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

CONTENTS

Annexes

SECTION A. General description of project activity

A.1. Title of the project activity:

a) Title: “Natal Landfill Gas to Energy Project”
b) Current version number of this document: Version 02
c) Date of completion: 23/05/2012

A.2. Description of the project activity:

The “Natal Landfill Gas to Energy Project”, hereinafter referred to as “the Project”, is located in Natal’s metropolitan landfill.

Natal’s metropolitan landfill is localized in Ceará-Mirim city, in the highway BR-406, 22 km far from Natal city, Rio Grande do Norte state, Brazil. The landfill belongs to Sereco S/A, a project participant, for which it was adjudicated the concession to landfill the urban solid wastes of the municipality of Natal until 2024, June, through a public bidding. The landfill was created specially to attend this concession contract.

The area where the landfill is built is owned by a third part with whom Sereco S/A has signed a plot rental contract bounded to its concession contract with the municipality of Natal for landfilling of urban solid waste, so both contracts have the same validity, ending in 2024, June.

Currently, the landfill receives waste from the municipalities of Natal, Ceará-Mirim, Parnamirim, Ielmo Marinho, Macaíba, São Gonçalo do Amarante, Rio de Fogo and Extremoz, encouraging the integration among these cities. Natal itself is responsible for more than 60% of total waste received in the site.

The closest built-up-area is 7 km far from the landfill. The area around the landfill may be considered humid, with an average annual precipitation of 1,380 mm and an average temperature of 26°C.

The landfill site occupies an area of 60 ha and is able to receive 1,300 tons of municipal solid waste per day. It started operating in June 2004, with a lifetime estimated in 20 years and a capacity to treat around 6.5 million tons of solid waste. In the end of 2010, the landfill accumulated a total of 1,976,147.91 tons of solid waste. The decomposition of disposed waste occurs under anaerobic conditions generating huge amounts of landfill gas (LFG) which are released into the atmosphere through the passive vents installed at the landfill for safety purposes. The LFG major constituent is the methane (CH_4), gas 21 times more damaging as a greenhouse gas than the carbon dioxide (CO_2). It means that the methane can significantly contribute to the effects of global warming. Moreover, the methane is a very flammable constituent of LFG and at the presence of oxygen exposure can drive the risk of explosion.

The objective of the Project is to replace the existing ineffective passive venting system by an effective collection and conveying system connected to a plant able to use the LFG to produce electric energy and to destroy the LFG in surplus into high temperature enclosed flares, in the following ways:

1. The LFG will be collected through vertical wells drilled in the waste mass and will be transported through a pipeline system connected to blowers towards the gas use section, where energy production and flare combustion sections are located.

2. Entering the gas use section, the LFG collected is treated from humidity and other impurities to be then sent to the electricity generation sets and/or to the enclosed flares. The LFG preferably flows to the power house; therefore, the major part of the LFG collected will be turned into electric energy. The enclosed flare section aims to safely combust the surplus of gas in case the LFG flow exceeds the maximum utilization capacity of the power house or it is in maintenance. Both uses lead to a complete destruction of the methane present in the LFG.

3. The electric energy produced from LFG will be set both for the self consumption of the plant and the supply to the grid. The Project is expected to produce more than 303,000 MWh in the crediting period by a total installed generation capacity of 4.2 MW.

The baseline scenario for the project activity is the current situation, wherein the gas is naturally produced by wet organic waste decomposing under anaerobic conditions and the landfill is not been engineered to capture and/or treat the gas, except for the ineffective passive venting system, in which occurs total release of the LFG from the SWDS. So the Project will dim the risks of explosion and promote an efficient emission reduction system by destroying the methane present in the LFG and by the displacement of electricity generated by fossil fuel based power plants connected to the grid. In detail, the Project will have a positive impact over sustainable development mainly in the following ways:

a) Environmental Benefits: An environmental benefit achieved by Project will be the destruction of methane that otherwise would be emitted to the atmosphere, increasing the impact on global warming. The Project will also generate electricity from a renewable source avoiding the generation of the same amount of energy by fossil fuels to the grid. Other positive effect is the reduction of diseases vectors and odors caused by landfill activities in the baseline scenario as well as the elimination of the risk of explosions on surrounding areas due to unmanaged biogas release.

The Project will, furthermore, promote an environmental consciousness concerning waste management, since it is based on best solid waste management practices afforded by new financial mechanisms (CDM revenues), which can trigger the interest of other government parties, as Municipalities.

b) Social / Income Generation Benefits / Labor Capacitating: As landfill gas electricity generation projects is a wide new venture in Brazil (only a few projects are already generating electricity from the landfill gas), new capacitated job positions will be created. A team of engineers and operators will be hired and trained in order to run the project and to make continuous monitoring and maintenance of the collecting system, gas station and power house. These job positions will receive a salary higher than the one actually paid by the market, as the project needs a more skilled labor. The project will bring also an enormous technological contribution by its integration with the electric sectors.

A.3. Project participants:

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

	(Brazilian private entity) • Sereco S/A (Brazilian private entity)	
(*) In accordance with the CDM modalities and procedures, at the time of making the CDM-PDD public at the stage of validation, a Party involved may or may not have provided its approval. At the time of requesting registration, the approval by the Party(ies) involved is required.		

A.4. Technical description of the project activity:

A.4.1. Location of the project activity:

The Project is located in Natal Landfill, on the highway BR-406, near km 159, 22 km from Natal city and 7 km from Ceará-Mirim's downtown.

A.4.1.1. Host Party(ies):

Brazil.

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

Rio Grande do Norte state, Northeast region of Brazil.

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

Municipality of Ceará-Mirim.

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

Natal Landfill is located, according to Google Earth, at the following coordinates:

- S 5.711788º
- W 35.382797º

The pictures below present the detailed location of the landfill:

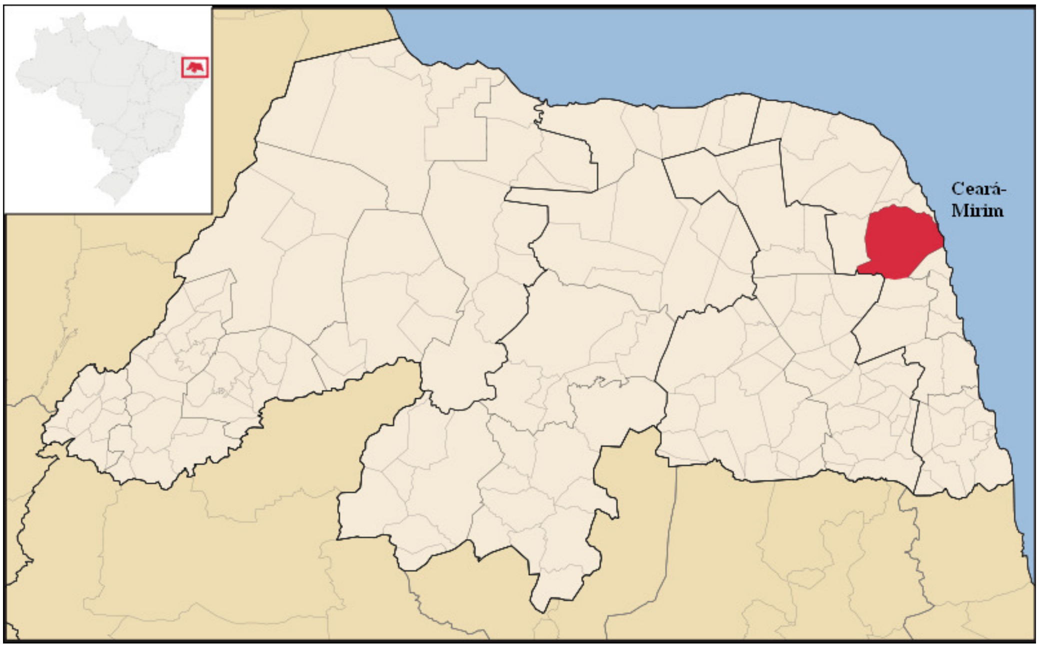

Figure 1: Ceará-Mirim city (in detail, location of Rio Grande do Norte state). Source: http://commons.wikimedia.org/wiki/File:RioGrandedoNorte_Municip_CearaMirim.svg, accessed on 06/12/10 (modified).

Figure 2: Location of the Landfill next to Natal, state of Rio Grande do Norte. Source: Google Earth.

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

Natal Landfill Gas to Energy Project is categorized in the following Sectoral Scope:

- *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.

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

As described in section A.2., the scenario existing prior to the implementation of the Project 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 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.

1. Collection System

Bearing in mind the dimensions of the Natal's Landfill, when considering the LFG collection the infrastructure 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 25-30 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 wellheads are equipped with threaded pipe unions to allow the installation of a submersible pump for leachate removal from the well and fitted with wiring and control float; in this case, the leachate accumulated within 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, whose 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 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 straightly connected to the gas production by the landfill; Project Proponents foresee the installation of 2 blowers with 3,000 Nm^3/h capacity each – one main and another standby unit that can be used at the same time if necessary. 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 the 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 this 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 4.2 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, ensuring 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.4.4. Estimated amount of emission reductions over the chosen crediting period:

Years	**Annual Estimation of emission reductions in tonnes CO_2e**
2012 (from 01/12/2012)	0
2013	134,274
2014	139,829
2015	145,073
2016	158,662
2017	163,521
2018	168,266
2019	172,931
2020	177,543
2021	182,123
2022 (until 30/11/2022)	171,130
Total estimated reductions (tons of CO_2e)	**1,613,352**
Total number of crediting years	**10**
Annual average over the crediting period of estimated reductions (tonnes of CO_2e)	**161,335**

A.4.5. Public funding of the project activity:

There will be no public funding on the project.

SECTION B. Application of a baseline and monitoring methodology

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

The Project applies the following methodology and tools:

- Version 12 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. Justification of the choice of the methodology and why it is applicable to the project activity:

a) ACM0001

This 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*	The conditions (a) and (b – item (*i*)) are applicable. The main objective of the project is to capture the LFG produced in the Natal Landfill, 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.

METHODOLOGY	PROJECT
activity and its efficiency is not impacted on by the project system: historical data on the amount of LFG capture and flared is available.	
(c) *Flare the LFG and/or use the captured LFG in any (combination) of the following ways:* (*i*) *Generating electricity;* (*ii*) *Generating heat in a boiler, air heater or kiln (brick firing only);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 Natal 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.*	The project will not imply any change in the waste received by the landfill; 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 sections B.4 and B.5, 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 kiln;*	This project only applies the methodology *ACM0001* and is not in combination with other approved methodologies.
(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*	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.

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.	

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

	Source	Gas	Included?	Justification / Explanation
Baseline	Emissions from electricity generation	***CO_2***	***Yes***	***Major emission source if 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 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.
	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 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.
Project Activity	Emissions from fossil fuel consumption for	CO_2	No	This source of project emissions will be neglected as no fossil fuel will be used on-site.

	purposes other than electricity generation or transportation due to the project activity	CH_4	No	Excluded for simplification. This emission source is assumed to be very small.
		N_2O	No	Excluded for simplification. This emission source is assumed to be very small.
	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.

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.

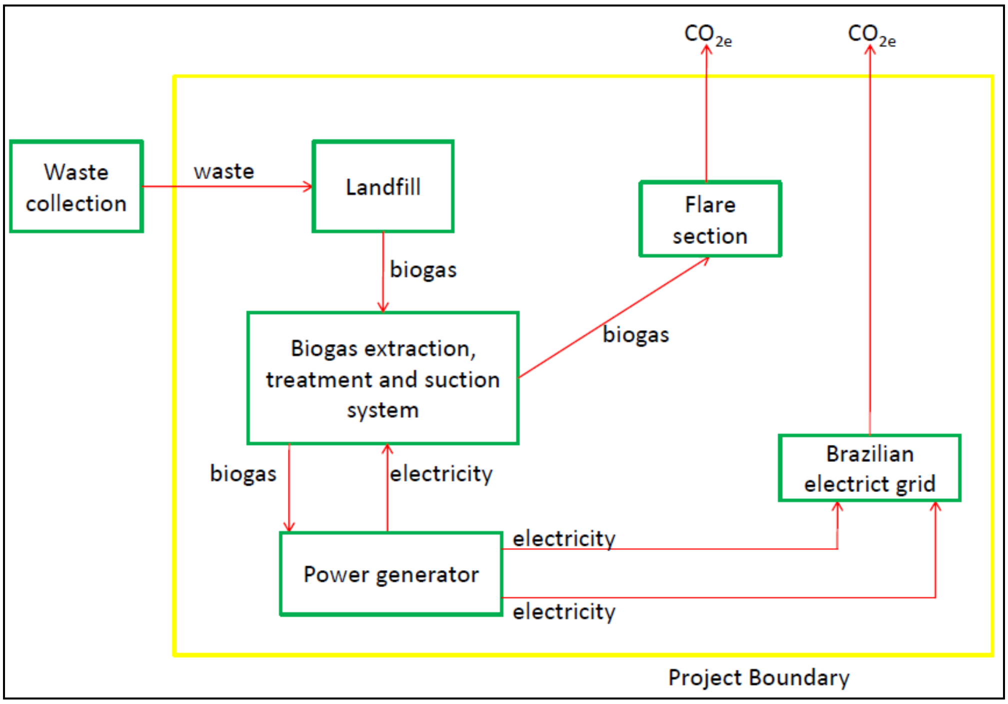

Figure 4: Flow diagram of the project boundary.

B.4. Description of how the baseline scenario is identified and description of the identified 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 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 1a and 1b presented below:

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	
LFG 1	The project activity implemented without being registered as a CDM project activity (i.e. capture and flaring or use of LFG);
LFG 2	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);
LFG 3	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.)**
LFG 4	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.)**
LFG 5	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 LFG 1 and LFG 2.

ALTERNATIVES FOR ELECTRICITY GENERATION	
E1	Electricity generated 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 nor policies which promote the productive use of landfill gas such as those for the production of renewable energy, or those that promote the processing of organic waste.

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 of landfill gas destruction nor the promotion of the landfill gas use, such as those for the production of renewable energy, or those that promote the processing of organic waste[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:

ALTERNATIVES	OBSERVATIONS	CONCLUSION
LFG 1	• There are no laws which obligate the destruction of the LFG produced. • There are no incentive policies to promote the use of the LFG to electricity generation. • There are no laws which obligate or forbid the use of the LFG for electricity generation.	OK, alternative in compliance with the mandatory applicable legal and regulatory requirements.
LFG 2	• Natal landfill has an authorization to operate, 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 obligate or forbid the electricity generation through existing and/or construction of a new grid-connected power plant; • There are no incentive policies to promote the power generation through existing and/or construction of a new grid-connected power plant.	OK, alternative in compliance with the mandatory applicable legal and regulatory requirements.

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

Outcome of the procedure for the selection of the most plausible baseline scenario

Despite its consistency with the requirements, 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.

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[1] "Política Nacional de Resíduos Sólidos"; Available at http://www.planalto.gov.br/ccivil_03/_ato2007-2010/2010/lei/l12305.htm, accessed on 02/09/2011.

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

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".*

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

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.

Outcome of Step 2: As both alternative scenarios LFG1 and LFG2 are 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. As the alternative LFG2 does not involve investment, therefore IRR will be used as the financial indicator.

Alternative LFG2

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 **11.40%**, which corresponds to the average of SELIC rates fixed in COPOM (Comitê de Política Monetária do Banco Central do Brasil) meetings held in the previous 5 years, counting from the date of investment decision, from July 19th 2006 to July 20th 2011.

Alternative LFG1

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 validity of plot rental contract for the use of the land area where the landfill is built, which is bonded to the end of the concession contract signed between Sereco S/A (project participant) and the municipality of Natal, ends in 2024. However, regarding the possibility of renewal of both the concession contract and the plot rental contract, the project participants expect to operate the project until 2028, when all electricity generation sets' lifetime will be exhausted. Project participants do not consider making further investment after 2024 because of the uncertainty related to the renewal of contracts, so project participants cannot assume the risk of any investment after the end of the contract.

  Therefore, the project lifetime is defined in 16 years, until 2028, being 9.9 years (9 years and 11 months) of simultaneous production of emission reductions and electricity and 6.1 years (6 years and 1 month) of electricity production only.

  As per the *Version 5 of the 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 was, therefore, 16 years.

- For IRR calculation, the input numbers are revenues, variable costs, depreciation, income tax and investment.

Project main revenues considered are the ones from electricity sale:

- "Annual average output (MWh)", in the sheet below, calculated as the simple average of the estimated annual electricity production; and

- "Total Electricity delivered to the grid", 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.

The investment costs include all the costs to implement the project (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, etc.) and the revamping cost each 60,000 working hours of the engines. Such costs are based on commercial proposals, whose values were added of an inflation rate when its date of emission was previous to the investment decision date (August 2nd 2011). The Table 1 below details the composition of more than 90% of total investment cost. Operational costs 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 investments in the year 2020 due to the revamping of the engines and to the addition of the LFG collection system which will not be able to be totally amortized until the end of the project possible lifetime (December of 2028), so the remaining value not depreciated were considered to be the fair value of the equipment. Therefore the average depreciation of project is 6.10%.

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

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 on real expenses of a similar project implemented by Asja Group in the country and

Table 1: Details on the total investment cost

Description of cost		Cost without inflation (EUR/y)						Source of cost
		2012	2013	2015	2016	2018	2020	
LFG Collection System	Drilling of wells	132,357.50	92,650.25	0	101,915.28	92,650.25	92,650.25	Commercial invoice for similar project
	HDPE piping for the wells	35,044.92	24,466.03	0	24,713.16	24,466.03	24,466.03	Commercial invoice for similar project
	Well heads	25,057.82	15,252.58	0	15,252.58	15,252.58	15,252.58	Commercial offer
	Leachate pumps	21,466.89	16,100.17	0	16,100.17	16,100.17	16,100.17	Commercial offer
LFG Conveying System	HDPE piping for LFG transport	43,705.15	35,846.55	0	35,846.55	35,846.55	35,846.55	Commercial offer
	Substation of regulation	40,357.94	40,357.94	0	40,357.94	40,357.94	40,357.94	Commercial offer
	Thermofusion equipment	15,216.60	0.00	0	0	0	0	Commercial offer
Gas Station	Heat exchangers	40,114.39	0	0	0	0	0	Commercial offer
	Chillers	53,618.56	0	0	0	0	0	Commercial offer
	Blowers	115,652.69	0	0	0	0	0	Commercial offer
	PLC controlling panel	224,463.10	0	0	0	0	0	Commercial offer
	Enclosed flare	131,426.42	0	0	0	0	0	Commercial offer
	Flow meters	14,608.70	4,869.57	4,869.57	0	0	0	Commercial offer
Power plant	Generation engines	2,764,395.58	0	1,382,197.79	0	0	0	Commercial offer
	Revamping of engines	0	0	0	0	0	2,155,234.09	Supplier statement
	Electrical substations	314,510.26	0	157,255.13	0	0	0	Commercial offer
Civil Works	Foundation of electrical substations	14,163.33	0	0	0	0	0	Commercial offer
	Other foundations and administrative office	120,027.92	0	15,904.71	0	0	0	Commercial offer
Others	Connection to the local grid	71,739.13	0	0.00	0	0	0	Commercial offer
	Incidental expenses (5% of total cost)	232,467.97	15,481.39	78,499.19	15,357.55	14,638.47	14,638.47	N/A

includes expenses with payment of employees, acquisition of services and materials, consumption of electricity and water and use of internet and telephone connections by the mentioned departments.

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 17/11/2011).

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

Financial parameters	
Annual average output (CERs)	161,335
Annual average output (MWh)	26,097
Total CERs to trade during lifetime of project (CERs)	1,613,352
Total electricity delivered to the grid (MWh)	417,559
Expected electricity sale (Euro/MWh)	65.02
Average installed capacity (MW)	3.50
Total investment (Euro)	10,884,531
Lifetime of project of CERs production (years)	10
Lifetime of project of Energy production (years)	16
Crediting period (years)	10
Depreciation rate (average)	6.10%
Annual operation cost on flaring production (Euro/year)	204,900
Annual operation cost on energy generation (Euro/MWh)	25
General and administrative expenses (Euro/year)	100,000

The financial analysis results are provided in the following tables:

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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).

Table 3: Financial analysis result.

Revenue Analysis	Project Activity without CDM	Business As Usual
Total investment IRR	inexistent	11.4%

The project IRR in the scenario LFG 1 (the project undertaken without carbon credits revenues) results negative, i.e. it financially does not offer return, and the NPV by the end of project lifetime is € (3,570,419), negative. Therefore, comparing both alternative scenarios, it is clear that the scenario LFG2 (Business As Usual) is the most attractive scenario.

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 54% 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	€ 26,876,961
O&M on Total costs (>= 20%)	54%
Total investment on Total costs (>= 20%)	40%
Electricity revenues on Total revenues (>= 20%)	99%

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 = 11.40%**
Floating total investment	4.0%	1.6%	0.6%	-0.4%	-1.3%	-2.1%	-3.6%	**-42.5%**
Electricity price	-11.9%	-5.4%	-2.8%	-0.4%	1.9%	4.0%	7.9%	**29.6%**
Operation cost (O&M)	4.4%	2.1%	0.9%	-0.4%	-1.7%	-3.0%	-6.0%	**-54.5%**

As it can be seen, the LFG1 project IRR remains inexistent or 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 the benchmark = 11.40%”, considering how much the electricity price on the MWh would have to increase and how much the operational costs and investments would have to decrease to achieve an 11.40% IRR in the alternative scenario LFG1. The results show that the project investment needs to decrease by 42% and the O&M costs by 54%, in order to achieve the expected IRR. None of reductions are likely to occur if national economic circumstances are considered.

The IGP-M (Índice Geral de Preços do Mercado) inflation rate is calculated every month by *Fundação Getúlio Vargas*, based on the price variation of different activities, as Industry, Construction, Agriculture, Retailer Commerce and Services and their many distinct stages of production, and, for this reason, it is largely used as a macroeconomic index in Brazil (http://portalibre.fgv.br/main.jsp?lumChannelId=402880811D8E34B9011D92B6B6420E96, accessed in 23/01/2012). According to *Banco Central do Brasil*, the historic of IGP-M rate shows an accumulated inflation of 36.92% over the past 5 years in relation to the investment decision date (from August 2006 to August 2011), with an average inflation of 7.38% per year (https://www3.bcb.gov.br/CALCIDADAO/publico/corrigirPorIndice.do?method=corrigirPorIndice, consulted in 23/01/2012). Comparing the inflation rate applied in the LFG1 scenario and the IGP-M rate historic, it is unlikely that the estimated investment costs will not be surpassed by the market prices. Therefore, it is also unlikely that the investment costs decrease around 42.5% to make the IRR of the project achieve the benchmark value.

For the same reason, Project Proponents do not expect the operational costs to decrease 54.5% to make the alternative LFG1 achieve the benchmark value, as the IGP-M rate clearly shows a trend of increase in general costs.

It is also unlikely that renewable energy price would increase by 29.6% from its current value. Considering the Brazilian hydroelectric energy descending trend of prices, which respond for more than half of national 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 variations is not realistic and it can be actually demonstrated that the scenario LFG1 (project activity without extra revenue from CDM) is not financially attractive.

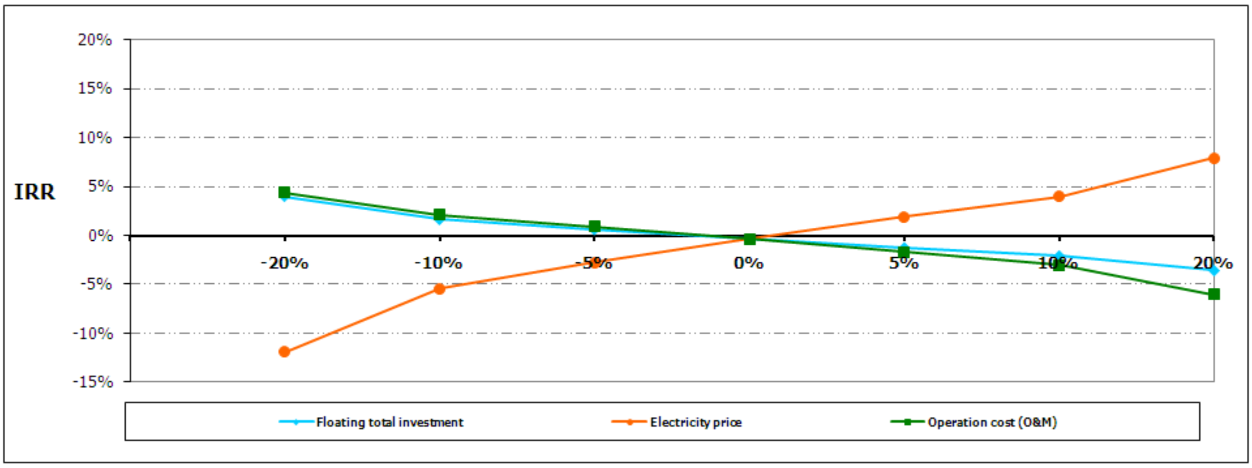

Figure 5: The impact from changes of floating total investment, electricity revenue and operation cost on IRR.

<u>Outcome of Step 3:</u>

The variations obtained for the alternative LFG1 are not realistic scenarios. Only in the situations of very favorable scenarios (but not realistic) it would be possible to reach the 11.40% benchmark. The IRR is inexistent or quite lower than the benchmark (stated as the IRR of the alternative scenario LFG2), based in the 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 "*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 19 in *Annex 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.

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[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.

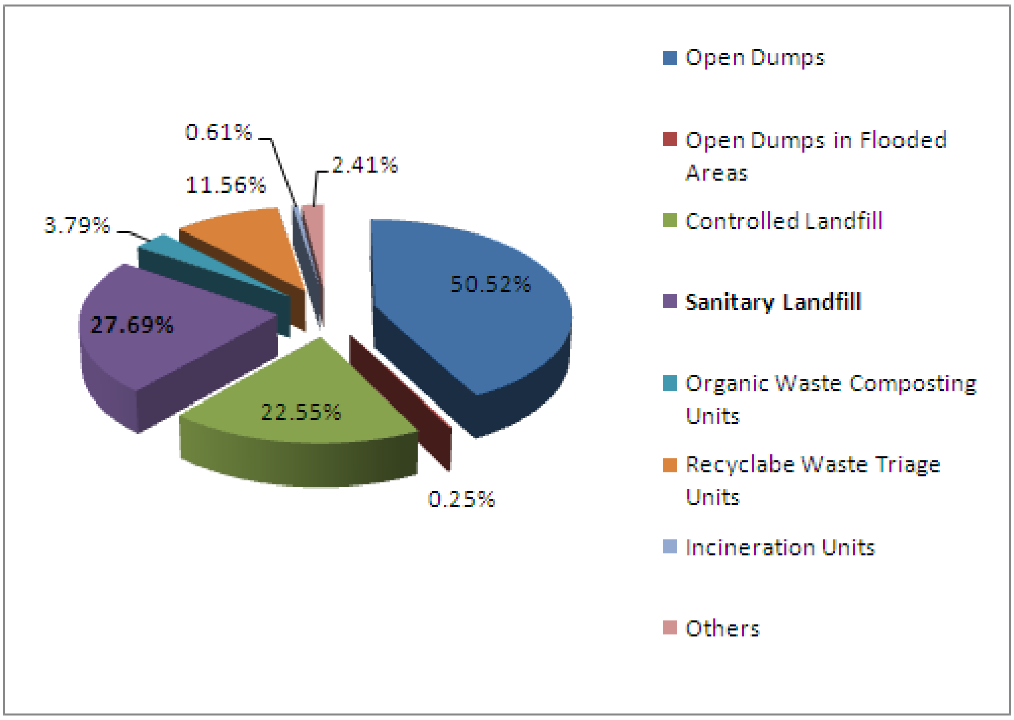

Figure 6: Districts with waste management service (total of 5,562), by final waste destination - 2008.

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:

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[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.

Table 6: Discussion about projects which have implemented "Gas Final Use" projects without the incentives of CDM.

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 destroy part in the top of the wells (phone call confirmation).
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).
CTR – Rio de Janeiro (RJ)	*Actual status:* LFG utilization system not implemented. The landfill does not exist and the project has never been approved to receive the Environmental Permission[9]. However, the project encompasses the installation of a degassing unit, with LFG flaring system.
Sanitary Landfill of Santa Bárbara d'Oeste (SP)	*Actual status:* LFG utilization system not implemented. The landfill drains the gas and destroy part in the top of the well (internet search confirmation[10]).
Sanitary Landfill of São Leopoldo (RS)	*Actual status:* LFG utilization system not implemented. The landfill have leachate evaporation and incineration system, only (phone call confirmation).
Sanitary Landfill of Goiânia (GO)	*Actual status:* LFG utilization system implemented, but not operating. Enclosed voluntarily flare 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. Nevertheless, according to the tool, if the proposed CDM project activity applies a measure that is listed in the definitions section of the tool 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 4.2 MW. Therefore, the applicable output range is 2.1 MW – 6.3 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.*

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[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.

According to a list published by ANEEL (*Agência Nacional de Energia Elétrica*)[11] informing the projects in Brazil which generate electricity, there are 561 with an installed capacity of 2.1 MW – 6.3 MW currently in operation.

Among these, 7 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 calculate in the *Step 4a(1),* represent $N_{all} = 554$.

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 554 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, $N_{diff} = 554$

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 $N_{all} = N_{diff} = 554$, therefore:

$F = 1 - N_{diff}/N_{all} = 1 – 554/554 = \mathbf{0}$

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.

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

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

<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.**

In the table below the key events of the project:

Key events	Date
Sending inviting letters to all local stakeholders of the project activity to know and comment about the proposed project activity.	9 February 2011
Hiring a Designated Operational Entity (DOE) for validation process.	15 July 2011
Signing of agreement between Sereco S/A and Asja Brasil Serviços para o Meio Ambiente Ltda. for developing the proposed CDM project activity.	2 August 2011
Start date of Validation process – Beginning of global stakeholders' consultation period.	27 September 2011
Sending letter of Prior Consideration of the CDM to Brazilian DNA.	21 October 2011
Sending letter of Prior Consideration of the CDM to UNFCCC.	28 October 2011
Purchasing and acquisition of the first equipment and services.	July 2012*
Vertical wells drilling starting date and LFG collection system assembling.	August 2012*
Gas station's equipment installation works and power plant assembling.	September 2012*
Power Plant Commissioning.	November 2012*
Start-up of the plant (energy generation and flaring).	January 2013*

*Estimated date based on expected Registration Date of the Project.

The investment decision was made in August 2nd 2011, date of signing of the agreement between the two project participants, Sereco S/A and Asja Brasil Serviços para o Meio Ambiente Ltda., for the development and implementation of the proposed project activity.

The starting date of the project corresponds to the purchasing and acquisition of the first equipment and services (July 2012), to happen when the Project is submitted to Registration with UNFCCC.

B.6. Emission reductions:

B.6.1. Explanation of methodological choices:

Baseline emissions, project emissions, leakage and emission reductions are calculated according to the Version 12.0 of the methodology *ACM0001* and the referred tools.

<u>***Baseline Emissions***</u>

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 Natal Landfill Gas to Energy Project 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:

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

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:

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

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).

Application of “Tool to determine the mass flow of a greenhouse gas in a gaseous stream” (for determination of $F_{CH4,EL,y}$)

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 hottest point of the LFG electricity generation pipeline, just after the blowers, in order to continuously monitor this parameter. If the temperature reaches $T_t = 60$ºC 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:

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

With

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

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:

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

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 CH_4 (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 hottest 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°C. Therefore, the amount of methane sent to the flare(s) will be calculated as per formula **(6)** to **(10)**.

$PE_{flare,y}$ 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.

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

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

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 ($\eta_{flare,h}$) will be:

- 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:

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

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 $PE_{flare,}$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 emissions of methane from the SWDS and emission reductions of the proposed project activity in the CDM-PDD. This parameter 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 activity

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 3 of 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"*. 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.

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

Table 7: 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 Natal Landfill Gas to Energy Project 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*".

So, as the Natal Landfill Gas to Energy Project 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

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

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:

$$F_{CH4,hist,y} = \frac{F_{CH4,BL,x-1}}{F_{CH4,x-1}} \cdot F_{CH4,PJ,y} \tag{17}$$

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:

$$F_{CH4,BL,x-1} = MD_{BL} \cdot F_{CH4,x-1} \tag{18}$$

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.

As per this study, a collection efficiency of 75% was attributed to the passive systems, what the authors acknoledge to be a conservative approach, not reflecting the reality of existent passive systems

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[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.

commonly used in Brazil, and the MD_{BL} for the landfill of Natal was 0.0007 and weighted average MD_{BL} for all landfills analysed was 0.0040 or, respectively, 0.07% and 0.40% (Table 20, in Annex 3). Regarding that the use of the weighted average MD_{BL} from the cited study is more representative of a real situation in the whole country and in conservative manner, for Natal Landfill Gas to Energy Project a methane destruction efficiency of 1.00% will be used for estimating the $F_{CH4,BL,x-1}$.

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

$$F_{CH4,BL,x-1} = 1.00\% \ . \ F_{CH4,x-1} \qquad \textbf{(19)}$$

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

$$F_{CH4,hist,y} = \frac{1.00\% \ . \ F_{CH4,x-1} \ .}{F_{CH4,x-1}} F_{CH4,PJ,y} \qquad \textbf{(20)}$$

Or

$$F_{CH4,hist,y} = 1.00\% \ . \ F_{CH4,PJ,y} \qquad \textbf{(21)}$$

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:

$$F_{CH4,BL,y} = 1.00\% \ . \ F_{CH4,PJ,y} \qquad \textbf{(22)}$$

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

According to the methodology, the baseline emissions associated with electricity generation in year *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 OM is the emission factor that refers to the group of existing power plants whose current electricity generation would be affected by the proposed CDM project activity. The BM is the emission factor that refers to the group of prospective power plants whose construction and future operation would be affected by the proposed CDM 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.

This tool involves the following six steps:

STEP 1. Identify the relevant electricity systems;
STEP 2. Choose whether to include off-grid power plants in the project electricity system (optional);
STEP 3. Select a method to determine the operating margin (OM);
STEP 4. Calculate the operating margin emission factor according to the selected method;
STEP 5. Calculate the build margin (BM) emission factor;
STEP 6. Calculate the combined margin (CM) emissions factor.

STEP 1. Identify the relevant electricity systems

For determining the electricity emission factors, a project electricity system is defined by the spatial extent of the power plants that are physically connected through transmission and distribution lines to the project activity (e.g. the renewable power plant location or the consumers where electricity is being saved) and that can be dispatched without significant transmission constraints.

According to the tool, if the DNA of the host country has published a delineation of the project electricity system and connected electricity systems, these delineations should be used. The Brazilian

DNA, *Comissão Interministerial de Mudança Global do Clima – CIMGC*, defined through its Resolução nº 8[15] the use a single interconnected electric system for CDM project activities applying the tool.
STEP 2. Choose whether to include off-grid power plants in the project electricity system (optional)
This step is applied by the Brazilian DNA, *CIMGC*.

As Option I is chosen, the *CIMGC* includes only the grid power plants in the calculation.

STEP 3. Select a method to determine the operating margin (OM)
This step is applied by the Brazilian DNA, *CIMGC*.

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

(a) Simple OM; or
(b) Simple adjusted OM; or
(c) Dispatch data analysis OM; or
(d) Average OM.

The *CIMGC* calculates the OM based on method c) Dispatched data analysis OM.

For the dispatch data analysis OM, it is necessary to use the year in which the project activity displaces grid electricity and update the emission factor annually during monitoring.

STEP 4. Calculate the operating margin emission factor according to the selected method
This step is applied by the Brazilian DNA, *CIMGC*.

The dispatch data analysis OM emission factor ($EF_{grid,OM-DD,y}$) is determined based on the grid power units that are actually dispatched at the margin during each hour *h* where the project is displacing grid electricity. This approach is not applicable to historical data and, thus, requires annual monitoring of $EF_{grid,OM-DD,y}$.

The emission factor is calculated as follows:

$$EF_{grid,OM-DD,h} = \frac{\sum_h EG_{PJ,h} \times EF_{EL,DD,h}}{EG_{PJ,y}} \qquad \textbf{(24)}$$

Where:
$EF_{grid,OM-DD,h}$ = Dispatch data analysis operating margin CO_2 emission factor in year *y* (tCO_2/MWh)
$EG_{PJ,h}$ = Electricity displaced by the project activity in hour *h* of year *y* (MWh)
$EF_{EL,DD,h}$ = CO_2 emission factor for grid power units in the top of the dispatch order in hour *h* in year *y* (tCO_2/MWh)
$EG_{PJ,y}$ = Total electricity displaced by the project activity in year *y* (MWh)

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[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 on 02/09/2011.

h = Hours in year *y* in which the project activity is displacing grid electricity
y = Year in which the project activity is displacing grid electricity

STEP 5. Calculate the build margin (BM) emission factor
The BM emission factor is calculated by the Brazilian DNA, *CIMGC*.

In terms of vintage of data, project participants can choose between one of the following two options:

Option 1: For the first crediting period, calculate the build margin emission factor *ex ante* based on the most recent information available on units already built for sample group *m* at the time of CDM-PDD submission to the DOE for validation. For the second crediting period, the build margin emission factor should be updated based on the most recent information available on units already built at the time of submission of the request for renewal of the crediting period to the DOE. For the third crediting period, the build margin emission factor calculated for the second crediting period should be used. This option does not require monitoring the emission factor during the crediting period.

Option 2: For the first crediting period, the build margin emission factor shall be updated annually, *ex post*, including those units built up to the year of registration of the project activity or, if information up to the year of registration is not yet available, including those units built up to the latest year for which information is available. For the second crediting period, the build margin emissions factor shall be calculated *ex ante*, as described in Option 1 above. For the third crediting period, the build margin emission factor calculated for the second crediting period should be used.

The **Option 2** has been chosen for this Project.

STEP 6. Calculate the combined margin (CM) emissions factor
The calculation of the combined margin (CM) emission factor ($EF_{grid,CM,y}$) is based on one of the following methods:

(a) Weighted average CM; or

(b) Simplified CM.

The weighted average CM method (option A) should be used as the preferred option and has been chosen for this Project.

The combined margin emissions factor will be calculated as follows:

$$EF_{grid,CM,y} = EF_{grid,OM,y} \times w_{OM} + EF_{grid,BM,y} \times w_{BM} \qquad \textbf{(25)}$$

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

According with the tool, values adopted for w_{OM} and w_{BM} were equal to 0.5 for each one during the 1^{st} crediting period.

Project Emissions

Project emissions are calculated as follows:

$$PE_y = PE_{EC,y} + PE_{FC,y} \qquad \textbf{(26)}$$

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 $PE_{FC,y} = 0$.

$PE_{EC,y}$ is determined using the *"Tool to calculate baseline, project and/or leakage emissions from electricity consumption"*.

*Determination of $PE_{EC,y}$ in equation **(26)** - Application of "Tool to calculate baseline, project and/or leakage emissions from electricity consumption"*

The tool is applicable because the "Scenario A: Electricity consumption from the grid." applies to the sources of electricity for this Project.

The general formula is:

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

Where:

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

$EC_{PJ,\ j,\ y}$ = Quantity of electricity consumed by the project electricity consumption source *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*. Project 20% default value has been used

j = Sources of electricity consumption in the project

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 needs to be accounted.

Emission Reductions

Emission Reductions will be calculated according with the equation below:

$$ER_y = BE_y - PE_y \tag{28}$$

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 that are available at validation:

Version 12 of ACM0001

Data / Parameter:	**OX_{top_layer}**
Data unit:	Dimensionless
Description:	Fraction of methane that would be oxidized in the top layer of the SWDS in the baseline
Source of data used:	Consistent with how oxidation is accounted for in the methodological tool *"Emission from solid waste disposal sites"*
Value applied:	0
Justification of the choice of data or description of measurement methods and procedures actually applied :	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.
Any comment:	Applicable to Step A of *ACM0001* version 12.

Data / Parameter:	**$F_{CH4,hist,y}$**
Data unit:	tCH_4 / yr
Description:	Historical amount of methane in the LFG which is captured and destroyed
Source of data used:	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 applied:	**$F_{CH4,hist,y}$ = 1.00% * $F_{CH4,PJ,y}$** Calculations are shown in the section B. The $F_{CH4,hist,y}$ value for each year is shown in the table:

Year	$F_{CH4,hist,y}$ [tCH_4/yr]
2013	61
2014	63
2015	66
2016	71

<table>
<tr><td></td><td><table><tr><td>2017</td><td>73</td></tr><tr><td>2018</td><td>75</td></tr><tr><td>2019</td><td>77</td></tr><tr><td>2020</td><td>80</td></tr><tr><td>2021</td><td>82</td></tr><tr><td>2022</td><td>77</td></tr></table>Obs.: 2022 refers to 11 months.</td></tr>
<tr><td>Justification of the choice of data or description of measurement methods and procedures actually applied:</td><td>Calculated as per the version 12 of <i>ACM0001</i> 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 <i>ACM0001</i> in order to calculate the $F_{CH4,BL,y}$.</td></tr>
<tr><td>Any comment:</td><td>Applicable to Case 3 of Step A.2 of <i>ACM0001</i> version 12.</td></tr>
</table>

Data / Parameter:	**GWP_{CH4}**
Data unit:	tCO_2e/tCH_4
Description:	Global Warming Potential of Methane
Source of data used:	2006 IPCC Guidelines for National Greenhouse Gas Inventories
Value applied:	21
Justification of the choice of data or description of measurement methods and procedures actually applied :	21 for the first commitment period. Shall be updated according to any future COP/MOP decisions.
Any comment:	-

Data / Parameter:	**η_{PJ}**
Data unit:	Dimensionless
Description:	Efficiency of the LFG capture system that will be installed in the project activity
Source of data used:	USEPA[16]
Value applied:	85%
Justification of the choice of data or description of measurement methods and procedures actually applied :	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.
Any comment:	Applicable to Step A.1.1 of *ACM0001* version 12.

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

Data / Parameter:	**$BE_{CH4,SWDS,y}$**
Data unit:	tCO_2e
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 used:	Calculated as per the Version 6.0.1 of the methodological tool *Emissions from solid waste disposal site.*
Value applied:	**Year** – **$BE_{CH4, SWDS}$ (tCO_2e)** **2013** – 159,689 **2014** – 167,248 **2015** – 174,384 **2016** – 181,216 **2017** – 187,829 **2018** – 194,285 **2019** – 200,633 **2020** – 206,909 **2021** – 213,142 **2022** – 219,353
Justification of the choice of data or description of measurement methods and procedures actually applied :	As per the version 6.0.1 of the methodological tool *Emissions from solid waste disposal site.*
Any comment:	Used for ex-ante estimation of the amount of methane that would have been destroyed/combusted during the year.

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

Data / Parameter:	**R_u**
Data unit:	$Pa.m^3/kmol.K$
Description:	Universal ideal gases constant
Source of data used:	"*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 applied:	8,314.472
Justification of the choice of data or description of measurement methods and procedures actually applied :	Physical constant.
Any comment:	-

Data / Parameter:	**MM_i**

<table>
<tr><td>Data unit:</td><td>kg/kmol</td></tr>
<tr><td>Description:</td><td>Molecular mass of greenhouse gas *i*</td></tr>
<tr><td>Source of data used:</td><td>“*Tool to determine the mass flow of a greenhouse gas in a gaseous stream*” version 02.0.0</td></tr>
<tr><td>Value applied:</td><td>
<table>
<tr><th>Compound (*i*)</th><th>Structure</th><th>Molecular mass (kg / kmol)</th></tr>
<tr><td>Carbon dioxide</td><td>CO_2</td><td>44.01</td></tr>
<tr><td>Methane</td><td>CH_4</td><td>16.04</td></tr>
<tr><td>Nitrous oxide</td><td>N_2O</td><td>44.02</td></tr>
<tr><td>Sulphur hexafluoride</td><td>SF_6</td><td>146.06</td></tr>
<tr><td>Perfluoromethane</td><td>CF_4</td><td>88.00</td></tr>
<tr><td>Perfluoroethane</td><td>C_2F_6</td><td>138.01</td></tr>
<tr><td>Perfluoropropane</td><td>C_3F_8</td><td>188.02</td></tr>
<tr><td>Perfluorobutane</td><td>C_4F_{10}</td><td>238.03</td></tr>
<tr><td>Perfluorocyclobutane</td><td>$c\text{-}C_4F_8$</td><td>200.03</td></tr>
<tr><td>Perfluoropentane</td><td>C_5F_{12}</td><td>288.03</td></tr>
<tr><td>perfluorohexano</td><td>C_6F_{14}</td><td>338.04</td></tr>
</table>
</td></tr>
<tr><td>Justification of the choice of data or description of measurement methods and procedures actually applied :</td><td>Physical constant.</td></tr>
<tr><td>Any comment:</td><td>For this Project, only CH_4 is analyzed.</td></tr>
</table>

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

Data / Parameter:	$\rho_{CH4,n}$
Data unit:	kg/m^3
Description:	Density of methane gas at normal conditions
Source of data used:	*Tool to determine project emissions from flaring gases containing methane*
Value applied:	0.716
Justification of the choice of data or description of measurement methods and procedures actually applied :	Density of methane gas at 0°C and 1,013 bar.
Any comment:	-

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

Data / Parameter:	$\varphi_{default}$
Data unit:	-
Description:	Default value for the model correction factor to account for model uncertainties
Source of data used:	-
Value applied:	0.75

Justification of the choice of data or description of measurement methods and procedures actually applied :	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.
Any comment:	Applicable to Option 1 in the procedure “Determining the model correction factor (φ_y)” of the tool.

Data / Parameter:	**OX**
Data unit:	-
Description:	Oxidation factor (reflecting the amount of methane from SWDS that is oxidized in the soil or other material covering the waste)
Source of data used:	Based on an extensive review of published literature on this subject, including the 2006 IPCC Guidelines for National Greenhouse Gas
Value applied:	0.1
Justification of the choice of data or description of measurement methods and procedures actually applied :	Default value as per the methodological tool *Emission from solid waste disposal site*.
Any 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**
Data unit:	-
Description:	Fraction of methane in the SWDS gas (volume fraction)
Source of data used:	IPCC 2006 Guidelines for National Greenhouse Gas Inventories
Value applied:	0.5
Justification of the choice of data or description of measurement methods and procedures actually applied :	Default value as per the tool “*Emission from solid waste disposal site*”.
Any comment:	Upon degradation, organic material is converted to a mixture of methane and carbon dioxide.

Data / Parameter:	**$DOC_{f,default}$**
Data unit:	Weight fraction
Description:	Default value for the fraction of degradable organic carbon (DOC) in MSW that

	decomposes in the SWDS
Source of data used:	IPCC 2006 Guidelines for National Greenhouse Gas Inventories
Value applied:	0.5
Justification of the choice of data or description of measurement methods and procedures actually applied :	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.
Any comment:	-

Data / Parameter:	**$MCF_{default}$**
Data unit:	-
Description:	Methane correction factor
Source of data used:	2006 IPCC Guidelines for National Greenhouse Gas Inventories
Value applied:	1.0
Justification of the choice of data or description of measurement methods and procedures actually applied :	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**.
Any comment:	The methane correction factor (MCF) accounts for the fact that unmanaged SWDS produce less methane from a given amount of waste than managed SWDS, because a larger fraction of waste decomposes aerobically in the top layers of unmanaged SWDS. 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:	**DOC_j**
Data unit:	-
Description:	Fraction of degradable organic carbon (by weight) in the waste type *j*
Source of data used:	IPCC 2006 Guidelines for National Greenhouse Gas Inventories (adapted from Volume 5, Tables 2.4 and 2.5)
Value applied:	See table below
Justification of the choice of data or	As per version 06.0.1 of methodological tool *Emission from solid waste disposal site*.

DOC_j (% wet waste)	**Waste type *j***
43	Wood and wood products
40	Pulp, paper and cardboard
15	Food, food waste, beverages and tobacco
24	Textiles
20	Garden, yard and park waste
0	Glass, plastic, metal, other inert waste

description of measurement methods and procedures actually applied :	
Any 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.

<table>
<tr><th>Data / Parameter:</th><th>k_j</th></tr>
<tr><td>Data unit:</td><td>-</td></tr>
<tr><td>Description:</td><td>Decay rate for the waste type <i>j</i></td></tr>
<tr><td>Source of data used:</td><td>2006 IPCC Guidelines for National Greenhouse Gas Inventories (adapted from Volume 5, Table 3.3)</td></tr>
<tr><td>Value applied:</td><td>
<table>
<tr><th colspan="2">Waste type <i>j</i></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>
</td></tr>
<tr><td>Justification of the choice of data or description of measurement methods and procedures actually applied :</td><td>Those values were adopted considering the following data:

$MAT_{historical}$ = 26.3ºC. (data from the landfill meteorological station);
$MAP_{historical}$ = 1,080.33 (data from the landfill meteorological station)
</td></tr>
<tr><td>Any comment:</td><td>No value of PET was applied once this parameter is only required when the MAT is below 20^{o}C.</td></tr>
</table>

Data / Parameter:	**f_y**
Data 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 used:	*ACM0001* (version 12.0.0)
Value applied:	0
Justification of the choice of data or	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

description of measurement methods and procedures actually applied :	accounted for in equation 2 of the methodology (and equation 3 of this project).
Any comment:	Estimated once for application A of methodological tool.

Data / Parameter:	**W_x**
Data unit:	tons
Description:	Total amount of waste disposed in a SWDS in year *x*
Source of data used:	Official data from landfill's management
Value applied:	see table below
Justification of the choice of data or description of measurement methods and procedures actually applied :	Data used are the official weight data stated from the landfill's management.
Any comment:	Estimated once for application A of methodological tool.

Years	**Waste to Landfill [t/y]**	**Years**	**Waste to Landfill [t/y]**	**Years**	**Waste to Landfill [t/y]**
2004	108,607	**2011**	341,093	**2018**	396,403
2005	271,955	**2012**	348,495	**2019**	405,005
2006	298,264	**2013**	356,057	**2020**	413,793
2007	304,765	**2014**	363,784	**2021**	422,773
2008	306,575	**2015**	371,678	**2022**	431,947
2009	327,287	**2016**	379,743	**2023**	441,320
2010	333,849	**2017**	387,983	**2024**	225,448

Data / Parameter:	**pn,j,x**
Data unit:	-
Description:	Weight fraction of the waste type *j* in deposited waste
Source of data used:	Official data from landfill's management
Value applied:	see table below

Waste type j	**Waste composition (%)**
Wood and wood products	0.53%
Pulp, paper and cardboard (other than	9.46%
Food, food waste, beverages and tobacco (other than sludge)	42.71%
Textiles	2.13%

Garden, yard and park waste	10.53%
Glass, plastic, metal, other inert waste	34.65%
TOTAL	100.0%

Justification of the choice of data or description of measurement methods and procedures actually applied :	Data used are the official data stated from the landfill's management.
Any comment:	This parameter is not needed to be monitored for application A of methodological tool.

Data / Parameter:	**z**
Data unit:	-
Description:	Number of samples collected during the year x
Source of data used:	Official data from landfill's management
Value applied:	10
Justification of the choice of data or description of measurement methods and procedures actually applied :	Number of samples was determined in the gravimetric research held by landfill's management from 2011, October 13th to 15th.
Any comment:	This parameter is not needed to be monitored for application A of methodological tool.

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

Regardless the crediting period starts in 2012, the landfill gas collection, flaring and electricity generation system is foreseen to start operating in 01/01/2013. Therefore, all calculation of emission reduction will be demonstrated from 2013 on, as no emission reduction will be generated in 2012.

LFG Generation

Applying the tool *Emissions from solid waste disposal sites*, the Table 8 resumes the calculation made over the 10 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 8: 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)**
2013	159,689	21	0.000716	0.50	21,250,859

2014	167,248	21	0.000716	0.50	22,256,768
2015	174,384	21	0.000716	0.50	23,206,422
2016	181,216	21	0.000716	0.50	24,115,549
2017	187,829	21	0.000716	0.50	24,995,539
2018	194,285	21	0.000716	0.50	25,854,781
2019	200,633	21	0.000716	0.50	26,699,576
2020	206,909	21	0.000716	0.50	27,534,755
2021	213,142	21	0.000716	0.50	28,364,105
2022	219,353	21	0.000716	0.50	29,190,665

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 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 performance of other similar projects operated by Asja Group.

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 by the fraction of methane in it, the calorific potential of methane and 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 9: Project Emissions from Flaring.

$PE_{flare,y} = \Sigma TM_{RG,h} * (1 - \eta_{flare,h}) * GWP_{CH4} / 1000$ (Eq.10)		**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**
$PE_{flare,y}$	Project emissions from flaring of the residual gas stream (tCO_2e) determined following the procedure described in the *Version 01 of the "Tool to determine project emissions from flaring gases containing methane"*	4,037	4,660	5,249	1,245	1,790	2,323	2,846	3,364	3,878	4,025
$\Sigma TM_{RG,h}$	Total mass flow rate in the residual gas (kg)	1,922,184	2,219,058	2,499,330	592,849	852,560	1,106,148	1,355,473	1,601,959	1,846,725	1,916,446
$\eta_{flare,h}$	Flare combustion efficiency	0.90	0.90	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	21	21

Table 10: 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)		2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
$F_{CH4,flared,y}$	Amount of methane in the LFG which is destroyed by flaring in the year (tCH4)	1,730	1,997	2,249	534	767	996	1,220	1,442	1,662	1,725
$V_{CH4,flare,db}$	Volumetric flow of gaseous stream during the year on dry basis (m^3)	5,371,744	6,201,388	6,984,637	1,656,777	2,382,568	3,091,246	3,788,009	4,476,841	5,160,866	5,355,707
$v_{CH4,db}$	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	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	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"*	4,037	4,660	5,249	1,245	1,790	2,323	2,846	3,364	3,878	4,025
GWP_{CH4}	Global Warming Potential value for methane for the first commitment period (tCO_2e/tCH_4)	21	21	21	21	21	21	21	21	21	21

Table 11: Amount of Methane Used for Electricity Generation.

$F_{CH4,EL,y} = (V_{CH4,EL,db} * v_{CH4,db} * \rho_{CH4})$ (Eq. 6 and 7)		**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**
$F_{CH4,EL,y}$	Amount of methane in the LFG which is used for electricity generation in the year (tCH4)	4,350	4,350	4,350	6,524	6,524	6,524	6,524	6,524	6,524	5,981
$V_{CH4,EL,db}$	Volumetric flow of gaseous stream during the year on dry basis (m^3)	12,155,363	12,155,363	12,155,363	18,233,045	18,233,045	18,233,045	18,233,045	18,233,045	18,233,045	16,713,625
$v_{CH4,db}$	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	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	0.000716	0.000716

Table 12: 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)		2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
$F_{CH4,PJ,y}$	Amount of methane in the LFG which is flared and/or used in the project activity in the year (tCH_4)	6,080	6,347	6,599	7,058	7,292	7,520	7,744	7,966	8,186	7,705
$F_{CH4,flared,y}$	Amount of methane in the LFG which is destroyed by flaring in the year (tCH4)	1,730	1,997	2,249	534	767	996	1,220	1,442	1,662	1,725
$F_{CH4,EL,y}$	Amount of methane in the LFG which is used for electricity generation in the year (tCH4)	4,350	4,350	4,350	6,524	6,524	6,524	6,524	6,524	6,524	5,981

Table 13: Amount of Methane Flared in the Baseline.

$F_{CH4,BL,y} = 0.01 * F_{CH4,PJ,y}$ (Eq. 22)		2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
$F_{CH4,BL,y}$	Amount of methane that would have been destroyed/combusted during the year y in the absence of the Project (tCH_4)	61	63	66	71	73	75	77	80	82	77
$F_{CH4,PJ,y}$	Amount of methane in the LFG which is flared and/or used in the project activity in the year (tCH_4)	6,080	6,347	6,599	7,058	7,292	7,520	7,744	7,966	8,186	7,705

Table 14: Baseline Emissions of Methane from the SWDS.

$BE_{CH4,y}$ = $(1 – OX_{top\_layer}) * (F_{CH4,PJ,y} - F_{CH4,BL,y}) * GWP_{CH4}$ (Eq. 3)		2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
$BE_{CH4,y}$	Baseline emissions of methane from the SWDS in the year *y* (tCO_2e)	126,394	131,949	137,193	146,735	151,594	156,339	161,004	165,616	170,196	160,197
OX_{top_layer}	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	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)	6,080	6,347	6,599	7,058	7,292	7,520	7,744	7,966	8,186	7,705
$F_{CH4,BL,y}$	Amount of methane that would have been destroyed/combusted during the year y in the absence of the Project (tCH_4)	61	63	66	71	73	75	77	80	82	77
GWP_{CH4}	Global Warming Potential value for methane for the first commitment period (tCO_2e/tCH_4)	21	21	21	21	21	21	21	21	21	21

Table 15: Baseline Emission Associated with Electricity Generation.

$BE_{EC,y}$ = $EC_{BL,k,y} * EF_{EL,k,y} *(1+TDL_{k,y})$ (Eq. 23)		2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
$BE_{EC,y}$	Baseline emissions associated with electricity generation in the project activity in the year *y* (tCO_2e)	8,424	8,424	8,424	12,636	12,636	12,636	12,636	12,636	12,636	11,583
$EC_{BL,k,y}$	Net amount of electricity generation in the project activity in the year (MWh)	22,680	22,680	22,680	34,020	34,020	34,020	34,020	34,020	34,020	31,185
$EF_{EL,k,y}$	Emission factor for electricity from the grid (tCO_2e/MWh)	0.3095	0.3095	0.3095	0.3095	0.3095	0.3095	0.3095	0.3095	0.3095	0.3095
$TDL_{k,y}$	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	0.20	0.20

Table 16. Project Emission from Electricity Consumption.

$PE_{EC,y}$ = $EC_{PJ,j,y}$ * $EF_{EL,j,y}$ *(1+$TDL_{j,y}$) (Eq. 27)		**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**
$PE_{EC,y}$	Project emissions from electricity consumption by the project activity during the year *y* (tCO_2e)	544	544	544	709	709	709	709	709	709	650
$EC_{PJ,j,y}$	Quantity of electricity consumed by the project activity consumption source *j* in the year *y* (MWh)	1,466	1,466	1,466	1,910	1,910	1,910	1,910	1,910	1,910	1,751
$EF_{EL,j,y}$	Emission factor for electricity from the grid (tCO_2e/MWh)	0.3095	0.3095	0.3095	0.3095	0.3095	0.3095	0.3095	0.3095	0.3095	0.3095
$TDL_{j,y}$	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	0.20	0.20

Table 17: Ex-ante Estimation of Emission Reductions.

$ER_y = BE_y - PE_y = (BE_{CH4,y} + BE_{EC,y}) - PE_{EC,y}$		2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
ER_y	Emissions reductions (tCO_2e)	134,274	139,829	145,073	158,662	163,521	168,266	172,931	177,543	182,123	171,130
$BE_{CH4,y}$	Baseline emissions of methane in the SWDS in the year *y* (tCO_2e)	126,394	131,949	137,193	146,735	151,594	156,339	161,004	165,616	170,196	160,197
$BE_{EC,y}$	Baseline emissions associated with electricity generation in the project activity in the year *y* (tCO_2e)	8,424	8,424	8,424	12,636	12,636	12,636	12,636	12,636	12,636	11,583
$PE_{EC,y}$	Project emissions from electricity consumption by the project activity during the year *y* (tCO_2e)	544	544	544	709	709	709	709	709	709	650

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

Year	Estimations of project activity emissions (tonnes of CO_2e)	Estimations of baseline emissions (tonnes of CO_2e)	Estimation of leakage (tonnes of CO_2e)	Estimation of overall emission reductions (tonnes of CO_2e)
2012 (from 01/12/2012)	0	0	0	0
2013	544	134,818	0	134,274
2014	544	140,373	0	139,829
2015	544	145,617	0	145,073
2016	709	159,371	0	158,662
2017	709	164,230	0	163,521
2018	709	168,975	0	168,266
2019	709	173,640	0	172,931
2020	709	178,252	0	177,543
2021	709	182,832	0	182,123
2022 (until 30/11/2022)	650	171,780	0	171,130
Total (tonnes of CO_2e)	**6,536**	**1,619,888**	**0**	**1,613,352**

Project activity emissions were estimated as the multiplication of the amount of electricity imported from the grid by the carbon emission factor for electricity from the grid, as can be seen at the Table 16 above.

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

B.7.1 Data and parameters monitored:

Version 12 of *ACM0001*

Data / Parameter:	$F_{CH4,BL,R,y}$
Data unit:	tCH_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 to be used:	Information of the host country's regulatory requirements relating to LFG, contractual requirements, or requirements to address safety and odour concerns
Value of data applied for the purpose of calculating expected emission reductions in section B.5	0
Description of measurement methods and procedures to be applied:	Monitored annually. $F_{CH4,BL,R,y}$ will be compared with the $F_{CH4,hist,y}$ as required by the version 12 of *ACM0001* in order to calculate the $F_{CH4,BL,y}$.
QA/QC procedures to be applied:	Internal audits are going to be performed in order to ensure correct monitoring of this parameter.

Any comment:	Applicable to Case 2 of Step A.2 of *ACM0001* version 12.

Data / Parameter:	**$\rho_{reg,y}$**
Data unit:	Dimensionless
Description:	Fraction of LFG that is required to be flared due to a requirement in year *y*
Source of data to be used:	Information of the host country's regulatory requirements relating to LFG, contractual requirements, or requirements to address safety and odour concerns
Value of data applied for the purpose of calculating expected emission reductions in section B.5	0
Description of measurement methods and procedures to be applied:	Monitored annually.
QA/QC procedures to be applied:	Internal audits are going to be performed in order to ensure correct monitoring of this parameter.
Any comment:	Applicable to Case 2 of Step A.2 of *ACM0001* version 12.

Data / Parameter:	**$PE_{flare,y}$**
Data unit:	tCO_2e
Description:	Project emissions from flaring of the residual gas stream in year *y*
Source of data to be used:	Calculated as per the *"Tool to determine project emissions from flaring gases containing methane"*
Value of data applied for the purpose of calculating expected emission reductions in section B.5	For the calculation see in Section B.6. In the table, the values for each year. **Year** | **$PE_{flare,y}$ [tCO_2e/y]** **2013** | 4,037 **2014** | 4,660 **2015** | 5,249 **2016** | 1,245 **2017** | 1,790 **2018** | 2,323 **2019** | 2,846 **2020** | 3,364 **2021** | 3,878 **2022** | 4,025 Obs.: 2022 refers to 11 months.
Description of measurement methods and procedures to be applied:	Project emissions from flaring will be calculated according the *"Tool to determine project emissions from flaring gases containing Methane"*, with flare efficiency $\eta_{flare,h}$.
QA/QC procedures to be applied:	Internal Audits are going to be performed in order to ensure correct monitoring of this parameter

Any comment:	Archive data will be kept minimum two years after the end of the crediting period.

Data / Parameter:	**Operation of the energy plant**
Data unit:	hours
Description:	Operation of the energy plant
Source of data to be used:	Engine's working hours counter meters
Value of data applied for the purpose of calculating expected emission reductions in section B.5	8,100 h/year (conservative) The working hour's estimation is done according to previous plants built by Asja Group.
Description of measurement methods and procedures to be applied:	Measured by hours counter meters, aggregated yearly, at least.
QA/QC procedures to be applied:	According to the engine manufacturer specifications.
Any comment:	This is monitored to ensure methane destruction is claimed for methane used in electricity plant when it is operational.

Data / Parameter:	**$PE_{EC,y}$**
Data unit:	tCO_2
Description:	Project emissions from electricity consumption by the project activity during the year y
Source of data to be used:	Calculated as per the "*Tool to calculate baseline, project and/or leakage emissions from electricity consumption*", as demonstrated in the section B.6.4.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	The $PE_{EC,y}$ estimated value, for each year, is shown in the table: Obs.: 2022 refers to 11 months.
Description of measurement methods	Project emissions from electricity consumption will be calculated according to the *"Tool to calculate baseline, project and/or leakage emissions from*

Years	**Project emissions from electricity consumption by the project activity [tCO2e]**
2013	544
2014	544
2015	544
2016	709
2017	709
2018	709
2019	709
2020	709
2021	709
2022	650

and procedures to be applied:	*electricity consumption”,* calculating the combined margin emission factor of the applicable electricity system, using the procedures in the *“Tool to calculate the emission factor for an electricity system”* ($EF_{EL,j/k/l,y} = EF_{grid,CM,y}$)
QA/QC procedures to be applied:	Internal Audits are going to be performed in order to ensure correct monitoring of this parameter.
Any 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:	$\mathbf{V_{t,db}}$
Data unit:	m^3 dry gas/h
Description:	Volumetric flow of the gaseous stream in time interval *t* on a dry basis
Source of data to be used:	Flow meter
Value of data applied for the purpose of calculating expected emission reductions in section B.5	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 $F_{CH4,EL,y}$.
Description of measurement methods and procedures to be applied:	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 section and delivered to the electricity generation 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): a) The moisture content of the gaseous stream is less or 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 hottest point of LFG pipeline, after the blowers.
QA/QC procedures to be applied:	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.
Any comment:	This parameter will be monitored in Option A of the tool.

Data / Parameter:	$\mathbf{v_{i,t,db}}$
Data 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 to be used:	Continuous gas analyser
Value of data applied for the purpose of calculating expected emission reductions in section B.5	For this Project, only CH_4 is analyzed. For flare, $\mathbf{v_{i,t,db} = fv_{CH4,RG,h}}$ = 50%.
Description of measurement methods and procedures to be applied:	Measured directly and continuously with a gas analyzer 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 or 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.
QA/QC procedures to be applied:	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.
Any comment:	Data will be archived electronically during the crediting period and two years after.

Data / Parameter:	$\mathbf{T_t}$
Data unit:	K
Description:	Temperature of the gaseous stream in time interval *t*
Source of data to be used:	Temperature sensor
Value of data applied for the purpose of calculating expected emission reductions in section B.5	-
Description of	Measured directly and continuously with temperature sensor to be installed at

measurement methods and procedures to be applied:	the hottest 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.
QA/QC procedures to be applied:	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.
Any 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:	$\mathbf{P_t}$
Data unit:	Pa
Description:	Pressure of the gaseous stream in time interval *t*
Source of data to be used:	-
Value of data applied for the purpose of calculating expected emission reductions in section B.5	-
Description of measurement methods and procedures to be applied:	-
QA/QC procedures to be applied:	-
Any comment:	As all parameters will be converted to normal conditions during the monitoring process, this parameter is then not needed to be monitored.

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

Data / Parameter:	$\mathbf{fv_{CH4,RG,h}}$
Data unit:	-
Description:	Volumetric fraction of methane in the residual gas on dry basis in the hour *h*
Source of data to be used:	Continuous gas analyser
Value of data applied for the purpose of calculating expected emission reductions in section B.5	$\mathbf{fv_{CH4,RG,h} = v_{i,t,db}}$ = 50%.
Description of measurement methods and procedures to be applied:	Measured directly and continuously with a gas analyzer 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°C for security purposes; it will be done through a temperature sensor to be installed at the hottest point of LFG pipeline, just after the blowers.
QA/QC procedures to be applied:	QA/QC procedures are planned for these data. The gas analyzer is subject to regular maintenance and testing regime to ensure accuracy according to manufacturer's specifications and calibration will be done at least every six months during the plant normal operation.
Any comment:	Data will be archived electronically during the crediting period and two years after.

Data / Parameter:	**$FV_{RG,h}$**
Data unit:	m^3/h
Description:	Volumetric flow rate of the residual gas in dry basis at normal conditions in the hour *h*
Source of data to be used:	Flow meter
Value of data applied for the purpose of calculating expected emission reductions in section B.5	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 $F_{CH4,EL,y}$.
Description of measurement methods and procedures to be applied:	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): a) The moisture content of the gaseous stream is less or 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.
QA/QC procedures to be applied:	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.
Any comment:	Data will be archived electronically during the crediting period and two years after

Data / Parameter:	T_{flare}
Data unit:	°C
Description:	Temperature in the exhaust gas of the enclosed flare(s)
Source of data to be used:	Type N thermocouple
Value of data applied for the purpose of calculating expected emission reductions in section B.5	T > 500 °C
Description of measurement methods and procedures to be applied:	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.
QA/QC procedures to be applied:	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.
Any comment:	Archive data will be kept minimum two years after the end of the crediting period.

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

Data / Parameter:	$EF_{grid,CM,y}$
Data unit:	tCO_2/MWh

Description:	Combined margin CO_2 emission factor for the project electricity system in the year *y*
Source of data to be used:	The data used to calculate the grid emission factor was taken from the Brazilian DNA.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	$\mathbf{EF_{grid,CM,2010}}$ = 0.3095 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]. $\mathbf{EF_{grid,CM,y} = EF_{EL,k,y} = EF_{EL,j,y}}$
Description of measurement methods and procedures to be applied:	Since *ex post* option has been chosen in the Operating Margin calculations applying the "*Tool to calculate the emission factor for an electricity system*", the 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 calculating the emission factor for year *y* is usually only available later than six months after the end of year *y*, alternatively the emission factor of the previous year (*y*-1) may be used. If the data is usually only available 18 months after the end of year *y*, the emission factor of the year proceeding the previous year (*y*-2) may be used. The same data vintage (*y*, *y*-1 or *y*-2) will be used throughout all crediting periods.
QA/QC procedures to be applied:	Internal Audits are going to be performed in order to ensure correct monitoring of this parameter.
Any comment:	-

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

Data / Parameter:	$\mathbf{EC_{BL,k,y}}$
Data unit:	MWh/yr
Description:	Net amount of electricity generated using LFG in the project activity in year *y*
Source of data to be used:	Electricity meter
Value of data applied for the purpose of calculating expected emission reductions in section B.5	The values calculated for each year for the Project are shown in section B and in the table below:

Year	$\mathbf{EC_{BL,k,y}}$ **(MWh)**
2013	22,680
2014	22,680
2015	22,680
2016	34,020
2017	34,020
2018	34,020
2019	34,020
2020	34,020

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[17] http://www.mct.gov.br (Accessed in 20/09/2011).

<table>
<tr><td></td><td><table><tr><td>2021</td><td>34,020</td></tr><tr><td>2022</td><td>31,185</td></tr></table>Obs.: 2022 refers to 11 months.</td></tr>
<tr><td>Description of measurement methods and procedures to be applied:</td><td>Required to estimate the baseline emission associated with electricity generation reductions. Data will be measured continuously with an electricity meter.</td></tr>
<tr><td>QA/QC procedures to be applied:</td><td>Electricity meter will be subject to regular maintenance (in accordance with stipulation of the meter supplier) 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.</td></tr>
<tr><td>Any comment:</td><td>Data will be archived electronically during the crediting period and two years after.</td></tr>
</table>

Data / Parameter:	$\mathbf{EF_{EL,k,y}}$
Data unit:	tCO_2/MWh
Description:	Emission factor for electricity generation for source *k* in year *y*
Source of data to be used:	The data used to calculate the grid emission factor was taken from the Brazilian DNA.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	Since baseline source of electricity is the grid, EF has been estimated using the "*Tool to calculate the emission factor for an electricity system*" and calculated to be equal to $EF_{EL,grid,2010} = 0.3095$. 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]. $\mathbf{EF_{EL,k,y} = EF_{grid,CM,y}}$
Description of measurement methods and procedures to be applied:	Required to evaluate CO_2 baseline emissions due to the electricity generation in the project activity; for this Project emissions factor will be updated annually during monitoring.
QA/QC procedures to be applied:	Internal Audits are going to be performed in order to ensure correct monitoring of this parameter.
Any comment:	-

Data / Parameter:	$\mathbf{TDL_{k,y}}$
Data unit:	-
Description:	Average technical transmission and distribution losses for providing electricity

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

	to source k in year *y*
Source of data to be used:	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 of data applied for the purpose of calculating expected emission reductions in section B.5	20% $\mathbf{TDL_{k,y} = TDL_{j,y}}$
Description of measurement methods and procedures to be applied:	Monitored annually. 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.
QA/QC procedures to be applied:	Internal Audits are going to be performed in order to ensure correct monitoring of this parameter.
Any comment:	Archive data will be kept minimum two years after the end of the crediting period.

<table>
<tr><td>Data / Parameter:</td><td>$\mathbf{EC_{PJ,j,y}}$</td></tr>
<tr><td>Data unit:</td><td>MWh/yr</td></tr>
<tr><td>Description:</td><td>Quantity of electricity consumed by the project electricity consumption source <i>j</i> in year <i>y</i></td></tr>
<tr><td>Source of data to be used:</td><td>Electricity meter</td></tr>
<tr><td>Value of data applied for the purpose of calculating expected emission reductions in section B.5</td><td>The estimated value, for each year, is shown in the table below. Calculations are shown in the section B.
<table>
<tr><th>Year</th><th>$\mathbf{EC_{PJ,j,y}}$ [MWh/y]</th></tr>
<tr><td>2013</td><td>1,466</td></tr>
<tr><td>2014</td><td>1,466</td></tr>
<tr><td>2015</td><td>1,466</td></tr>
<tr><td>2016</td><td>1,910</td></tr>
<tr><td>2017</td><td>1,910</td></tr>
<tr><td>2018</td><td>1,910</td></tr>
<tr><td>2019</td><td>1,910</td></tr>
<tr><td>2020</td><td>1,910</td></tr>
<tr><td>2021</td><td>1,910</td></tr>
<tr><td>2022</td><td>1,751</td></tr>
</table>
Obs.: 2022 refers to 11 months.</td></tr>
<tr><td>Description of measurement methods and procedures to be applied:</td><td>Required to evaluate CO_2 emissions due to the electricity 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</td></tr>
</table>

	administrator of the grid reports the values in monthly aggregations.
QA/QC procedures to be applied:	Electricity meter will be subject to regular maintenance (in accordance with stipulation of the meter supplier) and testing to ensure accuracy. 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 other similar project. Local administrator of electricity grid will be responsible for the maintenance of equipment.
Any comment:	Data will be archived electronically during the crediting period and two years after.

Data / Parameter:	**$TDL_{j,y}$**
Data unit:	-
Description:	Average technical transmission and distribution losses for providing electricity to source *j* in year *y*
Source of data to be used:	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 of data applied for the purpose of calculating expected emission reductions in section B.5	20% **$TDL_{j,y} = TDL_{k,y}$**
Description of measurement methods and procedures to be applied:	Monitored annually. 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.
QA/QC procedures to be applied:	Internal Audits are going to be performed in order to ensure correct monitoring of this parameter.
Any comment:	Archive data will be kept minimum two years after the end of the crediting period.

B.7.2. Description of the 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
- 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

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

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

Detailed information on the baseline study is available in the *Annex 3* of this PDD. Complete monitoring plan is described in the *Annex 4* 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 02/09/2011.

Contact information:
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SECTION C. Duration of the project activity / crediting period

C.1. Duration of the project activity:

C.1.1. Starting date of the project activity:

01/07/2012.
The starting date of the project activity corresponds to the Purchasing and acquisition of the first equipment and services.

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

16 years.
Expected operational lifetime of the project activity is defined by the electricity generation sets' lifetime, to be exhausted in 2028, regarding the possibility of renewal of the concession contract signed between Sereco S/A (project participant) and the municipality of Natal and the plot rental contract for the use of the land area where the landfill is built, both ending in 2024.

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

C.2.1. Renewable crediting period:

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

N/A, as Project Participants decided to adopt a fixed 10 years of crediting period.

C.2.1.2. Length of the first crediting period:

N/A, as Project Participants decided to adopt a fixed 10 years of crediting period.

C.2.2. Fixed crediting period:

C.2.2.1. Starting date:

01/12/2012 or Registration date.

C.2.2.2. Length:

10 years, equal to 120 months.

SECTION D. Environmental impacts

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

Natal Landfill was built according with all the specifications of environmental and sanitary engineering, constituting an adequate technological alternative to a final destination of domiciliary solid waste in the metropolitan area of Natal, which was indiscriminately disposed in rubbish dump.

The installation and operation of the landfill were submitted to an EIA/RIMA (Environmental Impact Assessment) which is mandatory by the law, described in the article 225 of the Brazilian Federal Constitution (Constituição Federal Brasileira), and both were approved by the responsible environmental agency IDEMA (Rio Grande do Norte's Institute to Economic Development and Environment).

Based on the results of the Assessment, the environmental licenses were granted to the Natal Landfill which is in accordance with federal, state and municipal legislation, the determination of the Environmental Ministry and the resolutions of the Brazilian Environment Council (CONAMA). The initial Operational License Nº 2006 – 006289/TEC/RLO – 0614 was emitted in February, 7th 2007 and has been renewed and replaced by the Operational License N° 2007 - 015408/TEC/RLO – 1662 (dated of 4th August, 2008), granted to SERECO S/A. permitting Braseco's Landfill activities. After that, the Operation License was renewed in 2009 (license Nº 2008-023922/TEC/RLO-1420) and in 2011 (license Nº 2010-038585/TEC/RLO-0233).

The proposed CDM Project will collect and destroy landfill gases produced by the landfill operation. It will reduce both global and local environmental effects of uncontrolled emissions, and besides, it will avoid new electricity generation plants based on fossil fuels to be connected to the national grid.

The activity of combusting LFG into enclosed flares and generating electricity through the landfill gas was presented in the EIA/RIMA that generated the current operational license as possibilities to be further studied in the future. According to IDEMA, in order to install and operate the flaring and electricity generation systems foreseen in the Project, a License of Alteration will be required. To obtain it the Project Participants shall simply submit the detailed project of the power plant, not being necessary to elaborate an additional EIA/RIMA.

Baseline scenario: the main global environmental concern over the LFG is the fact that it is a Greenhouse Gas. The LFG also contains more than 150 trace components that can cause other local and global environmental effects such as odour nuisances, stratospheric ozone layer depletion, and ground-level ozone creation, also related to the project activity.

Project activity: Through an appropriate management, the landfill gases will be captured and combusted in enclosed flares and electricity generation engines, removing the risk of toxic effects on the local community and environment, including phreatic layers, watercourse pollution and odour nuisances. Besides, there will be displacement of electricity generated from fossil fuel sources.

Thus, the installation of a set of wells designated for gas collection and consequent flaring and electricity generation will lead into a daily monitoring (as stated at the monitoring plan) and proper landfill operation and no significant adverse impacts are expected due to the project activity implementation.

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

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 IDEMA may identify.

SECTION E. Stakeholders' comments

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

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

- Resolution nº 1 of September 11, 2003;
- Resolution nº 2 of August 10, 2005;
- Resolution nº 3 of March 24, 2006;
- Resolution nº 4 of December 6, 2006;
- Resolution nº 5 of April 5, 2007;
- Resolution nº 6 of June 6, 2007;
- Resolution nº 7 of March 5, 2008;

- Resolution nº 8 of May 26, 2008;
- Resolution nº 9 of March 20, 2009; and
- Manual for Submitting CDM Projects Activities (version 2), of July 2, 2008.

All of them establish rules and procedures in order to obtain the letter of approval of the project.
In accordance to these procedures, project proponents performed the stakeholder consultation process in as described below.

Invitation letters were sent by mail with return receipt in 09/02/2011 in order to invite the following persons to submit comments on the Project.

Table 18: Invitees for local stakeholder consultation process

Name	Position	Institution
Severino Francisco Lima Júnior	Chairman	Association of recycle material collectors of Natal
Antônio Marcos de Abreu Peixoto	Mayor	City Hall of Ceará-Mirim
Ronaldo Venâcio Marques Rodrigues	Chairman of city concil	City Council of Ceará-Mirim
(not specified)	Secretary	Municipal Enrironmental Secretary
Manoel Onofre de Souza Neto	Prosecutor	State Attorney General of Rio Grande do Norte
Marcelo Saldanha Toscano	General Director	Economic development and environment institute of Rio Grande do Norte
Lauro Pinto Cardoso Neto	General Secretary	Federal Attorney General
Ester Neuhaus	Executive Manager	Brazilian NGO Forum and Social Movements for the Environment and Development

E.2. Summary of the comments received:

During the period of local stakeholder consultation, Project Proponents received the following answers:

- *Municipal Environmental Secretary* – by e-mail in March 15th 2011, declared its favorable opinion on the Project, which according to the Secretary will contribute to the local sustainability.

- *Federal Attorney General* – by letter March 25th 2011, declared it could not emmit opinion on this kind of project, since the Attorney is forbiden to provide consultance.

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

Project participants appreciated the comments received. No further action was done since neither negative comment nor suggestion of change was made.

Annex 1

CONTACT INFORMATION ON PARTICIPANTS IN THE PROJECT ACTIVITY

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Postcode/ZIP:	59056-100
Country:	Brazil
Telephone:	+55 84 3231 - 9068
FAX:	
E-Mail:	
URL:	
Represented by:	Mr. Henrique Muniz Dantas
Title:	Administrative Director
Salutation:	Mr.
Last name:	Muniz Dantas
Middle name:	
First name:	Henrique
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Represented by:	Enrico Maria Roveda
Title:	Managing Director
Salutation:	Mr.
Last name:	Roveda
Middle name:	
First name:	Enrico Maria
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Direct FAX:	
Direct tel:	
Personal e-mail:	em.roveda@aria-co2.com

Annex 2

INFORMATION REGARDING PUBLIC FUNDING

There are no public financing for the Project

Annex 3

BASELINE INFORMATION

Common Practice Analysis

Table 19: 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.

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

Table 20: 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. (Visited at June, 06th 2011)

Annex 4

MONITORING INFORMATION

Introduction

According to *ACM0001*, direct monitoring will be conducted on the LFG 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 is 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 Factor
- $TDL_{k/j,y}$ = 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.

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.

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 allows 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°C for more than 40 minutes during the hour considered.

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.

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/national grid's administrator. Maintenance of this equipment will be also local/national grid's administrator responsibility. Both amounts of electricity will be taken from official electricity bills emitted by the local administrator of the grid, unless it is possible to connect the electricity meter directly to the PLC.

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

Both project emissions from consumption of electricity and baseline emissions associated with electricity generation in the project activity are calculated based on the quantity of electricity consumed and generated (respectively), 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.

$TDL_{k/l,y}$ 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 based, 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 activity of the project, the following equipment will be installed. (Figure 7)

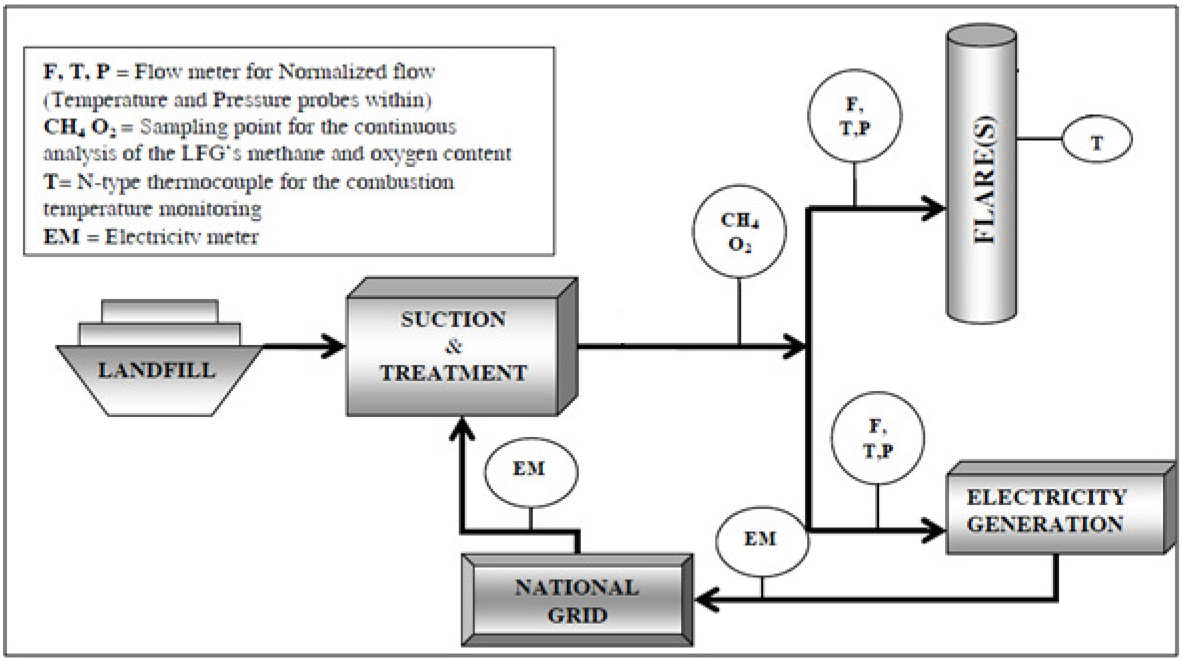

Figure 7: Monitoring points.

4 CALCULATION OF THE AMOUNT OF ERs

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

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 equipment

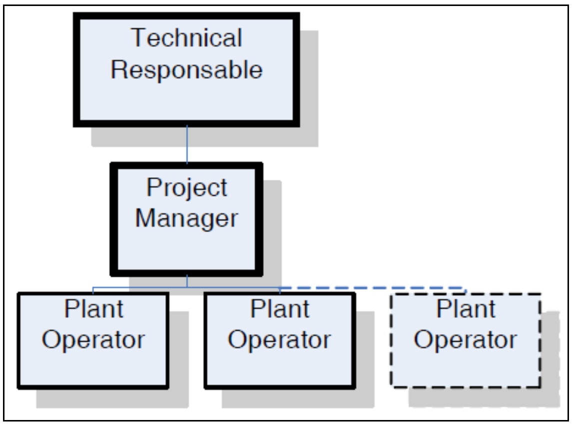

Figure 8: Organization Chart.

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.

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