>k_j</th></tr><tr><td rowspan="2">**Slowly degrading**</td><td>Pulp, paper, cardboard (other than sludge), textiles</td><td>0.070</td></tr><tr><td>Wood, wood products and straw</td><td>0.035</td></tr><tr><td>**Moderately degrading**</td><td>Other (non-food) organic putrescible garden and park waste</td><td>0.17</td></tr><tr><td>**Rapidly degrading**</td><td>Food, food waste, sewage sludge, beverages and tobacco</td><td>0.4</td></tr></table>
Choice of data or Measurement methods and procedures	Those values were adopted considering the following data: • $MAT_{historical}$ = 24°C (data from the landfill's meteorological station); • $MAP_{historical}$ = 1,642 mm (data from ANA – Agência Nacional de Água)
Purpose of data	Calculation of baseline emissions.
Additional comment	No value of PET was applied once this parameter is only required when the MAT is below 20°C.

Data / Parameter	f_y
Unit	-
Description	Fraction of methane captured at the SWDS and flared, combusted or used in another manner that prevents the emissions of methane to the atmosphere in year *y*
Source of data	*ACM0001* (version 12.0.0)
Value(s) applied	0
Choice of data or Measurement methods and procedures	As per *ACM0001*, for this parameter will be assigned a value of 0 because the amount of LFG that would have been captured and destroyed is already accounted for in equation 2 of the methodology (and equation 3of this project).
Purpose of data	Calculation of baseline emissions.
Additional comment	Estimated once for application A of methodological tool.

Data / Parameter	W_x
Unit	t
Description	Total amount of waste disposed in a SWDS in year *x*
Source of data	Official data from landfill's management
Value(s) applied	(see table below)
Choice of data or Measurement methods and procedures	Data used are the official weight data stated from the landfill's management.
Purpose of data	Calculation of baseline emissions.
Additional comment	Estimated once for application A of methodological tool.

Years	Waste to Landfill [t/y]	Years	Waste to Landfill [t/y]
1995	35,110	2012	173,012
1996	153,304	2013	176,576
1997	124,398	2014	180,214
1998	120,280	2015	183,926
1999	130,675	2016	187,715
2000	141,735	2017	191,582
2001	140,944	2018	195,528
2002	140,388	2019	199,556
2003	126,865	2020	203,667
2004	125,405	2021	207,863
2005	126,930	2022	212,145
2006	139,500	2023	216,515
2007	143,812	2024	220,975
2008	148,895	2025	225,527
2009	163,100	2026	230,173
2010	166,098	2027	234,914
2011	169,520	2028	59,938

Data / Parameter	$p_{n,j,x}$
Unit	-
Description	Weight fraction of the waste type *j* in deposited waste

Source of data	Official data from landfill's management
Value(s) applied	<table><tr><th>Waste type j</th><th>Waste composition (%)</th></tr><tr><td>Wood and wood products</td><td>0.00%</td></tr><tr><td>Pulp, paper and cardboard (other than sludge)</td><td>17.80%</td></tr><tr><td>Food, food waste, beverages and tobacco (other than sludge)</td><td>50.30%</td></tr><tr><td>Textiles</td><td>1.40%</td></tr><tr><td>Garden, yard and park waste</td><td>9.00%</td></tr><tr><td>Glass, plastic, metal, other inert waste</td><td>21.50%</td></tr><tr><td>TOTAL</td><td>100.00%</td></tr></table>
Choice of data or Measurement methods and procedures	Data used are the official data stated from the landfill's management from sampling realized in 2010.
Purpose of data	Calculation of baseline emissions.
Additional comment	This parameter is not needed to be monitored for application A of methodological tool.

Data / Parameter	**z**
Unit	-
Description	Number of samples collected during the year *x*
Source of data	Official data from landfill's management
Value(s) applied	8
Choice of data or Measurement methods and procedures	Number of samples was determined in the gravimetric research held by landfill's management from 2010, October 25th to 28th.
Purpose of data	Calculation of baseline emissions.
Additional comment	This parameter is not needed to be monitored for application A of methodological tool.

B.6.3. Ex ante calculation of emission reductions

LFG Generation

Applying the Version 6.0.1 of the tool "*Emissions from Solid Waste Disposal Sites*", the Table 7 resumes the calculation made over the 7 years of crediting period. In order to estimate the amount of LFG being generated by the landfill during the crediting period, the methane generated by the landfill estimated according to the tool was divided by the Global Warming Potential of the methane, by the methane density and by the estimated methane fraction in the LFG.

Table 7: *Ex-ante* estimation of LFG generated in the Project.

Year	$BE_{CH4,SWDS,y}$	GWP_{CH4}	ρ_{CH4}	$fv_{CH4,i,y}$	LFG generated by tool = $BE_{CH4,SWDS,y}$ / (GWP_{CH4} * ρ_{CH4} * $fv_{CH4,i,y}$)

	(tCO_2e)	(tCO_2e/tCH_4)	(tCH_4/m^3CH_4)	(m^3CH_4/m^3LFG)	(Nm^3LFG/y)
2012	107,084	21	0.000716	0.5	14,250,363
2013	110,772	21	0.000716	0.5	14,741,122
2014	114,335	21	0.000716	0.5	15,215,325
2015	117,816	21	0.000716	0.5	15,678,505
2016	121,243	21	0.000716	0.5	16,134,620
2017	124,639	21	0.000716	0.5	16,586,555
2018	128,020	21	0.000716	0.5	17,036,456
2019	131,398	21	0.000716	0.5	17,485,957

The efficiency of the LFG capture system that will be installed in the project activity (η_{PJ} = 85%) has then been taken into account to evaluate the 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. Such collection efficiency was adopted based on the careful management of the waste disposing activity applied at the landfill and the performance of other similar projects operated by Asja Group. In Uberlândia Landfill waste compaction is made bottom-up to improve waste disposal and diminish empty spaces in the mass and all disposed material is covered by the end of working day.

The amounts of LFG to be used to produce energy and flared in the flare section were estimated considering the energetic theoretical potential of LFG and the preferable use of gas in the generating sets. Therefore, when the energy generation potential of the flow is lesser than the maximum generation capacity of the engines, all the LFG is sent to the power house; and when it is bigger, the exceeding LFG is sent to the enclosed flares. The energy generation potential of the flow is calculated by multiplying the amount of LFG with the fraction of methane in it, the calorific potential of methane, and, with the efficiency of the engines (a value of 38.9% was adopted in this Project).

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 8: Project Emissions from Flaring.

1. $PE_{flare,y} = \Sigma TM_{RG,h} * (1 - \eta_{flare,h}) * GWP_{CH4} / 1000$ (Eq. 10)		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"	505	430	444	457	696	976	1,255	1,022
$\Sigma TM_{RG,h}$	Total mass flow rate in the residual gas (kg)	240,672	204,732	211,318	217,751	331,450	464,830	597,609	486,847
$\eta_{flare,h}$	Flare combustion efficiency	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
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

Table 9: Amount of Methane Destroyed by Flaring.

$F_{CH4,flared,y} = (V_{CH4,flare,db} * v_{CH4,db} * \rho_{CH4}) - (PE_{flare,y}/GWP_{CH4})$ (Eq. 6, 7 and 8)		2012	2013	2014	2015	2016	2017	2018	2019
$F_{CH4,flared,y}$	Amount of methane in the LFG which is destroyed by flaring in the year (tCH4)	217	184	190	196	298	418	538	438
$V_{CH4,flare,db}$	Volumetric flow of gaseous stream during the year on dry basis (m^3)	672,584	572,144	590,549	608,526	926,272	1,299,015	1,670,080	1,360,544
$v_{CH4,db}$	Volumetric fraction of methane in the gaseous stream in the year on dry basis (m^3 CH_4 / m^3 LFG)	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
ρ_{CH4}	Methane density (tCH_4/m^3CH_4)	0.000716	0.000716	0.000716	0.000716	0.000716	0.000716	0.000716	0.000716
$PE_{flare,y}$	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"	505	430	444	457	696	976	1,255	1,022
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

Table 10: Amount of Methane Used for Electricity Generation.

$F_{CH4,EL,y} = (V_{CH4,EL,db} * v_{CH4,db} * \rho_{CH4})$ (Eq. 6 and 7)		2012	2013	2014	2015	2016	2017	2018	2019
$F_{CH4,EL,y}$	Amount of methane in the LFG which is used for electricity generation in the year (tCH4)	1,127	4,146	4,279	4,409	4,430	4,430	4,430	2,954
$V_{CH4,EL,db}$	Volumetric flow of gaseous stream during the year on dry basis (m^3)	3,148,843	11,585,916	11,958,620	12,322,660	12,381,106	12,381,106	12,381,106	8,254,071
$v_{CH4,db}$	Volumetric fraction of methane in the gaseous stream in the year on dry basis (m^3 CH_4 / m^3 LFG)	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
ρ_{CH4}	Methane density (tCH_4/m^3CH_4)	0.000716	0.000716	0.000716	0.000716	0.000716	0.000716	0.000716	0.000716

Table 11: Amount of Methane Flared and/or Used in the Project Activity.

$F_{CH4,PJ,y} = F_{CH4,flared,y} + F_{CH4,EL,y}$ (Eq. 5)		2012	2013	2014	2015	2016	2017	2018	2019
$F_{CH4,PJ,y}$	Amount of methane in the LFG which is flared and/or used in the project activity in the year (tCH_4)	1,343	4,430	4,469	4,605	4,729	4,849	4,968	3,392
$F_{CH4,flared,y}$	Amount of methane in the LFG which is destroyed by flaring in the year (tCH4)	217	184	190	196	298	418	538	438
$F_{CH4,EL,y}$	Amount of methane in the LFG which is used for electricity generation in the year (tCH4)	1,127	4,146	4,279	4,409	4,430	4,430	4,430	2,954

Table 12: Amount of Methane Flared in the Baseline.

$F_{CH4,BL,y} = 0.0176 * F_{CH4,PJ,y}$ (Eq. 22)		2012	2013	2014	2015	2016	2017	2018	2019
$F_{CH4,BL,y}$	Amount of methane that would have been destroyed/combusted during the year y in the absence of the Project (tCH_4)	24	76	79	81	83	85	87	60
$F_{CH4,PJ,y}$	Amount of methane in the LFG which is flared and/or used in the project activity in the year (tCH_4)	1,343	4,430	4,469	4,605	4,729	4,849	4,968	3,392

Table 13: Baseline Emission of Methane from the SWDS.

$BE_{CH4,y} = (1 - OX) * (F_{CH4,PJ,y} - F_{CH4,BL,y}) * GWP_{CH4}$ (Eq. 3)		2012	2013	2014	2015	2016	2017	2018	2019
$BE_{CH4,y}$	Baseline emissions of methane from the SWDS in the year *y* (tCO_2e)	27,714	89,331	92,205	95,012	97,554	100,031	102,496	69,973
OX	Fraction of methane in the LFG that would be oxidized in the top layer of the SWDS in the baseline (-)	0	0	0	0	0	0	0	0
$F_{CH4,PJ,y}$	Amount of methane in the LFG which is flared and/or used in the project activity in the year (tCH_4)	1,343	4,430	4,469	4,605	4,729	4,849	4,968	3,392
$F_{CH4,BL,y}$	Amount of methane that would have been destroyed/combusted during the year y in the absence of the Project (tCH_4)	24	76	79	81	83	85	87	60
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

Table 14: Baseline Emission Associated with Electricity Generation.

$BE_{EC,y} = EC_{BL,k,y} * EF_{EL,k,y} *(1+TDL_{k,y})$ (Eq. 23)		2012	2013	2014	2015	2016	2017	2018	2019
$BE_{EC,y}$	Baseline emissions associated with electricity generation in the project activity in the year *y* (tCO_2e)	1,153	4,241	4,378	4,511	4,532	4,532	4,532	3,021
$EC_{BL,k,y}$	Net amount of electricity generation in the project activity in the year (MWh)	5,875	21,618	22,313	22,992	23,101	23,101	23,101	15,401
$EF_{EL,k,y}$	Emission factor for electricity from the grid (tCO_2e/MWh)	0.1635	0.1635	0.1635	0.1635	0.1635	0.1635	0.1635	0.1635
$TDL_{k,y}$	Average technical transmission and distribution losses for providing electricity to source k in year y (-)	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20

Table 15: Project Emissions from Electricity Consumption.

$PE_{EC,y} = EC_{PJ,j,y} * EF_{EL,j,y} *(1+TDL_{j,y})$ (Eq. 26)		2012	2013	2014	2015	2016	2017	2018	2019
$PE_{EC,y}$	Project emissions from electricity consumption by the project activity during the year *y* (tCO_2e)	73	223	223	223	223	223	223	149
$EC_{PJ,j,y}$	Quantity of electricity consumed by the project activity consumption source *j* in the year *y* (MWh)	370	1,139	1,139	1,139	1,139	1,139	1,139	759
$EF_{EL,j,y}$	Emission factor for electricity from the grid (tCO_2e/MWh)	0.1635	0.1635	0.1635	0.1635	0.1635	0.1635	0.1635	0.1635
$TDL_{j,y}$	Average technical transmission and distribution losses for providing electricity to source j in year y (-)	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20

Table 16: *Ex-ante* Estimation of Emission Reductions.

$ER_y = BE_y - PE_y = (BE_{CH4,y} + BE_{EC,y}) - PE_{EC,y}$		2012	2013	2014	2015	2016	2017	2018	2019
ER_y	Emissions reduction (tCO_2e)	28,794	93,349	96,360	99,300	101,863	104,340	106,805	72,845
$BE_{CH4,y}$	Baseline emissions of methane in the SWDS in the year *y* (tCO_2e)	27,714	89,331	92,205	95,012	97,554	100,031	102,496	69,973
$BE_{EC,y}$	Baseline emissions associated with electricity generation in the project activity in the year *y* (tCO_2e)	1,153	4,241	4,378	4,511	4,532	4,532	4,532	3,021
$PE_{EC,y}$	Project emissions from electricity consumption by the project activity during the year *y* (tCO_2e)	73	223	223	223	223	223	223	149

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

Year	Baseline emissions ($t\ CO_2e$)	Project emissions ($t\ CO_2e$)	Leakage ($t\ CO_2e$)	Emission reductions ($t\ CO_2e$)
2012	28,867	73	0	28,794
2013	93,572	223	0	93,349
2014	96,583	223	0	96,360
2015	99,523	223	0	99,300
2016	102,086	223	0	101,863
2017	104,563	223	0	104,340
2018	107,028	223	0	106,805
2019	72,994	149	0	72,845
Total	705,216	1,560	0	703,656
Total number of crediting years	7			
Annual average over the crediting period	100,745	223	0	100,522

OBS: 2012 refers to 4 months; 2019 refers to 8 months.

B.7. Monitoring plan

B.7.1. Data and parameters to be monitored

(Copy this table for each piece of data and parameter.)

Version 12 of *ACM0001*

Data / Parameter	$F_{CH4,BL,R,y}$
Unit	$t\ CH_4/yr$
Description	Amount of methane in the LFG which is flared in the baseline due to a requirement in year *y*
Source of data	Information of the host country's regulatory requirements relating to LFG, contractual requirements, or requirements to address safety and odour concerns
Value(s) applied	0
Measurement methods and procedures	$F_{CH4,BL,R,y}$ will be compared with the $F_{CH4,hist,y}$ as required by the version 12 of *ACM0001* in order to calculate the $F_{CH4,BL,y}$.
Monitoring frequency	Monitored annually.
QA/QC procedures	Internal audits are going to be performed in order to ensure correct monitoring of this parameter.
Purpose of data	Calculation of baseline emissions.
Additional comment	Applicable to Case 2 of Step A.2 of *ACM0001* version 12.

Data / Parameter	$\rho_{reg,y}$
Unit	Dimensionless
Description	Fraction of LFG that is required to be flared due to a requirement in year *y*
Source of data	Information of the host country's regulatory requirements relating to LFG, contractual requirements, or requirements to address safety and odour concerns
Value(s) applied	0

Measurement methods and procedures	-
Monitoring frequency	Monitored annually.
QA/QC procedures	Internal audits are going to be performed in order to ensure correct monitoring of this parameter.
Purpose of data	Calculation of baseline emissions.
Additional comment	Applicable to Case 2 of Step A.2 of *ACM0001* version 12.

Data / Parameter	**$PE_{flare,y}$**
Unit	t CO_2e
Description	Project emissions from flaring of the residual gas stream in year *y*
Source of data	Calculated as per the *“Tool to determine project emissions from flaring gases containing methane”*.
Value(s) applied	For the calculation see the Table 8 in the Section B.6.3. The $PE_{flare,y}$ value for each year is shown in the table: **Year** / **$PE_{flare,y}$ [t CO_2e/y]**: **2012**: 505 **2013**: 430 **2014**: 444 **2015**: 457 **2016**: 696 **2017**: 976 **2018**: 1,255 **2019**: 1,022 OBS: 2012 refers to 4 months; 2019 refers to 8 months.
Measurement methods and procedures	Project emissions from flaring will be calculated according the “*Tool to determine project emissions from flaring gases containing methane”* with flare efficiency $\eta_{flare,h}$.
Monitoring frequency	Continuously.
QA/QC procedures	Internal Audits are going to be performed in order to ensure correct monitoring of this parameter.
Purpose of data	Calculation of baseline emissions.
Additional comment	Archive data will be kept minimum two years after the end of the crediting period.

Data / Parameter	**Operation of the energy plant**
Unit	hr
Description	Operation of the energy plant
Source of data	Engine’s working hours counter meters
Value(s) applied	8,100 h/yr (conservative). The estimation of working hours is done according to previous plants built by Asja Group.
Measurement methods and procedures	Measured by hours counter meters. Aggregated at least yearly.
Monitoring frequency	Continuously.
QA/QC procedures	According to the engine manufacturer specifications.
Purpose of data	Calculation of baseline emissions.

Additional comment	This is monitored to ensure methane destruction is claimed for methane used in electricity plant when it is operational.

Data / Parameter	$\mathbf{PE_{EC,y}}$
Unit	tCO_2
Description	Project emissions from electricity consumption by the project activity during the year y
Source of data	Calculated as per the "*Tool to calculate baseline, project and/or leakage emissions from electricity consumption*".
Value(s) applied	The values calculated for each year for the Project are shown in the Table 15 in the section B.6.3 and in the table below: <table><tr><th>Years</th><th>Project emissions from electricity consumption by the project activity [tCO₂e]</th></tr><tr><td>**2012**</td><td>73</td></tr><tr><td>**2013**</td><td>223</td></tr><tr><td>**2014**</td><td>223</td></tr><tr><td>**2015**</td><td>223</td></tr><tr><td>**2016**</td><td>223</td></tr><tr><td>**2017**</td><td>223</td></tr><tr><td>**2018**</td><td>223</td></tr><tr><td>**2019**</td><td>149</td></tr></table>OBS: 2012 refers to 4 months; 2019 refers to 8 months.
Measurement methods and procedures	Project emissions from electricity consumption will be calculated according to the "*Tool to calculate baseline, project and/or leakage emissions from electricity consumption*", calculating the combined margin emission factor of the applicable electricity system, using the procedures in the of the "*Tool to calculate the emission factor for an electricity system*" ($EF_{EL,j/k/l,y} = EF_{grid,CM,y}$).
Monitoring frequency	Continuously.
QA/QC procedures	Internal Audits are going to be performed in order to ensure correct monitoring of this parameter.
Purpose of data	Calculation of project emissions.
Additional comment	Archive data will be kept minimum two years after the end of the crediting period.

Version 02.0.0 of *Tool to determine the mass flow of a greenhouse gas in a gaseous stream*

Data / Parameter	$\mathbf{V_{t,db}}$
Unit	m^3 dry gas/h
Description	Volumetric flow of the gaseous stream in time interval *t* on a dry basis
Source of data	Flow meter
Value(s) applied	For flare, $\mathbf{V_{t,db} = FV_{RG,h}}$. Expected emission reductions were calculated based on *ex ante* estimation of $F_{CH4,PJ,y}$, $F_{CH4,flared,y}$ and $F_{CH4,EL,y}$.

Measurement methods and procedures	Instant flow will be continuously measured by a flow meter, one for each flare's feeding pipeline and for each electricity generation equipment pipeline, normalized according to landfill gas actual 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 and electricity generation sections, then monthly and yearly for reporting. According to the *Tool to determine the mass flow of a greenhouse gas in a gaseous stream*, flow measurement on a dry basis is not doable for a wet gaseous stream. Therefore, it is necessary to demonstrate that the gaseous stream is dry by demonstrating that (one of the two options): a) The moisture content of the gaseous stream is less of equal to 0.05 kg H_2o/m^3 dry gas; or b) The temperature of the gaseous stream (T_t) is less than 60°C (333.15 K) at the flow measurement point. In the Project, the plant will be design not to operate under temperatures greater than 60°C for security purposes; it will be done through a temperature sensor to be installed at the hotter point of LFG pipeline, after the blowers.
Monitoring frequency	Continuously.
QA/QC procedures	Data with low level of uncertainty. Flow meter will have a minimum accuracy of +/- 2% and no manipulation will be applied to the data, which will be directly sent to the Programmable Logic Controller (PLC). QA/QC procedures are planned for these data. Flow meters will be periodically calibrated against a primary device provided by an independent accredited laboratory at least every 3 years. Calibration and frequency of calibration will be according to manufacturer's specifications.
Purpose of data	Calculation of baseline emissions.
Additional comment	This parameter will be monitored in Option A of the tool.

Data / Parameter	$\mathbf{v_{i,t,db}}$
Unit	m^3 gas *i*/m^3 dry gas
Description	Volumetric fraction of greenhouse gas *i* in a time interval *t* in a dry basis
Source of data	Continuous gas analyser
Value(s) applied	For this Project, only CH_4 is analysed. Therefore: $\mathbf{v_{i,t,db} = fv_{CH4,RG,h} =}$ 50%.
Measurement methods and procedures	Measured directly and continuously with a gas analyser on dry basis, and aggregated hourly, monthly and yearly. According to the *Tool to determine the mass flow of a greenhouse gas in a gaseous stream*, flow measurement on a dry basis is not doable for a wet gaseous stream. Therefore, it is necessary to demonstrate that the gaseous stream is dry by demonstrating that (one of the two options): a) The moisture content of the gaseous stream is less of equal to 0.05 kg H_2o/m^3 dry gas; or b) The temperature of the gaseous stream (T_t) is less than 60°C (333.15 K) at the flow measurement point. In the Project, the plant will be design not to operate under temperatures greater than 60°C for security purposes; it will be done through a temperature sensor to be installed at the measured lines.
Monitoring frequency	Continuously.

QA/QC procedures	QA/QC procedures are planned for these data. The gas analyzer will be subjected to regular maintenance and testing regime to ensure accuracy according to manufacturer's specifications and calibration will be done at least every six months during the plant normal operation. Calibration will include zero verification with an inert gas (e.g. N_2) and at least one reading verification with a standard gas (single calibration gas or mixture calibration gas). All calibration gases will have a certificate provided by the manufacturer and will be under their validity period.
Purpose of data	Calculation of baseline emissions.
Additional comment	Data will be archived electronically during the crediting period and two years after.

Data / Parameter	T_t
Unit	K
Description	Temperature of the gaseous stream in time interval *t*
Source of data	Temperature sensor
Value(s) applied	-
Measurement methods and procedures	Measured directly and continuously with temperature sensor to be installed at the hotter point of LFG pipeline, just after the blowers, to assure that the applicability condition related to the gaseous stream flow temperature being below 60ºC is met.
Monitoring frequency	Continuously.
QA/QC procedures	QA/QC procedures are planned for these data. Periodic calibration against a primary device provided by an independent accredited laboratory will be made. Calibration and frequency of calibration will be according to manufacturer's specifications.
Purpose of data	Calculation of baseline emissions.
Additional comment	As all parameters are converted to normal conditions during the monitoring process, this parameter is needed exclusively to ensure the gaseous stream is dry (applicability condition).

Data / Parameter	P_t
Unit	Pa
Description	Pressure of the gaseous stream in time interval *t*
Source of data	-
Value(s) applied	-
Measurement methods and procedures	-
Monitoring frequency	-
QA/QC procedures	-
Purpose of data	-
Additional comment	As all parameters will be converted to normal conditions during the monitoring process, this parameter is not needed to be monitored.

Version 01 of *Tool to determine project emissions from flaring gases containing methane*

Data / Parameter	$fv_{CH4,RG,h}$
Unit	-
Description	Volumetric fraction of methane in the residual gas on dry basis in the hour *h*
Source of data	Continuous gas analyser

Value(s) applied	For this Project, only CH_4 is analysed. Therefore: $\mathbf{fv_{CH4,RG,h} = v_{i,t,db}}$ = 50%.
Measurement methods and procedures	Measured directly and continuously with a gas analyser on dry basis, and aggregated hourly, monthly and yearly. According to the *Tool to determine project emissions from flaring gases containing methane*, if the residual gas moisture is significant (temperature greater than 60ºC), the measured flow rate of the residual gas that is usually referred to wet basis should be corrected to dry basis due to the fact that the measurement of methane is usually undertaken on a dry basis (i.e. water is removed before sample analysis). In the Project, the residual gas moisture would not be significant 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 should not be corrected to dry basis to be comparable with the measurement of methane that will be undertaken on a dry basis. Moreover, the plant will be design not to operate under temperatures greater than 60℃ for security purposes; it will be done through a temperature sensor to be installed at the hotter point of LFG pipeline, just after the blowers.
Monitoring frequency	Continuously.
QA/QC procedures	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 calibration will be done at least every six months during the plant normal operation.
Purpose of data	Calculation of baseline emissions.
Additional comment	Data will be archived electronically during the crediting period and two years after.

Data / Parameter	$\mathbf{FV_{RG,h}}$
Unit	m^3/h
Description	Volumetric flow rate of the residual gas in dry basis at normal conditions in the hour *h*
Source of data	Flow meter
Value(s) applied	For flare, $\mathbf{FV_{RG,h} = V_{t,db}}$. Expected emission reductions were calculated based on *ex ante* estimation of $F_{CH4,PJ,y}$, $F_{CH4,flared,y}$ and $F_{CH4,EL,y}$.

Measurement methods and procedures	Instant flow will be continuously measured by a flow meter, one for each flare's feeding pipeline, normalized according to landfill gas actual 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 flare. 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. According to the *Tool to determine the mass flow of a greenhouse gas in a gaseous stream*, flow measurement on a dry basis is not doable for a wet gaseous stream. Therefore, it is necessary to demonstrate that the gaseous stream is dry by demonstrating that (one of the two options): c) The moisture content of the gaseous stream is less of equal to 0.05 kg H_2o/m^3 dry gas; or d) The temperature of the gaseous stream (T_t) is less than 60°C (333.15 K) at the flow measurement point. In the Project, the plant will be design not to operate under temperatures greater than 60°C for security purposes; it will be done through a temperature sensor to be installed at the measured lines.
Monitoring frequency	Continuously.
QA/QC procedures	Data with low level of uncertainty. QA/QC procedures are planned for these data. Flow meters will be periodically calibrated against a primary device provided by an independent accredited laboratory. Calibration and frequency of calibration will be according to manufacturer's specifications.
Purpose of data	Calculation of baseline emissions.
Additional comment	Data will be archived electronically during the crediting period and two years after.

Data / Parameter	T_{flare}
Unit	°C
Description	Temperature in the exhaust gas of the enclosed flare
Source of data	Type N thermocouple
Value(s) applied	T > 500 °C
Measurement methods and procedures	The 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. The temperature of the exhaust gas will be used to define the flare efficiency in the hour h ($\eta_{flare,h}$), as follows: • 0% if the temperature in the exhaust gas of the flare (T_{flare}) is below 500 °C for more than 20 minutes during the hour h; • 50% if the temperature in the exhaust gas of the flare (T_{flare}) is above 500 °C for more than 40 minutes during the hour h, but the manufacturer's specifications on proper operation of the flare are not met at any point in time during the hour h; and • 90% if the temperature in the exhaust gas of the flare (T_{flare}) is above 500 °C for more than 40 minutes during the hour h and the manufacturer's specifications on proper operation of the flare are met continuously during the hour h.
Monitoring frequency	Continuously.

QA/QC procedures	Thermocouple will be calibrated every year using a reference thermocouple, in case of failure in calibration the thermocouple will be replaced. Each enclosed flare will be equipped with an extra thermocouple Type N at the bottom part of chamber (height of main combustion occurrence). Data from this equipment can be used to assess whether the flare was correctly operating or not in case of failure of thermocouple installed at the top of flare. Equipment is expected to have a maximum error of 3°C.
Purpose of data	Calculation of baseline emissions.
Additional comment	Archive data will be kept minimum two years after the end of the crediting period.

Version 01 of *Tool to calculate baseline, project and/or leakage emissions from electricity consumption*

Data / Parameter	$EC_{BL,k,y}$
Unit	MWh/yr
Description	Net amount of electricity generated using LFG in year *y*
Source of data	Electricity meter
Value(s) applied	The values calculated for each year for the Project are shown in section B and in the table below: **Year** — $EC_{BL,k,y}$ **(MWh)** **2012** — 5,875 **2013** — 21,680 **2014** — 22,313 **2015** — 22,992 **2016** — 23,101 **2017** — 23,101 **2018** — 23,101 **2019** — 15,401 OBS: 2012 refers to 4 months; 2019 refers to 8 months.
Measurement methods and procedures	Required to estimate the baseline emission associated with electricity generation reductions. Data will be measured continuously with an electricity meter.
Monitoring frequency	Continuously.
QA/QC procedures	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. The accuracy of the measurement depends on the electricity meter to be defined by the local/national administrator of the grid to which the plant will be connected. However equipment is expected to have a minimum accuracy of +/- 3%, based on equipment defined by the grid's administrator to a similar project connected to the same electricity grid. Local administrator of electricity grid will be responsible for the maintenance of equipment.
Purpose of data	Calculation of baseline emissions.
Additional comment	Data will be archived electronically during the crediting period and two years after.

Data / Parameter	$EF_{EL,k,y}$
Unit	tCO_2/MWh

Description	Emission factor for electricity generation for source *k* in year *y*
Source of data	The data used to calculate the grid emission factor was taken from the Brazilian DNA.
Value(s) applied	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 $EF_{EL,grid,2009}$=0.1635. Brazilian DNA calculates the national grid's carbon emission factor in both Build Margin and Operating Margin and makes these data publicly available in DNA's website. This is the last value published in the site[17]. $\mathbf{EF_{EL,k,y} = EF_{grid,CM,y}}$
Measurement methods and procedures	Required to evaluate CO_2 baseline emissions due to the electricity generation in the project activity.
Monitoring frequency	For this Project emissions factor to be updated annually during monitoring.
QA/QC procedures	Internal Audits are going to be performed in order to ensure correct monitoring of this parameter.
Purpose of data	Calculation of baseline emissions.
Additional comment	-

Data / Parameter	$\mathbf{TDL_{k,y}}$
Unit	-
Description	Average technical transmission and distribution losses for providing electricity to source k in year *y*
Source of data	According to the "*Tool to calculate baseline, project and/or leakage emissions from electricity consumption*", scenario A applies to the project as the source of electricity consumption and, since no recent, accurate and reliable data were available, the option to choose a default value of 20% was chosen.
Value(s) applied	20% $\mathbf{TDL_{k,y} = TDL_{j,y}}$
Measurement methods and procedures	According to the "*Tool to calculate baseline, project and/or leakage emissions from electricity consumption*" the Project has electricity consumption from the grid and until no references from utilities, network operators or other official documentation will be available, a default value of 20% will be used.
Monitoring frequency	Monitored annually.
QA/QC procedures	Internal Audits are going to be performed in order to ensure correct monitoring of this parameter.
Purpose of data	Calculation of baseline emissions.
Additional comment	Archive data will be kept minimum two years after the end of the crediting period.

Data / Parameter	$\mathbf{EC_{PJ,j,y}}$
Unit	MWh
Description	Quantity of electricity consumed by the project electricity consumption source *j* in year *y*
Source of data	Electricity meter

[17] http://www.mct.gov.br (Accessed in 16/08/2011).

Value(s) applied	The value calculated for each year is shown in section B. <table><tr><th>Year</th><th>$EC_{PJ,j,y}$ [MWh / y]</th></tr><tr><td>**2012**</td><td>370</td></tr><tr><td>**2013**</td><td>1,139</td></tr><tr><td>**2014**</td><td>1,139</td></tr><tr><td>**2015**</td><td>1,139</td></tr><tr><td>**2016**</td><td>1,139</td></tr><tr><td>**2017**</td><td>1,139</td></tr><tr><td>**2018**</td><td>1,139</td></tr><tr><td>**2019**</td><td>759</td></tr></table>OBS: 2012 refers to 4 months; 2019 refers to 8 months.
Measurement methods and procedures	Required to evaluate CO_2 emissions due to the power consumption of the project activity imported from the National Grid. Data will be measured by electricity meters owned by the local administrator of the grid; Project Participants will take the data from electricity bills, where the local administrator of the grid reports the values in monthly aggregations.
Monitoring frequency	Continuously
QA/QC procedures	Electricity meter will be subject to regular (in accordance with stipulation of the meter supplier) maintenance and testing to ensure accuracy. The accuracy of the measurement depends on the electricity meter to be defined by the local administrator of the grid to which the plant will be connected. However equipment is expected to have a minimum accuracy of +/- 3%, based on equipment defined by the grid's administrator to other similar project. Local administrator of electricity grid will be responsible for the maintenance of equipment.
Purpose of data	Calculation of project emissions.
Additional comment	Data will be archived electronically during the crediting period and two years after

Data / Parameter	$\mathbf{EF_{grid,CM,y}}$
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	The data used to calculate the grid emission factor was taken from the Brazilian DNA.
Value(s) applied	$EF_{grid,j,2009}$=0.1635 Brazilian DNA calculates the national grid's carbon emission factor in both Build Margin and Operating Margin and makes these data publicly available in DNA's website. This is the last value published in the site[18]. $\mathbf{EF_{grid,CM,y} = EF_{EL,k,y} = EF_{EL,j,y}}$

[18] http://www.mct.gov.br (Accessed in 16/08/2011).

Measurement methods and procedures	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 emission factor is determined for 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.
Monitoring frequency	Annually
QA/QC procedures	Internal Audits are going to be performed in order to ensure correct monitoring of this parameter.
Purpose of data	Calculation of project emissions.
Additional comment	-

Data / Parameter	$\mathbf{TDL_{j,y}}$
Unit	-
Description	Average technical transmission and distribution losses for providing electricity to source *j* in year *y*
Source of data	According to the “*Tool to calculate baseline, project and/or leakage emissions from electricity consumption*”, scenario A applies to the project as the source of electricity consumption and, since no recent, accurate and reliable data were available, the option to choose a default value of 20% was chosen
Value(s) applied	20% $\mathbf{TDL_{j,y} = TDL_{k,y}}$
Measurement methods and procedures	According to the “*Tool to calculate baseline, project and/or leakage emissions from electricity consumption*” the Project has electricity consumption from the grid and until no references from utilities, network operators or other official documentation will be available, a default value of 20% will be used.
Monitoring frequency	Monitored annually.
QA/QC procedures	Internal Audits are going to be performed in order to ensure correct monitoring of this parameter.
Purpose of data	Calculation of project emissions.
Additional comment	Archive data will be kept minimum two years after the end of the crediting period.

B.7.2. Sampling plan

Not applicable.

B.7.3. Other elements of monitoring plan

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

- Landfill gas flow into flare
- Landfill gas flow into power plant
- Methane content in the landfill gas
- Temperature of exhaust gas from flaring

- Electricity imported from the power grid
- Electricity exported to the power grid
- Power plant working hours
- Emission Factors
- $TDL_{k/j,y}$ = Average technical transmission and distribution losses for providing electricity to source *k/j* in year *y*
- Information of the host country's regulatory requirement relating to LFG, contractual requirements, or requirements to address safety and odour concerns

The monitoring of the operation parameters during the operation of the plant will be carried out according to the monitoring plan in Appendix 5.

B.7.4. Date of completion of application of methodology and standardized baseline and contact information of responsible persons/ entities

Detailed information on the baseline study is available in the Appendix 3 and Appendix 4 of this PDD. Complete monitoring plan is described in the Appendix 5 of this PDD.

The baseline study and monitoring plan were developed by Asja Brasil Serviços para o Meio Ambiente Ltda. (Project Participant) and finished on 10/06/2011.

Contact information:

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SECTION C. Duration and crediting period

C.1. Duration of project activity

C.1.1. Start date of project activity

03/05/2011
This is the date of creation of Energas Geração de Energia Ltda., composed by Limpebrás Resíduos Ltda. and Asja Brasil Serviços para o Meio Ambiente Ltda. exclusively for the development of the Project.

C.1.2. Expected operational lifetime of project activity

21 years
The landfill gas production is expected to abruptly decrease once the Landfill II stops receiving waste (2028), so the Project Proponents estimate the lifetime of project in around 4 years after the end of landfill operational lifetime.

C.2. Crediting period of project activity

C.2.1. Type of crediting period

Renewable (first period).

C.2.2. Start date of crediting period

04/09/2012 (Registration Date).

C.2.3. Length of crediting period

7 year, equal to 84 months.

SECTION D. Environmental impacts

D.1. Analysis of environmental impacts

According with the Brazilian Legislation, all pollution sources activities must receive an authorization from the competent environmental supervision agency.

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. For this Project the competent environmental agency is the *Superintendência Regional de Meio Ambiente e Desenvolvimento Sustentável*, hereinafter named SUPRAM.

The Uberlândia Landfill, received in October 8th 2010, the environmental licence nº 151 issued by SUPRAM, valid for four years, for the activities of disposing waste at the solid waste disposal site and collection, transmission and flaring of LFG.

Project Proponents will make all necessary efforts to request the licence for the activity of electricity generation using LFG in time and to comply with all environmental requirements.

The project will not have any transboundary impacts – all potential environmental impacts will occur inside the project boundary, more specifically inside the landfill.

D.2. Environmental impact assessment

The Project does not expect to create any negative environmental impacts. Rather, it will improve the actual destruction of gas from the landfill by installing an efficient burning system which assures a rate of more than 99% of destruction.

Additionally, the Project will avoid the usage of fossil fuel in grid-connected power plants.

Anyway Project Participants will comply with all requirements SUPRAM may identify.

SECTION E. Local stakeholder consultation

E.1. Solicitation of comments from local stakeholders

The local stakeholder consultation process was carried out according with Resolução nº 7 from the Brazilian DNA.

A copy from the PDD translated to Portuguese and an explanation on how the project will contribute to the promotion of sustainable development, as determined by the Annex III of Resolução nº 1 of Brazilian DNA, was sent, in June 10th 2010, to each of the stakeholders described in the table below.

Table 17: Local stakeholders consultation.

Resolução nº7	Stakeholder invited
City Hall of the host-city	City Hall of Uberlândia (Mr. Odelmo Leão Carneiro – Mayor)
Legislative Chamber of the host-city	Legislative Chamber of Uberlândia (Mr. Hélio Ferraz – President)
State Environmental Authority	FEAM – Fundação Estadual do Meio Ambiente (*Environmental State Foundation*) (Mr. José Cláudio Junqueira Ribeiro – President)
	Secretaria Estadual de Meio Ambiente e Desenvolvimento Sustentável – SEMAD *(Environmental State Secretariat)* (Mr. José Carlos Carvalho – Secretary)
Municipal Environmental Authority	Municipal Environmental Secretary (Mrs. Raquel Mendes – Secretary)
Fórum Brasileiro de ONG's e Movimentos Sociais para o Meio Ambiente e Desenvolvimento (*Brazilian NGO Forum*)	Fórum Brasileiro de ONG's e Movimentos Sociais para o Meio Ambiente e Desenvolvimento *(Brazilian NGO Forum)*
State Public Attorney	State Public Attorney of Minas Gerais
Federal Public Attorney	Federal Public Attorney (Mr. Roberto Monteiro Gurgel Santos – General Attorney)
Other Stakeholders	Associação dos Recicladores e Catadores Autônomos (Arca) *(NGO)* (Mr. Antônio – President)
	Associação dos Moradores do bairro Guarani *(NGO)* (Mr. Idevaldo José de Souza – President)
	Associação dos Moradores do bairro Tocantins *(NGO)* (Mr. Celson Rosa de Melo – President)

E.2. Summary of comments received

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

- *FEAM – Fundação Estadual do Meio Ambiente (Environmental State Foundation)* – by letter in July 27th 2010

FEAM's comment is positive. The Foundation considers that the project will bring positive environmental benefits both for capturing and destroying methane from landfill gas and for avoiding the use of fossil fuel by adding renewable energy to the grid. The foundation emphasizes the project activity is in tune with Minas Gerais State's directives of supporting projects aiming to mitigate global warming.

- *Federal Public Attorney* – by letter in August 24th 2010

The entity states that it is not allowed to proceed the analysis of the project due to constitutional obligation.

E.3. Report on consideration of comments received

Project participants appreciated the comments received. No further action was done since no negative comment nor suggestion of change was made.

SECTION F. Approval and authorization

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Appendix 1. Contact information of project participants and responsible persons/ entities

Project participant and/or responsible person/ entity	☒ Project participant ☐ Responsible person/ entity for application of the selected methodology (ies) and, where applicable, the selected standardized baselines to the project activity
Organization name	Energas Geração de Energia Ltda.
Street/P.O. Box	Rodovia BR-452, s/n, km 123.8, Anel Viário, Setor A, Distrito Industrial
Building	-
City	Uberlândia
State/Region	Minas Gerais
Postcode	38402-343
Country	Brazil
Telephone	+55 (34) 3291-9000
Fax	+55 (34) 3291-9000
E-mail	-
Website	-
Contact person	Mr. Eduardo Lima Santos
Title	-
Salutation	Mr.
Last name	Lima Santos
Middle name	-
First name	Eduardo
Department	-
Mobile	-
Direct fax	+55 (34) 3291-9000
Direct tel.	+55 (34) 3291-9000
Personal e-mail	eduardosantos@limpebras.com.br

Project participant and/or responsible person/ entity	☒ Project participant ☐ Responsible person/ entity for application of the selected methodology (ies) and, where applicable, the selected standardized baselines to the project activity
Organization name	Limpebrás Resíduos Ltda.
Street/P.O. Box	Avenida José Andraus Gassani, 1298
Building	-
City	Uberlândia
State/Region	Minas Gerais
Postcode	38402-322
Country	Brazil
Telephone	+55 (34) 3291-9000
Fax	+55 (34) 3291-9000
E-mail	limpebras@limpebras.com.br

Website	http://www.limpebras.com.br
Contact person	Mr. Heitor Eduardo dos Santos
Title	Superintendent
Salutation	Mr.
Last name	dos Santos
Middle name	-
First name	Heitor Eduardo
Department	Directory
Mobile	-
Direct fax	+55 (34) 3291-9000
Direct tel.	+55 (34) 3291-9000
Personal e-mail	heitor@limpebras.com.br

Project participant and/or responsible person/ entity	☒ Project participant ☒ Responsible person/ entity for application of the selected methodology (ies) and, where applicable, the selected standardized baselines to the project activity
Organization name	Asja Brasil Serviços para o Meio Ambiente Ltda.
Street/P.O. Box	Avenida Professor Mário Werneck, 26, sala 801
Building	Edifício Souto Lima II
City	Belo Horizonte
State/Region	Minas Gerais
Postcode	30455-610
Country	Brazil
Telephone	+55 (31) 3286-3311
Fax	+55 (31) 3286-3311
E-mail	infobrasil@aria-co2.com
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Middle name	-
First name	Enrico Maria
Department	-
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Direct fax	-
Direct tel.	-
Personal e-mail	em.roveda@aria-co2.com

Appendix 2. Affirmation regarding public funding

There is no public funding involved in the development of the Project Uberlândia landfills I and II.

Appendix 3. Applicability of methodology and standardized baseline

Common practice analysis

Table 18: Districts with waste collection services, by final waste destination unit, according to Municipalities size and population density – 2008.

Municipalities grouped sizes and population density	Cities									
	Total	With management of solid wastes								
		Total	Domestic and/or public solid waste destination units							
			Open Dumps	Open Dumps in Flooded Areas	Controlled Landfill	Sanitary Landfill	Organic Waste Composting Units	Recyclable Waste Triage Units	Incineration Units	Others
Total	**5564**	**5562**	**2810**	**14**	**1254**	**1540**	**211**	**643**	**34**	**134**
Less than 50 000 habitants and population density of 80 hab./km^2	4 511	4 509	2 402	11	1 005	1 098	166	470	18	111
Less then 50 000 habitants and population density greater than of 80 hab./km2	487	487	241	-	91	159	15	64	5	8
50 000 a 100 000 habitants and population density smaller than 80 hab./km^2	148	148	84	2	43	39	4	21	1	4
50 000 a 100 000 habitants and population density greater than 80 hab./km^2	165	165	41	-	41	92	5	29	3	4
100 000 a 300 000 habitants population density smaller than 80 hab./km^2	39	39	19	-	11	14	1	5	1	-
100 000 a 300 000 habitants and population density greater than 80 hab./km^2	135	135	15	1	35	85	10	29	2	4
300 000 a 500 000 habitants	43	43	4	-	16	24	4	9	2	1
500 000 a 1 000 000 habitants	22	22	3	-	7	16	-	8	1	1
More then 1 000 000 habitants	14	14	1	-	5	13	6	8	1	1

Source: IBGE, Diretoria de Pesquisas de População e Indicadores Sociais, Pesquisa Nacional de Saneamento Básico 2000 (Consulted in 2011, June 9th).
Note 1: One same district might have more than one final destination of waste collected.

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

Historical amount of methane in the LFG which is captured ad destroyed ($F_{CH4,hist,y}$)

Table 19: Estimated MD_{BL} to Brazilian landfills.

City	MD_{BL}	$MD_{Project}$	AF	AF_{PR}	City	MD_{BL}	$MD_{Project}$	*AF*	AF_{PR}

	a	b	c=a/b			a	b	c=a/b	
Americana	0.0105	0.7425	0.0142	n.p.	Joinville	0.0084	0.7425	*0.0114*	n.p.
Belo Horizonte	0.0143	0.7425	0.0192	n.p.	Natal	0.0007	0.7425	*0.0009*	n.p.
Betim	0.0340	0.7425	0.0458	n.p.	Niterói	0.0143	0.7425	*0.0193*	n.p.
Blumenau	0.0197	0.7425	0.0265	n.p.	Osasco	0.0501	0.7425	*0.0675*	n.p.
Caieiras	0.0308	0.7425	0.0415	0.20	Palmas	0.0258	0.7425	*0.0348*	n.p.
Camaçari	0.0444	0.7425	0.0598	n.p.	Paulínia	0.0071	0.7425	*0.0095*	0.20
Carapicuíba	0.0000	0.7425	0.0000	n.p.	Ribeirão das Neves	0.0025	0.7425	*0.0034*	n.p.
Contagem	0.0034	0.7425	0.0045	n.p.	Salvador	0.0314	0.7425	*0.0422*	n.ap.
Cuiabá	0.0055	0.7425	0.0074	n.p.	Santos	0.0339	0.7425	*0.0457*	0.20
Curitiba	0.0537	0.7425	0.0724	n.p.	São Francisco do Conde	0.0237	0.7425	*0.0320*	n.p.
Duque de Caxias	0.0030	0.7425	0.0040	0.05	São Leopoldo	0.0190	0.7425	*0.0256*	n.p.
Embu	0.0075	0.7425	0.0101	n.p.	São Paulo - Bandeirantes	0.0225	0.7425	*0.0303*	0.20
Goiânia	0.0138	0.7425	0.0185	n.p.	São Paulo - São João	0.0132	0.7425	*0.0178*	0.20
Gravataí	0.0371	0.7425	0.0500	n.p.	Serra	0.0152	0.7425	*0.0205*	n.p.
Guarujá	0.0246	0.7425	0.0331	n.p.	Valinhos	0.0222	0.7425	*0.0299*	n.p.
Itaquaquecetuba	0.0198	0.7425	0.0266	n.p.	Vera Cruz	0.0019	0.7425	*0.0025*	n.p.
Jaboatão dos Guararapes	0.0023	0.7425	0.0030	n.p.	Vitória	0.0006	0.7425	*0.0008*	n.p.
João Pessoa	0.0005	0.7425	0.0007	0.10					
Brazilian sample average MD_{BL}, $MD_{Project}$ and AF						**0.0176**	**0.7425**	***0.0238***	
Brazilian weighted average MD_{BL}, $MD_{Project}$ and AF						**0.0040**	**0.7425**	**0.0054**	

n.p.: no LFG extracting and destruction CDM project activity is registered and implemented at landfill.
n.ap.: not applicable to this landfill.
Source: Article *Reducing the uncertainty of methane recovered (R) in GHG inventories from waste sector and of adjustment factor (AF) in landfill gas projects under CDM*, presented at the *3rd International Workshop on Uncertainty in Greenhouse Gas Inventories*, available at http://ghg.org.ua/fileadmin/user_upload/book/Proceedengs_UncWork.pdf; accessed in 06/06/2011.

Appendix 5. Further background information on monitoring plan

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 A – 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 flow into flare
- Landfill gas flow into power plant
- Methane content in the landfill gas
- Temperature of exhaust gas from flaring
- Electricity imported from the power grid
- Electricity exported to the power grid
- Power plant working hours
- Emissions from flaring
- Emission Factors
- $TDL_{k/j,y}$ = Average technical transmission and distribution losses for providing electricity to source *k/j* in year *y*
- Information of the host country's regulatory requirement relating to LFG, contractual requirements, or requirements to address safety and odour concerns

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

2 DATA COLLECTED, FREQUENCY AND QUALITY CONTROL

Landfill gas flow:

- 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. 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 already included in the flow meter equipment. And to limit the time of operation with no flow signal in case of failure, the flow meter will be exchanged as soon as possible.

Flow meters will be subjected to regular maintenance and testing regime to ensure accuracy according to manufacturer's specifications, which recommends this equipment to be calibrated every 10 years. In a conservative way, the equipment will be calibrated at least every 3 years, by a qualified third party.

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.

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 least every six month during the plant normal operation.

Temperature of exhaust gas

Project owners will measure and control the temperature of the exhaust gas with an N-type thermocouple installed in the upper section of the flare, at 80% of the flare's height, in order to determine the efficiency of the flare.

All equipment of monitoring system 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 value of flare efficiency will be correlated with the value of temperature of the exhaust gas. Flare efficiency will just be considered higher than zero if the temperature in the exhaust gas is higher than 500℃ for more than 40 minutes during the hour considered.

Each enclosed flare will be equipped with an extra thermocouple N-Type at the bottom part of chamber (height of main combustion occurrence). Data from this equipment can be used to assess whether the flare was correctly operating or not in case of failure of thermocouple installed at the top of flare.

Thermocouple will be calibrated every year using a reference thermocouple, in case of failure in calibration the thermocouple will be replaced.

Electricity imported from and exported to power grid

Electricity imported and exported by power grid will be measured by electricity meters owned by the local administrator of the grid, who will be responsible for the maintenance of this equipment. Both amounts of electricity will be taken from official electricity bills emitted by the local administrator of the grid.

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 emission factor is determined for 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.

TDL

Project emissions from consumption of electricity are calculated based on the quantity of electricity consumed, an emission factor for electricity generation and TDL, a factor to account for transmission losses.

The Average technical transmission and distribution losses for providing electricity to the Project in year y will be monitored annually. In the absence of data from the relevant year, most recent figures should be used, but not older than 5 years.

TDLy should be estimated for the distribution and transmission networks of the electricity grid of the same voltage as the connection where the proposed CDM project activity is connected to. The technical distribution losses should not contain other types of grid losses (e.g. commercial losses/theft). The distribution losses can either be calculated by the project participants or be based on references from utilities, network operators or other official documentation.

Internal Audits are going to be performed in order to ensure correct monitoring of this parameter.

Information of the host country's regulatory requirement relating to LFG, contractual requirements, or requirements to address safety and odour concerns
The regulatory requirement relating to LFG valid in the host country, contractual requirements, or requirements to address safety and odour concerns will be monitored annually, in order to define the amount of methane in the LFG that would have been flared in the baseline, as per equation (14) in the section B.6.1 of the PDD.

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_2e. No special actions are possible to avoid this.

3 MONITORING EQUIPMENT AND INSTALLATION

All measurements equipment is 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 equipment will be installed. (Figure 7)

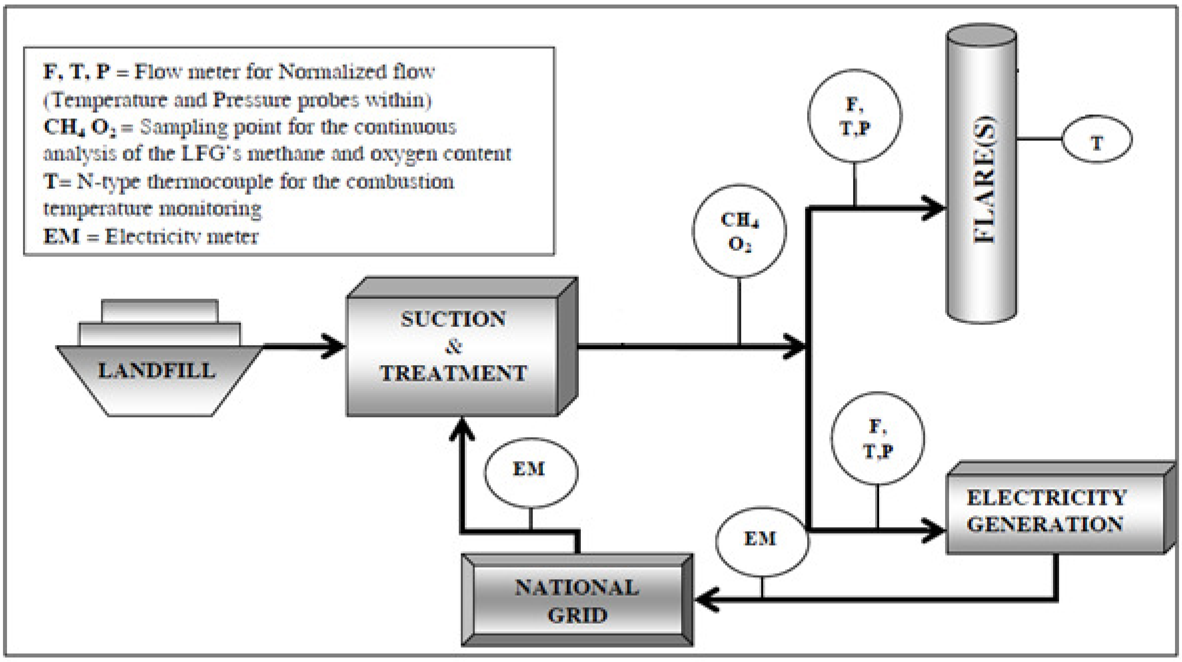

Figure 7: Monitoring points.

4 CALCULATION OF THE AMOUNT OF ERs

The greenhouse gas emission reduction achieved by the project activity during a given year "y" (ERy) 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. And the personnel will be trained before the plant enters into operation (Figure 8).

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 equipment

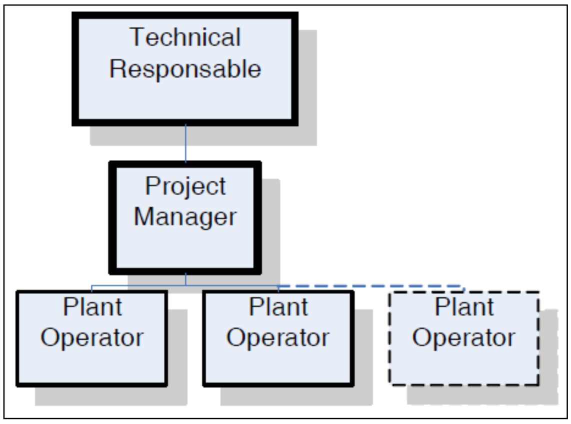

Figure 8: Organization Chart.

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 equipment 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.

Appendix 6. Summary of post registration changes

In the registered PDD the indicative output power of the project activity is stated 2.8 MW, planned to be implemented in two phases; the first phase of 1.4 MW to occur in 2012 and the second phase of 1.4 MW in 2014. However, the project has been implemented as follows:

- On March 2012, one generator of 1.426 MW was installed; and
- On October 2012, a second generator of 1.426 MW was installed, totalizing 2.852 MW of capacity.

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Document information

Version	*Date*	*Description*
05.0	25 June 2014	Revisions to: • Include the Attachment: Instructions for filling out the project design document form for CDM project activities (these instructions supersede the "Guidelines for completing the project design document form" (Version 01.0)); • Include provisions related to standardized baselines; • Add contact information on a responsible person(s)/ entity(ies) for the application of the methodology (ies) to the project activity in B.7.4 and Appendix 1; • Change the reference number from *F-CDM-PDD* to *CDM-PDD-FORM;* • Editorial improvement.
04.1	11 April 2012	Editorial revision to change version 02 line in history box from Annex 06 to Annex 06b
04.0	13 March 2012	Revision required to ensure consistency with the “Guidelines for completing the project design document form for CDM project activities” (EB 66, Annex 8).
03.0	26 July 2006	EB 25, Annex 15
02.0	14 June 2004	EB 14, Annex 06b
01.0	03 August 2002	EB 05, Paragraph 12 Initial adoption.

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