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

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## SECTION A. General description of project activity

### A.1. Title of the project activity:

CGR Guatapara Landfill Project
Version 3
01/07/2011

### A.2. Description of the project activity:

The proposed project activity has the objective of capture and flare the biogas produced in the "Centro de Gerenciamento de Resíduos (CGR) de Guatapará", located in the municipal district of same name in the State of São Paulo, Brazil. The project activity includes two phases. The first phase aims to only capture and flare the LFG and the second phase will install a power generation facility that will use LFG to generate electricity. The installed capacity is expected change during the project lifetime.

The first phase of the project aims to replace the existing passive venting system with an active gas collection and flaring system. This will require an investment in a very efficient collection and flaring system, thus reducing the odour, safety destructing this flammable gas and reducing the adverse environmental impacts.

During the second phase, the project will install generators that will combust the LFG to produce electricity, using part of it for self consumption and part will be exported to the grid. The flare will be kept in operation, due to LFG excess or periods when electricity is not produced or other operational reasons. The LFG power plant is expected to have around 5.5 MW installed capacity once it is completely installed, but actual equipment to be installed may vary according to the equipment available in the market at the time of actual implementation of phase 2 of the Project.

The LFG collection system will consist of a grid collection system, centrifugal blower(s), and all other supporting mechanical and electrical subsystems and appurtenances necessary to collect the LFG. The power generation facility will be comprised of LFG engine generator sets of high performance standards. The engine-generator sets will be the primary equipment to combust the collected LFG once they are installed. A fraction of the collected LFG will be diverted to flares, which will be used to combust any gas in excess of the fuel demand for the engines, as well as a contingency backup.

The landfill began its operation on 01 August 2007, receiving up to 3,500 tonnes per day of household , commercial and industrial waste (Class II-A and II-B), according to License of Operation 52000232 valid up to 22/03/14. There is the possibility of increasing the waste disposal area, however this possibility will be analyzed in the future.

**Contribution of the Project Activity to Sustainable Development:**

With the implementation of the project activity, besides the emissions of greenhouse gases ($CH_4$) reduction there will also be contribution for the sustainable development through the improvement of the local environmental conditions (as for instance, the destruction of volatile compositions). During the operational phase, which will take place 24 hours/day, 7 days/week, there will be new jobs created locally for duties related to operations and maintenance, landscaping, plumbing, monitoring and security personnel. These people will be fully trained by CGR Guatapara on their duties and tasks.

## A.3. Project participants:

| Name of Party involved ((host) indicates a host Party) | Private and/or public entity(ies) project participants (as applicable) | Kindly indicate if the Party involved wishes to be considered as project participant (Yes/No) |
|---|---|---|
| Brazil (host) | CGR Guatapará – Centro de Gerenciamento de Resíduos Ltda. | No |
| (*) In accordance with the CDM modalities and procedures, at the time of making the CDM-PDD public at the stage of validation, a Party involved may or may not have provided its approval. At the time of requesting registration, the approval by the Party(ies) involved is required. | | |

## A.4. Technical description of the project activity:

### A.4.1. Location of the project activity:

#### A.4.1.1. Host Party(ies):

Brazil

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

São Paulo State

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

Guatapará City

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

CGR Guatapara is located aside the margins of the Highway SP-253 in the denominated place "Fazenda Figueira" in the domains of the municipal district of Guatapará, more precisely, in its northeast area. The access can be accomplished taking the Highway Deputed Cunha Bueno (SP-253), on the km 183, being reached the denominated place "Fazenda Figueira"

Geographical Coordinates: (Latitude: 21º23'45'' S and Longitude: 47º57'18'' W)[1]

[1] The information is in the environmental impact report of the CGR Guatapara landfill and the document will be given to DOE in validation visit.


**Figure 1 - Geographical position of Guatapara city, inside of São Paulo State**
(Source: http://www.ibge.gov.br/cidadesat/default.php)

**Figure 2 - Aerial view of CGR Guatapará Landfill before the beginning of the operation for residues disposition.**

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

Sectoral Scope: 13 (waste handling and disposal).

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

The implementation and operation of CGR Guatapara Landfill Project consist concisely in: soil impermeability, leachate drainage, gases drainage, pluvial waters drainage and compacting and constant covertures of the received residue.

**Soil impermeability**

The soil impermeability is made through layers of compacted clay and of geo-membrane of High Density Polyethylene (HDP). After applied the blanket of HDP is put on the same HDP layer exactly 50cm of clay that works as mechanical protection of the blanket avoiding and preventing its deterioration.

**Drainage of the leachate**

The drainage of the leachate (liquid generated by the decomposition of the residues), it is done by pipes of High Density Polyethylene (HDPE) or similar material and for stone breaks covered with geotextile blanket. The liquid drains through the pipes until the storage tank and then taken for treatment. The gases are also drained through concrete tubes, where they suffer combustion. Already the drainage of pluvial waters is made through support pipes, concrete tubes and sedimentation boxes. This way are prevent that the water bodies near and in front of the enterprise suffer sand excesses. The operation of waste reception consists of compacting and covering. The compacting is accomplished so that the residues occupy the smallest possible landfill space and this helps in the terrain stability and in the increase of landfill useful life. The waste covering is made daily in way to avoid bad odors and animals attraction.

In the proposed project activity, the used technology will be the improvement of biogas collection and flare produced in the landfill, through the installation of an active recovery system composed for:

- Collection pipes;
- Biogas transport pipe system;
- Gas suction and flare system (located in the Biogas Station).
- A Power generation plant eventually will also be installed.

The technology for biogas collection, flaring and power generation can be considered state of art in the Brazilian sanitation context (see Step 4: Analysis of common practices).

**Collection system**

The biogas collection infrastructure of landfill was based in vertical drains. Those elements will be connected to a collection pipe that will accomplish the transport of gas to Control Stations - used to control the drains loss of load. Some horizontal drains can be built, if necessary.

**Figure 3 - Control Station (manifolds)**
Source: Multiambiente Comércio e Serviços de Ambiente e Energia Ltda.

CGR Guatapará intends to install drains directly in the landfill. A covering layer will be installed around the drains to avoid the exhaust gases.

Technical analyses can lead to conclusion on the need to install horizontal drains and a final cover of the landfill cell with a blanket of high density polyethylene (HDPE) or similar.

The top of the drains will be equipped with headstocks. This element is important because it makes the connection between the drain and pipe collection. The headstocks are made of HDPE or similar ø 200 mm to 1 m in length. In the body of the head, a derivation of HDPE or similar ø 90 mm will be installed and attached to a butterfly valve which is connected to a hose ø 90 mm of HDPE, which is finally connected to the tubing of collection.

**Figure 4 - Example of well head**
Source: Multiambiente Comércio e Serviços de Ambiente e Energia Ltda.

The collection pipe will be built using HDPE or similar. The sizing of the piping was done considering the maximum production of landfill gas that can reach. Activities will be intense welding tubing to connect each station of the adjustment. The pipe will be covered with materials that do not pose any possibility of damage to the material.

Removers of condensate will be provided to drain traces of manure collected from the gas. These removers are constructed at points of lower elevation of the tubing and collection stations, located before the adjustment. The condensate removed will be returned to the landfill, through pumps installed at the base of the removers.

All drains will be connected to the adjustment of station located around the landfill, through the collection pipes. The CGR Guatapará will install the 13 Stations of adjustment when the closure of the landfill, each with capacity to receive the connection of up to 20 Drain. The basic functions of the stations will promote the systematic control and monitoring of the characteristics of biogas extracted. Each station will have an adjustment of additional condensate remover, valves and regulating valves-drawer.

**Transport System**

The transmission pipeline is the last step of the collecting system. It transports the collected LFG to the flare. The transmission pipeline might be connected to all manifolds or gas regulation stations around the landfill.

**Figure 5 - Example of transmission pipelines**
Source: ESTRE Ambiental S.A.

**Blowering System**

The blowering system is responsible to give negative pressure to the landfill, blowing the gas to the pipeline. The dimensioning of the blower will depend on the final use of the gas (flare, boiler, electricity).

In order to preserve the operation of the blowers, a dewatering system is installed to remove the condensate. This equipment is a single knock-out dewatering component.

**Figure 6 - Example of blower system**
Source: ESTRE Ambiental S.A.

**Flare System**

The destruction of the methane content in the LFG collected will be made via an enclosed flare, in order to assure higher methane destruction (above 99%)[2].

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

[2] The destruction of the methane content in the LFG is above 99%, according to manufacturer specifications. The document (Flare efficiency.pdf) will be given to DOE in validation visit.

**Figure 7 - Detail of Enclosed Flare**
Source: ESTRE Ambiental S.A.

**Biogas Station**

The collection of gas within the landfill will be made by applying a pressure differential in each drain. The depressurization system shall be composed of a group of centrifugal multi-stage blowers, connected in parallel with the central collector. The depressurization of the system will depend on the pressure of operation of flares. In addition, the Station of Biogas will have the following:

- Safety valve on/off;
- Remover of condensate;
- Gas Analyzer;
- Meter for pressure;
- Meter for temperature.

**Figure 8 - Example of a biogas station**
Source: ESTRE Ambiental S.A.

The Biogas Station will have, even a system of destruction of methane through flares. This system will be composed initially by 1 enclosure flare with a capacity of 2,500 $Nm^3/h$ and can get others units of 2,500 $Nm^3/h$ each, according to the generation of gas. The flare is constructed in a vertical cylindrical combustion chamber, where the biogas is flared at a constant temperature (around 1,000 º C), controlled by the admission of air, and with a residence time > 0.3 seconds

**Power generation**

The power generation system will be comprised of around 5.5 MW. The electricity generated by the Project will be supplied to the grid.

This kind of technology is still not widely applied in Brazil. Very few landfills have already installed equipment for the collection and flare of LFG. Therefore, the company will need engineers and other specialists with experience in this area to advice the company while implementing the project. These professionals will also train local operators and engineers on operations and maintenance of the facilities.

Technology will have to come from abroad and mainly from the United States, Canada and Europe. Hence, technology transfer will occur from countries with strict environmental legislative requirements and environmentally sound technologies.

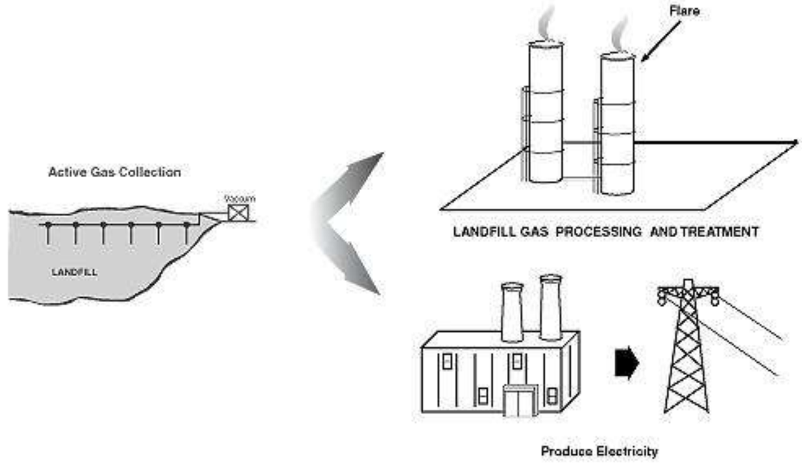



**Figure 9 – Power generation diagram**

The anticipated number of gensets and the expected output is shown on the table below:

| Year | Number of engines installed (unit) | Installed capacity (MW) | Electricity generated in the plant (MWh) |
|---|---|---|---|
| 2011 | 0 | 0.0 | 0 |
| 2012 | 0 | 0.0 | 0 |
| 2013 | 4 | 3.648 | 28,761 |
| 2014 | 4 | 3.648 | 28,761 |
| 2015 | 4 | 3.648 | 28,761 |
| 2016 | 5 | 4.560 | 35,951 |
| 2017 | 5 | 4.560 | 35,951 |
| 2018 | 5 | 4.560 | 35,951 |
| 2019 | 6 | 5.472 | 43,141 |

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

For the first crediting period (from 01/01/2012 to 31/12/2018) the estimation of emission reductions is:

| Years | Annual estimation of emission reductions in tonnes of $CO_2e$ |
|---|---|
| 2012 | 152.417 |
| 2013 | 176.546 |
| 2014 | 191.588 |
| 2015 | 203.557 |
| 2016 | 223.534 |
| 2017 | 238.187 |
| 2018 | 249.926 |
| **Total estimated reductions** (tonnes of $CO_2e$) | **1.435.755** |

| | |
|---|---|
| **Total Number of crediting years** | 7 |
| **Annual average over the crediting period of estimated reductions** (tonnes of $CO_2e$) | 205.108 |

### A.4.5. Public funding of the project activity:

There is no Annex I public funding involved in the CGR Guatapara Landfill 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 following methodologies are applicable to this project activity:

- ACM0001 - Consolidated baseline and monitoring methodology for landfill gas project activities, version 11;
- Tool for the demonstration and assessment of additionality – version 5.2;
- Combined tool to identify the baseline scenario and demonstrate additionality – version 3.0.0.
- Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site – version 5.1;
- Tool to calculate baseline, project and/or leakage emissions from electricity consumption – version 1;
- Tool to determine project emissions from flaring gases containing methane – EB 28, annex 13;
- Tool to calculate the emission factor for an electricity system – version 2.2.0;
- Tool to calculate project or leakage $CO_2$ emissions from fossil fuel combustion – version 2;
- Tool to determine the mass flow of a greenhouse gas in a gaseous stream – version 2.

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

The methodology ACM0001 is applicable for project activities that comprise one of the following scenarios:

- The captured gas is flared; and/or
- The captured gas is used to produce energy (e.g. electricity/thermal energy);
- The captured gas is used to supply consumers through natural gas distribution network.

The project activity corresponds to first and second of these three scenarios. In the first phase the LFG will be only flared and during the second phase will be installed power generators. So, the methodology ACM0001 was deemed appropriate.

- “Tool for demonstration and assessment of additionality” is applicable to the project activity, as it is included in the ACM0001 methodology.

- “Combined tool to identify the baseline scenario and demonstrate additionality” could be applied as all alternatives are available options of the project participants. However, for this project activity, the “Tool for demonstration and assessment of additionality” was used to evaluate the additionality, as required in the ACM0001 version 11.

- "Tool to determine methane emissions avoided from dumping waste at a solid waste disposal site" is applicable as the solid waste disposal site is clearly identified, there are no hazardous wastes and this is not a stockpile case.

- "Tool to calculate baseline, project and/or leakage emissions from electricity consumption" is also applicable to the project activity because electricity will be consumed from the grid and electricity can be occasionally generated using a standby generator located on site.

- "Tool to determine project emissions from flaring gases containing methane" is applicable to this project activity because:

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

- "Tool to calculate the emission factor for an electricity system" is applicable as this project will supply electricity to the grid.

- "Tool to calculate project or leakage $CO_2$ emissions from fossil fuel combustion" is not applicable to the project activity because there is no consumption of heat in the project activity.

- "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" will be applicable when necessary to convert residual gas flow rate from wet basis on dry basis.

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

| | Source | Gas | Included? | Justification / Explanation |
|---|---|---|---|---|
| **Baseline** | Emissions from decomposition of waste at the landfill site. | $CH_4$ | Yes | The major source of emissions in the baseline. |
| | | $N_2O$ | No | $N_2O$ emissions are small compared to $CH_4$ emissions from landfills. Exclusion of this gas is conservative. |
| | | $CO_2$ | No | $CO_2$ emissions from the decomposition of organic waste are not accounted. |
| | Emissions from electricity consumption | $CO_2$ | Yes | Electricity may be consumed from the grid or generated onsite /offsite in the baseline scenario |
| | | $CH_4$ | No | Excluded for simplification. This is conservative. |
| | | $N_2O$ | No | Excluded for simplification. This is conservative. |
| **Project Activity** | On-site fossil fuel consumption due to the project activity other than for electricity generation | $CO_2$ | No | There is no on-site fossil fuel consumption due to the project activity other than for electricity generation. |
| | | $CH_4$ | 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 on-site | $CO_2$ | Yes | May be an important emission source |

| | | | | |
|---|---|---|---|---|
| | electricity use | $CH_4$ | 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 flow diagram is presented below:

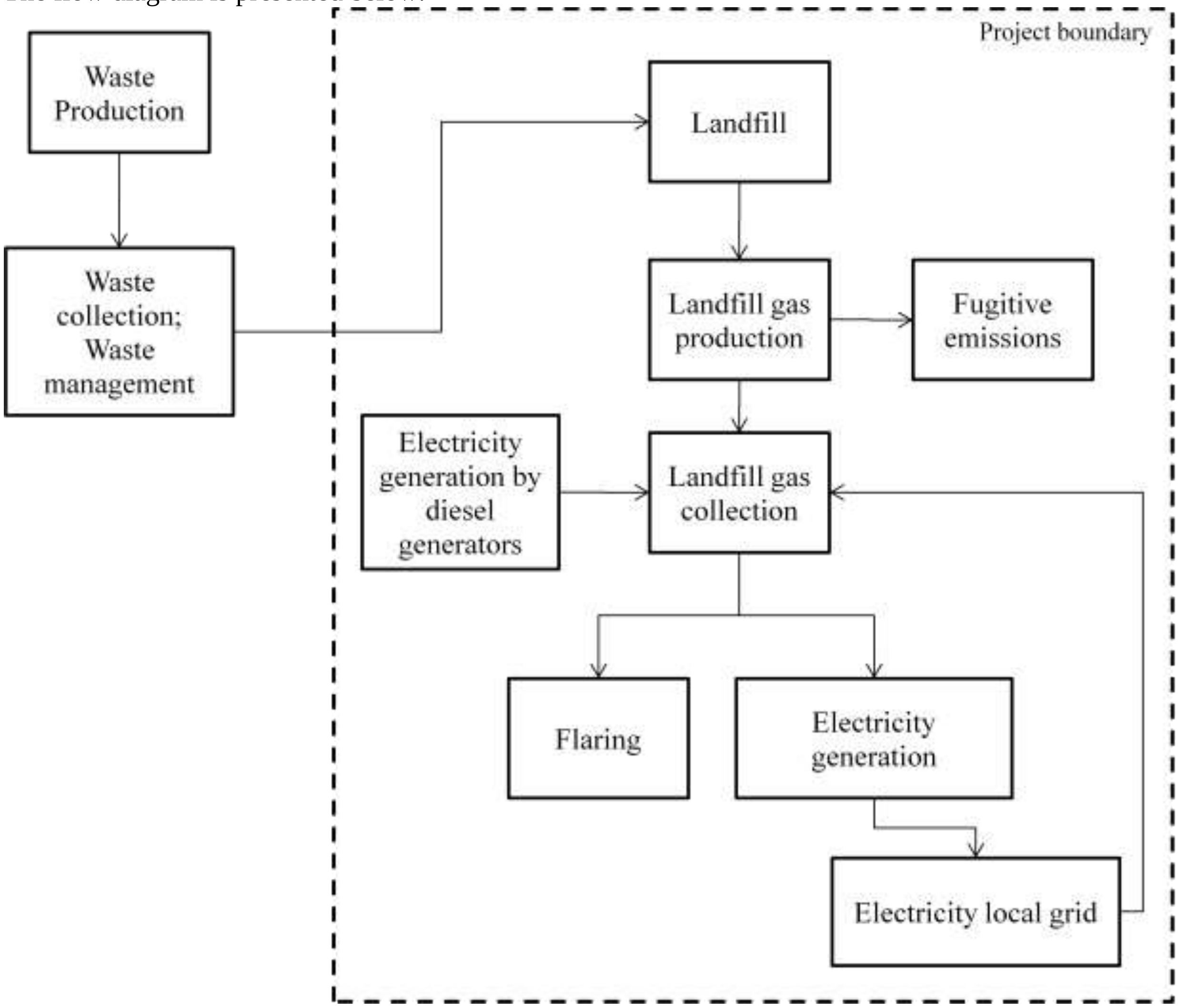



**Figure 10 – Flow diagram project boundary**

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

The baseline scenario for the project activity is identified using step 1 of the ‘Tool for demonstration and assessment of additionality” (Version 05.2), as agreed in ACM0001 “Consolidated baseline and monitoring methodology for landfill gas project activities” (version 11).

Realistic and credible alternatives to the project activity that can be part of the baseline scenario are defined through the following sub-steps:

***Step 1: Identification of alternative scenarios***

The project participants will monitor all relevant policies and circumstances at the beginning of each crediting period and adjust the baseline accordingly.

The identified alternatives for the disposal/treatment of the waste in the absence of the project activity include:

| | |
|---|---|
| ***LFG1*** | The project activity (capture of landfill gas and power generation) undertaken without being registered as a CDM project activity; |
| ***LFG2*** | Atmospheric release of the landfill gas. |
| ***LFG3*** | Capture of landfill gas and its flare, without being registered as a CDM project activity. |

For power generation, the realistic and credible alternatives include:

Since the project uses LFG for generating electricity, according to ACM0001 Version 11 realistic and credible alternatives also may include the following:

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

As there is no alternative to use heat inside the landfill and there is no consumer nearby the project activity, the heat generation was not considered a realistic alternative by the project participants (P2 and P3). The alternatives P4 and P5 were not considered realistic as there is no need for power at the landfill site and power generation is not CGR Guatapara's core business; consequently no captive power is required to be built in the project surroundings.

The only remaining real alternatives to the project activity are LFG1, LFG2, LFG3, P1, and P6.

**Outcome of Step 1a**: Five realistic and credible alternative scenarios to the project activity were identified.

Alternatives LFG1, LFG3 and P1 comply with all applicable laws and regulations. In Brazil there is no regulation or policy requesting the LFG capture and flare, neither is forecasted any policy of this kind.

Alternatives LFG2 and P6, a continuation of the current situation (partial or total release of LFG to the atmosphere) represents the business as usual practice for the project site as well as for most of the landfills in Brazil, according to "Sistema Nacional de Informações sobre Saneamento: diagnóstico do manejo de resíduos sólidos urbanos – 2007".[3]

The project participants will monitor all relevant policies and circumstances at the beginning of each crediting period and adjust the baseline accordingly.

[3] SNIS – 2007, page II.281 (http://www.pmss.gov.br/snis/PaginaCarrega.php?EWRErterterTERTer=80)

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

The power consumed by the project activity could be bought from Brazilian interconnected electric system where the emission factor is 0.1635 $tCO_2e$/MWh (see section B.6.3). The project activity will supply energy to the grid, displacing energy from fossil fuel fired power plants connected to this grid.

***Step 3: Assessment using Step2 and/or Step 3 of the latest approved version of the "Tool for demonstration and assessment of additionality"***

Applying this step for the waste disposal:

The alternatives LFG1 and LFG 3 were not deemed a realistic and credible alternative as showed in item B.5. So, the only plausible alternative is the continuation of the baseline scenario, LFG2.

Applying this step for the power generation:

The alternative P1 was not deemed a realistic and credible alternative as showed in item B.5.
The only plausible alternative is to continue electricity generation from existing and/or new grid-connected power plants, P6.

Thus, the most plausible baseline scenario for the LFG is identified as atmospheric release of LFG with electricity supplied from grid connected power plants, being applicable to version 11 of ACM0001.

The project participants identified the scenario A: Electricity consumption from the grid from the *"Tool to calculate baseline, project and/or leakage emissions from electricity consumption"* for the project electricity consumption during the first phase and if necessary the electricity consumption in the subsequent phase.

**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):**

The following table shows the timeline of the project activity showing that the CDM benefits were taken into account to implement it.

**Table 1 - Implementation timeline of the Project**

| Key Events | Date |
|---|---|
| PDD in Global Stakeholder Consultation (GSC) for the first time | 07/04/2009 to 06/05/2009 |
| Designated Operational Entity (DOE) issues draft validation report | 29/10/2009 |
| PDD in GSC for the second time* | August/2010 |
| Starting date of the project activity (the CGR Guatapara will decide to implement the project activity after to receive the Brazilian Letter of Approval. The date chosen on 13/09/2011 is the forecast date of the Brazilian DNA meeting[4]. | 13/09/2011 |
| Purchasing equipments (Phase I)* | October/2011 |
| Operation starting date (Phase I)* | January/2012 |
| Purchasing equipments (Phase II)* | June/2012 |
| Operation starting date (Phase II)* | January/2013 |

*Estimated

According to "Guidelines on the demonstration and assessment of prior consideration of the CDM" – EB 49/Annex 22 paragraph #2:

> *"The Board decided that for project activities with a starting date on or after 02 August 2008, the project participant must inform a Host Party DNA and the UNFCCC secretariat in writing of the commencement of the project activity and of their intention to seek CDM status. Such notification must be made within six months of the project activity start date and shall contain the precise geographical location and a brief description of the proposed project activity, using the standardized form F-CDM-Prior Consideration. Such notification is not necessary if a PDD has been published for global stakeholder consultation or a new methodology proposed to the Executive Board for the specific project before the project activity start date."*

As the PDD will be published for global stakeholder consultation before the project activity start date, the notification for Brazilian DNA and the UNFCCC secretariat s are not necessary.

The additionality of the project activity will be demonstrated and assessed using version 5.2 of the "Tool for the demonstration and assessment of additionality" agreed by the CDM Executive Board.

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

***Sub-step 1a. Define alternatives to the project activity***

The identified alternatives for the disposal of the waste in the absence of the project activity include:

[4] Source: http://www.mct.gov.br/index.php/content/view/327781.html, accessed on 21/02/2011.

- LFG1 – The project activity (capture of landfill gas and power generation) undertaken without being registered as a CDM project activity;
- LFG2 – Atmospheric release of the landfill gas;
- LFG3 **-** Capture of landfill gas and its flare, without being registered as a CDM project activity.

For power generation, the realistic and credible alternatives include:

- P1 – Power generated from landfill gas undertaken without being registered as CDM project activity;
- P6 – Existing and/or new grid-connected power plants;

The only remaining real alternatives to the project activity are LFG1, LFG2, LFG3, P1, and P6.

**Outcome of Step 1a**: Five realistic and credible alternative scenarios to the project activity were identified.

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

In Brazil, there is no regulation or policy that obliges the landfill operator to burn the LFG generated in the landfill. According to Brazil's New National Solid Waste Policy (NSWP)[5], ratified by the President on 02/08/2010 after 19 years under discussion, does not request the LFG capture and/or flare and there is not forecast to approve any regulation or policy in the next years. Moreover, it is presented two documents elaborated by official sources proving that there is no regulation or obligation about burning LFG in landfill.

**Table 2 - Relevant policies and documents about solid waste sector**

| Documents | Elaborated by | Reference |
|---|---|---|
| Emission reduction in the final waste disposal (in Portuguese, Redução de emissões na disposição final) | Ministry of Environment and Ministry of Cities | http://www.ibam.org.br/media/arquivos/estudos/03-aterro_mdl_1.pdf, accessed on 11/02/2011.[6] |
| SNIS | Ministry of Cities | SNIS: Secretaria Nacional de Informações sobre Saneamento Sistema Nacional de Informações sobre Saneamento: diagnóstico do manejo de resíduos sólidos urbanos, page II.281 http://www.pmss.gov.br/snis/PaginaCarrega.php?EWRErterterTERTer=80, accessed on 02/08/2010. |

The project participants will monitor all relevant policies and circumstances at the beginning of each crediting period and adjust the baseline (i.e. the adjustment factor - AF) accordingly and if any changes

[5] http://www.planalto.gov.br/ccivil_03/_ato2007-2010/2010/lei/l12305.htm

[6] The document was sent to DOE during validation process.

were found. Even if there is no regulation or policy requiring to burn the LFG generated, the PPs adopted a conservative approach and considered AF = 10%, as explained in Section B.6.1 below.

***Step2. Investment analysis***

***Sub-step2a. Determine appropriate analysis method***

As the proposed project activity will generate financial benefits other than CDM related income, the Option II is chosen.

***Sub-step2b. – Option II. Apply investment comparison analysis***

For the purpose of assessing the financial/economic attractiveness, the indicator used was the Net Present Value (NPV).

The discount rate parameter method for this comparison analysis is present below:

**Table 3 - Discount Rate method**

| **Discount Rate real terms** | | |
|---|---|---|
| **A** | US-Tbonds year 2010 | 8.46% |
| **B** | Country risk premium | 3.00% |
| **C** | Market Risk Premium (S&P 500 - T-Bonds) | 6.39% |
| **D** | Unlevered Beta (in lack of open companies with the same risk profile) | 0.49 |
| **E** | Expected inflation rate **[3]** | 1.50% |
| **F = (A - E) + B + C x D** | Benchmark - Real Terms | **13.08%** |

The government bond rate chosen is the US-Tbonds. The fixed rate used for the discount rate calculation was based on data 2010, resulting in 8.46%. This index has included the inflation rate, (1.5%) which was excluded from the T-bonds yield. Thus the investment analysis was done in real terms.

In order to calculate this spread, the project participants used the risk premium calculated by the difference between the S&P 500 and the US T-bonds in 2010. This would result in a Market risk premium of 6.39%.[7]

The US-Tbonds is not enough to address the risk of investing in a developing country as emerging markets' lower degree of diversification to the world goods and financial markets represent the main causes for the country risk premium. Investors may view some country-level factors as country-specific and demand a premium due to risks of financial, economic, and political nature, such as currency volatility, losses from exchange controls, volatility of the economy, inflation, labor issues, economic planning failures, political leadership and frequency of change, poorly developed legal system and others. Damodaran's informs a country risk premium of 3% for Brazil investments.

To estimate the risk in investing in a power generation project, the project participants should consider also the beta of companies with the same risk profile (such as public held companies with the same

[7] Source: http://www.stern.nyu.edu/~adamodar/pc/datasets/histretSP.xls, accessed on 08 April 2011.

portfolio). However, there is no other company with a comparable portfolio to the project activity listed in a stock exchange. Therefore, the project proponents considered the beta of all electricity utilities (0.49).[8] This approach is deemed conservative as most of those companies operates with widely known technologies, less risky than LFG to energy projects. With these input data, the discount rate calculated follows:

[8] Source: http://www.stern.nyu.edu/~adamodar/pc/archives/betas07.xls, accessed on 04 April 2011.

***Sub-step 2c. Calculation and comparison of financial indicators***

The following assumptions were taken for the purpose of the calculation of the financial indicator:

**Table 4 - Main assumptions**

| | Parameter | Value | Unit | Reference |
|---|---|---|---|---|
| Assumptions | Discount Rate | 13.08% | % | CGR Guatapara - Discount Rate 2011 03 23 MR.xls |
| | Asset's Life time | 25 | Years | Feasibility study |
| | Installed capacity for each engine | 0.912 | MW | Feasibility study |
| | Total installed capacity | 5.5 | MW | Feasibility study |
| | Load factor | 90.00% | % | Feasibility study |
| | Exchange Rate | 2.31 | R$/EUR | "Banco Central do Brasil" on 19/07/2010 (http://www4.bcb.gov.br/?TXCONVERSAO) |
| | Electricity price | 148.00 | R$/MWh | Feasibility study |
| | Tax - IRPJ (income tax) | 25% | % | Incomex tax (http://www.receita.fazenda.gov.br/legislacao/ins/Ant2001/Ant1997/1995/insrf05195.htm) |
| | Tax - CSLL (social contribution) | 9% | % | Social contribution (http://www.planalto.gov.br/ccivil_03/LEIS/L7689.htm) |
| | Assumed profit tax | 32% | % | https://www.receita.fazenda.gov.br/PessoaJuridica/DIPJ/2005/PergResp2005/pr517a555.htm |
| | Transport and import taxes | 60% | % | Feasibility study |
| | Power plant O&M cost | 60.23 | R$/MWh | Feasibility study |
| | Biogas plant O&M cost | 8% | % | Feasibility study |
| | Tax (PIS) | 1.65% | % | Contribution to the Social Integration Program and Civil Service Asset Formation Program – PIS/PASEP (http://www.receita.fazenda.gov.br/principal/Ingles/SistemaTributarioBR/Taxes.htm) |
| | Tax (Cofins) | 7.60% | % | COFINS - Contribution to Social Security Financing (http://www.receita.fazenda.gov.br/principal/Ingles/SistemaTributarioBR/Taxes.htm) |
| | Depreciation | 10% | years | Secretary of the Federal Revenue of Brazil. Available on http://www.receita.fazenda.gov.br/legislacao/ins/ant2001/1998/in16298ane1.htm, accessed on 15/02/2011. Item: 8501 |

Note: All numbers are in Brazilian Real (R$) terms

## Alternative LFG1

For the first alternative: LFG1 – The project activity (capture of landfill gas and power generation) undertaken without being registered as a CDM project activity, the estimated project cash flow is presented below:

| *Biogas Flaring* | Year | 0 | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|---|---|
| | | YEARLY INVESTIMENT ANALYSIS | | | | | | |
| | | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
| **COSTS ANALYSIS x INCOME** | | | | | | | | |
| Gross Reveneus (R$) | | | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| PIS/Cofins Tax | 9.25% | | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Net Reveneus (R$) | | | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| O&M Costs | | | (549,722.42) | (549,722.42) | (549,722.42) | (549,722.42) | (549,722.42) | (549,722.42) |
| Operational Results | | | (549,722.42) | (549,722.42) | (549,722.42) | (549,722.42) | (549,722.42) | (549,722.42) |
| Outcome after taxes | | | (549,722.42) | (549,722.42) | (549,722.42) | (549,722.42) | (549,722.42) | (549,722.42) |
| CapEx | | (2,955,530.20) | (271,656.00) | | | | | |
| **Net Cash Flow Total (Biogas)** | | **(R$ 2,955,530)** | **(R$ 821,378)** | **(R$ 549,722)** | **(R$ 549,722)** | **(R$ 549,722)** | **(R$ 549,722)** | **(R$ 549,722)** |

Note: All numbers are in real (R$) terms

| *Electricity Generation* | | YEARLY INVESTIMENT ANALYSIS | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
| **COST ANALYSIS x INCOME** | | | | | | | | |
| **Dispatched electricity (MWh/year)** | | | | | **28,761** | **28,761** | **28,761** | **35,951** |
| **Electricity Price (R$)** | | | | | **148.00** | **148.00** | **148.00** | **148.00** |
| Gross Reveneus (R$) | | | | | 4,256,603.14 | 4,256,603.14 | 4,256,603.14 | 5,320,753.92 |
| Tax (PIS Cofins) | 9.25% | | | | (393,735.79) | (393,735.79) | (393,735.79) | (492,169.74) |
| Net reveneus | | | | | 3,862,867.35 | 3,862,867.35 | 3,862,867.35 | 4,828,584.18 |
| O&M Costs | | | | | (2,002,264.91) | (2,002,264.91) | (2,002,264.91) | (2,435,331.14) |
| Operational Results | | | | | 1,860,602.43 | 2,254,338.22 | 2,254,338.22 | 2,885,422.78 |
| IRPJ/ CSLL taxes Real Profit) | 34.00% | | | | (632,604.83) | (766,475.00) | (766,475.00) | (981,043.75) |
| Outcome after taxes | | | | | 1,227,997.61 | 1,487,863.23 | 1,487,863.23 | 1,904,379.04 |
| CapEx | | | | (8,758,150.40) | 0.00 | 0.00 | (2,420,337.92) | 0.00 |

| *Biogas flaring + Electricity generation* | | YEARLY INVESTIMENT ANALYSIS | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
| **COST ANALYSIS x INCOME** | | | | | | | | |
| Net Reveneus (R$) | | 0.00 | 0.00 | 0.00 | 3,862,867.35 | 3,862,867.35 | 3,862,867.35 | 4,828,584.18 |
| O&M Costs | | 0.00 | (549,722.42) | (549,722.42) | (2,551,987.33) | (2,551,987.33) | (2,551,987.33) | (2,985,053.56) |
| Operational Results | | 0.00 | (549,722.42) | (549,722.42) | 1,310,880.02 | 1,310,880.02 | 1,310,880.02 | 1,843,530.63 |
| EBITDA | | 0.00 | (549,722.42) | (549,722.42) | 1,310,880.02 | 1,310,880.02 | 1,310,880.02 | 1,843,530.63 |
| Depreciation | | 0.00 | (295,553.02) | (322,718.62) | (1,198,533.66) | (1,198,533.66) | (1,198,533.66) | (1,440,567.45) |
| EBIT | | 0.00 | (845,275.44) | (872,441.04) | 112,346.36 | 112,346.36 | 112,346.36 | 402,963.18 |
| IRPJ/ CSLL taxes (Real Profit) | 34.00% | 0.00 | 0.00 | 0.00 | (38,197.76) | (38,197.76) | (38,197.76) | (137,007.48) |
| Outcome after taxes | | 0.00 | (845,275.44) | (872,441.04) | 74,148.60 | 74,148.60 | 74,148.60 | 265,955.70 |
| Depreciation | | 0.00 | 295,553.02 | 322,718.62 | 1,198,533.66 | 1,198,533.66 | 1,198,533.66 | 1,440,567.45 |
| CapEx | | (2,955,530.20) | (271,656.00) | (8,758,150.40) | 0.00 | 0.00 | (2,420,337.92) | 0.00 |
| **Net Cash Flow Total (Biogas + Electricity)** | | **(R$ 2,955,530)** | **(R$ 821,378)** | **(R$ 9,307,873)** | **R$ 1,272,682** | **R$ 1,272,682** | **(R$ 1,147,656)** | **R$ 1,706,523** |

Note: All numbers are in real (R$) terms

| 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
|---|---|---|---|---|---|---|---|---|---|
| **2017** | **2018** | **2019** | **2020** | **2021** | **2022** | **2023** | **2024** | **2025** | **2026** |
| 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| (549,722.42) | (549,722.42) | (549,722.42) | (549,722.42) | (549,722.42) | (549,722.42) | (549,722.42) | (549,722.42) | (549,722.42) | (549,722.42) |
| (549,722.42) | (549,722.42) | (549,722.42) | (549,722.42) | (549,722.42) | (549,722.42) | (549,722.42) | (549,722.42) | (549,722.42) | (549,722.42) |
| (549,722.42) | (549,722.42) | (549,722.42) | (549,722.42) | (549,722.42) | (549,722.42) | (549,722.42) | (549,722.42) | (549,722.42) | (549,722.42) |
| **(R$ 549,722)** | **(R$ 549,722)** | **(R$ 549,722)** | **(R$ 549,722)** | **(R$ 549,722)** | **(R$ 549,722)** | **(R$ 549,722)** | **(R$ 549,722)** | **(R$ 549,722)** | **(R$ 549,722)** |

| **2017** | **2018** | **2019** | **2020** | **2021** | **2022** | **2023** | **2024** | **2025** | **2026** |
|---|---|---|---|---|---|---|---|---|---|
| **35,951** | **35,951** | **43,141** | **43,141** | **43,141** | **43,141** | **35,951** | **28,761** | **21,571** | **14,380** |
| **148.00** | **148.00** | **148.00** | **148.00** | **148.00** | **148.00** | **148.00** | **148.00** | **148.00** | **148.00** |
| 5,320,753.92 | 5,320,753.92 | 6,384,904.70 | 6,384,904.70 | 6,384,904.70 | 6,384,904.70 | 5,320,753.92 | 4,256,603.14 | 3,192,452.35 | 2,128,301.57 |
| (492,169.74) | (492,169.74) | (590,603.69) | (590,603.69) | (590,603.69) | (590,603.69) | (492,169.74) | (393,735.79) | (295,301.84) | (196,867.90) |
| 4,828,584.18 | 4,828,584.18 | 5,794,301.02 | 5,794,301.02 | 5,794,301.02 | 5,794,301.02 | 4,828,584.18 | 3,862,867.35 | 2,897,150.51 | 1,931,433.67 |
| (2,435,331.14) | (2,435,331.14) | (2,868,397.37) | (2,868,397.37) | (2,868,397.37) | (2,868,397.37) | (2,435,331.14) | (2,002,264.91) | (1,569,198.68) | (1,136,132.46) |
| 2,885,422.78 | 2,885,422.78 | 3,516,507.34 | 3,516,507.34 | 3,516,507.34 | 3,516,507.34 | 2,885,422.78 | 2,254,338.22 | 1,623,253.67 | 992,169.11 |
| (981,043.75) | (981,043.75) | (1,195,612.49) | (1,195,612.49) | (1,195,612.49) | (1,195,612.49) | (981,043.75) | (766,475.00) | (551,906.25) | (337,337.50) |
| 1,904,379.04 | 1,904,379.04 | 2,320,894.84 | 2,320,894.84 | 2,320,894.84 | 2,320,894.84 | 1,904,379.04 | 1,487,863.23 | 1,071,347.42 | 654,831.61 |
| 0.00 | (2,420,337.92) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

| **2017** | **2018** | **2019** | **2020** | **2021** | **2022** | **2023** | **2024** | **2025** | **2026** |
|---|---|---|---|---|---|---|---|---|---|
| 4,828,584.18 | 4,828,584.18 | 5,794,301.02 | 5,794,301.02 | 5,794,301.02 | 5,794,301.02 | 4,828,584.18 | 3,862,867.35 | 2,897,150.51 | 1,931,433.67 |
| (2,985,053.56) | (2,985,053.56) | (3,418,119.78) | (3,418,119.78) | (3,418,119.78) | (3,418,119.78) | (2,985,053.56) | (2,551,987.33) | (2,118,921.10) | (1,685,854.87) |
| 1,843,530.63 | 1,843,530.63 | 2,376,181.24 | 2,376,181.24 | 2,376,181.24 | 2,376,181.24 | 1,843,530.63 | 1,310,880.02 | 778,229.41 | 245,578.80 |
| 1,843,530.63 | 1,843,530.63 | 2,376,181.24 | 2,376,181.24 | 2,376,181.24 | 2,376,181.24 | 1,843,530.63 | 1,310,880.02 | 778,229.41 | 245,578.80 |
| (1,440,567.45) | (1,440,567.45) | (1,682,601.24) | (1,682,601.24) | (1,387,048.22) | (1,359,882.62) | (484,067.58) | (484,067.58) | (484,067.58) | (242,033.79) |
| 402,963.18 | 402,963.18 | 693,579.99 | 693,579.99 | 989,133.01 | 1,016,298.61 | 1,359,463.04 | 826,812.43 | 294,161.83 | 3,545.01 |
| (137,007.48) | (137,007.48) | (235,817.20) | (235,817.20) | (336,305.22) | (345,541.53) | (462,217.43) | (281,116.23) | (100,015.02) | (1,205.30) |
| 265,955.70 | 265,955.70 | 457,762.79 | 457,762.79 | 652,827.79 | 670,757.08 | 897,245.61 | 545,696.21 | 194,146.81 | 2,339.71 |
| 1,440,567.45 | 1,440,567.45 | 1,682,601.24 | 1,682,601.24 | 1,387,048.22 | 1,359,882.62 | 484,067.58 | 484,067.58 | 484,067.58 | 242,033.79 |
| 0.00 | (2,420,337.92) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **R$ 1,706,523** | **(R$ 713,815)** | **R$ 2,140,364** | **R$ 2,140,364** | **R$ 2,039,876** | **R$ 2,030,640** | **R$ 1,381,313** | **R$ 1,029,764** | **R$ 678,214** | **R$ 244,373** |

| 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 |
|---|---|---|---|---|---|---|---|---|
| **2027** | **2028** | **2029** | **2030** | **2031** | **2032** | **2033** | **2034** | **2035** |
| 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| (549,722.42) | (549,722.42) | (549,722.42) | (549,722.42) | (549,722.42) | (549,722.42) | (549,722.42) | (549,722.42) | (549,722.42) |
| (549,722.42) | (549,722.42) | (549,722.42) | (549,722.42) | (549,722.42) | (549,722.42) | (549,722.42) | (549,722.42) | (549,722.42) |
| (549,722.42) | (549,722.42) | (549,722.42) | (549,722.42) | (549,722.42) | (549,722.42) | (549,722.42) | (549,722.42) | (549,722.42) |
| **(R$ 549,722)** | **(R$ 549,722)** | **(R$ 549,722)** | **(R$ 549,722)** | **(R$ 549,722)** | **(R$ 549,722)** | **(R$ 549,722)** | **(R$ 549,722)** | **(R$ 549,722)** |

| 2027 | 2028 | 2029 | 2030 | 2031 | 2032 | 2033 | 2034 | 2035 |
|---|---|---|---|---|---|---|---|---|
| **14,380** | **14,380** | **7,190** | **7,190** | **7,190** | **7,190** | **7,190** | **7,190** | **7,190** |
| **148.00** | **148.00** | **148.00** | **148.00** | **148.00** | **148.00** | **148.00** | **148.00** | **148.00** |
| 2,128,301.57 | 2,128,301.57 | 1,064,150.78 | 1,064,150.78 | 1,064,150.78 | 1,064,150.78 | 1,064,150.78 | 1,064,150.78 | 1,064,150.78 |
| (196,867.90) | (196,867.90) | (98,433.95) | (98,433.95) | (98,433.95) | (98,433.95) | (98,433.95) | (98,433.95) | (98,433.95) |
| 1,931,433.67 | 1,931,433.67 | 965,716.84 | 965,716.84 | 965,716.84 | 965,716.84 | 965,716.84 | 965,716.84 | 965,716.84 |
| (1,136,132.46) | (1,136,132.46) | (703,066.23) | (703,066.23) | (703,066.23) | (703,066.23) | (703,066.23) | (703,066.23) | (703,066.23) |
| 992,169.11 | 992,169.11 | 361,084.56 | 361,084.56 | 361,084.56 | 361,084.56 | 361,084.56 | 361,084.56 | 361,084.56 |
| (337,337.50) | (337,337.50) | (122,768.75) | (122,768.75) | (122,768.75) | (122,768.75) | (122,768.75) | (122,768.75) | (122,768.75) |
| 654,831.61 | 654,831.61 | 238,315.81 | 238,315.81 | 238,315.81 | 238,315.81 | 238,315.81 | 238,315.81 | 238,315.81 |
| 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

| 2027 | 2028 | 2029 | 2030 | 2031 | 2032 | 2033 | 2034 | 2035 |
|---|---|---|---|---|---|---|---|---|
| 1,931,433.67 | 1,931,433.67 | 965,716.84 | 965,716.84 | 965,716.84 | 965,716.84 | 965,716.84 | 965,716.84 | 965,716.84 |
| (1,685,854.87) | (1,685,854.87) | (1,252,788.64) | (1,252,788.64) | (1,252,788.64) | (1,252,788.64) | (1,252,788.64) | (1,252,788.64) | (1,252,788.64) |
| 245,578.80 | 245,578.80 | (287,071.81) | (287,071.81) | (287,071.81) | (287,071.81) | (287,071.81) | (287,071.81) | (287,071.81) |
| 245,578.80 | 245,578.80 | (287,071.81) | (287,071.81) | (287,071.81) | (287,071.81) | (287,071.81) | (287,071.81) | (287,071.81) |
| (242,033.79) | (242,033.79) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 3,545.01 | 3,545.01 | (287,071.81) | (287,071.81) | (287,071.81) | (287,071.81) | (287,071.81) | (287,071.81) | (287,071.81) |
| (1,205.30) | (1,205.30) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 2,339.71 | 2,339.71 | (287,071.81) | (287,071.81) | (287,071.81) | (287,071.81) | (287,071.81) | (287,071.81) | (287,071.81) |
| 242,033.79 | 242,033.79 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **R$ 244,373** | **R$ 244,373** | **(R$ 287,072)** | **(R$ 287,072)** | **(R$ 287,072)** | **(R$ 287,072)** | **(R$ 287,072)** | **(R$ 287,072)** | **(R$ 287,072)** |

For the alternative LFG 1 (electricity generation plant and the landfill gas extraction system), the NPV is R$ - 5,802,423.38.

## Alternative LFG2

The second alternative LFG2 (atmospheric release of the landfill gas) is the continuation of the current practice, which is in compliance with all applicable regulations and policies, and was deemed the most plausible alternative to the project activity.

The NPV = R$ 0.

## Alternative LFG3

For the third alternative: LFG3 – Capture of landfill gas and its flare, without being registered as a CDM project activity, the cash flow to install a collection and flaring system is presented below:

| | Year | 0 | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|---|---|
| *Biogas Flaring* | | YEARLY INVESTIMENT ANALYSIS | | | | | | |
| | | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
| COSTS ANALYSIS x INCOME | | | | | | | | |
| Gross Reveneus (R$) | | | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| PIS/Cofins Tax | 9.25% | | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Net Reveneus (R$) | | | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| O&M Costs | | | (549,722.42) | (549,722.42) | (549,722.42) | (549,722.42) | (549,722.42) | (549,722.42) |
| Operational Results | | | (549,722.42) | (549,722.42) | (549,722.42) | (549,722.42) | (549,722.42) | (549,722.42) |
| Outcome after taxes | | | (549,722.42) | (549,722.42) | (549,722.42) | (549,722.42) | (549,722.42) | (549,722.42) |
| CapEx | | (2,955,530.20) | (271,656.00) | | | | | |
| **Net Cash Flow Total (Biogas)** | | **(R$ 2,955,530)** | **(R$ 821,378)** | **(R$ 549,722)** | **(R$ 549,722)** | **(R$ 549,722)** | **(R$ 549,722)** | **(R$ 549,722)** |

Note: All numbers are in real (R$) terms

| 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
|---|---|---|---|---|---|---|---|---|---|
| **2017** | **2018** | **2019** | **2020** | **2021** | **2022** | **2023** | **2024** | **2025** | **2026** |
| 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| (549,722.42) | (549,722.42) | (549,722.42) | (549,722.42) | (549,722.42) | (549,722.42) | (549,722.42) | (549,722.42) | (549,722.42) | (549,722.42) |
| (549,722.42) | (549,722.42) | (549,722.42) | (549,722.42) | (549,722.42) | (549,722.42) | (549,722.42) | (549,722.42) | (549,722.42) | (549,722.42) |
| (549,722.42) | (549,722.42) | (549,722.42) | (549,722.42) | (549,722.42) | (549,722.42) | (549,722.42) | (549,722.42) | (549,722.42) | (549,722.42) |
| | | | | | | | | | |
| **(R$ 549,722)** | **(R$ 549,722)** | **(R$ 549,722)** | **(R$ 549,722)** | **(R$ 549,722)** | **(R$ 549,722)** | **(R$ 549,722)** | **(R$ 549,722)** | **(R$ 549,722)** | **(R$ 549,722)** |

| 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 |
|---|---|---|---|---|---|---|---|---|
| **2027** | **2028** | **2029** | **2030** | **2031** | **2032** | **2033** | **2034** | **2035** |
| 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| (549,722.42) | (549,722.42) | (549,722.42) | (549,722.42) | (549,722.42) | (549,722.42) | (549,722.42) | (549,722.42) | (549,722.42) |
| (549,722.42) | (549,722.42) | (549,722.42) | (549,722.42) | (549,722.42) | (549,722.42) | (549,722.42) | (549,722.42) | (549,722.42) |
| (549,722.42) | (549,722.42) | (549,722.42) | (549,722.42) | (549,722.42) | (549,722.42) | (549,722.42) | (549,722.42) | (549,722.42) |
| | | | | | | | | |
| **(R$ 549,722)** | **(R$ 549,722)** | **(R$ 549,722)** | **(R$ 549,722)** | **(R$ 549,722)** | **(R$ 549,722)** | **(R$ 549,722)** | **(R$ 549,722)** | **(R$ 549,722)** |

For the alternative LFG 3 (capture of landfill gas and its flare), the NPV is R$ - 7,204,047.37.

***Sub-step 2d. Sensitivity analysis***

The sensitivity analysis was performed varying the electricity tariff (revenues), the capital expenses (CapEx) and operational and maintenance costs (O&M) for the alternatives. All parameters ranging from -10% to +10%, as the result presented below:

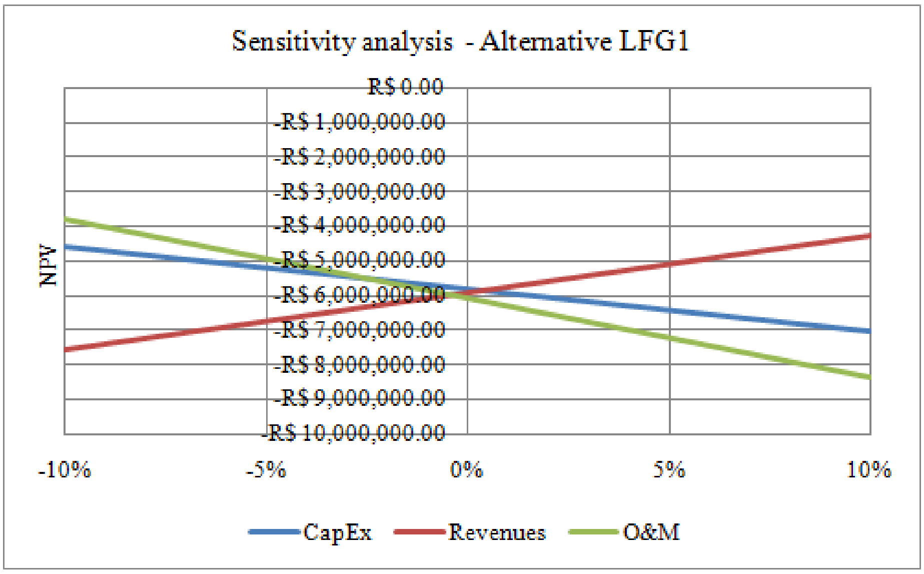
**Table 5 - Sensitivity analysis**

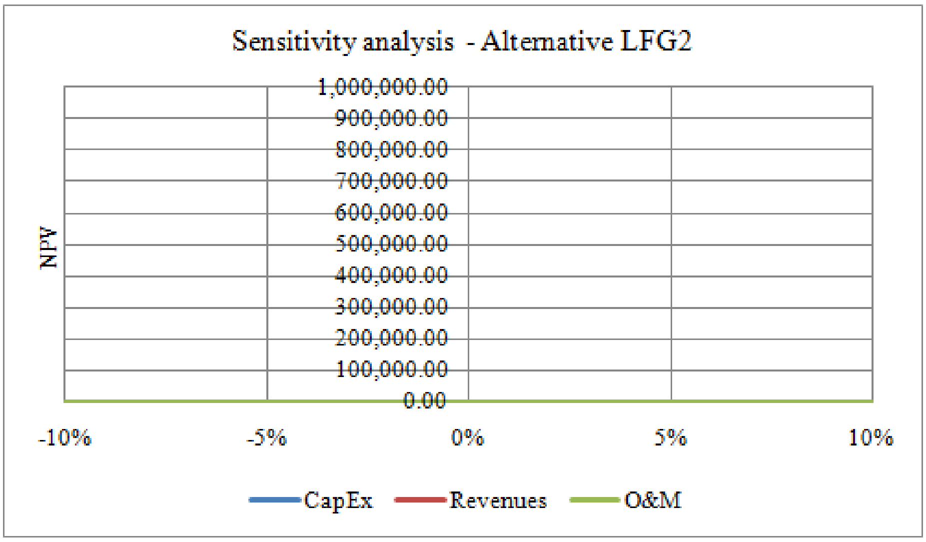
| Parameter | Variation | NPV (R$) | | |
|---|---|---|---|---|
| | | Alternative LFG1 | Alternative LFG2 | Alternative LFG3 |
| CapEx | -10% | -4,576,493.90 | 0.00 | -6,884,471.00 |
| | 10% | -7,028,352.86 | 0.00 | -7,523,623.74 |
| Revenues | -10% | -7,568,661.93 | 0.00 | -7,204,047.37 |
| | 10% | -4,266,624.41 | 0.00 | -7,204,047.37 |
| e | -10% | -3,810,240.92 | 0.00 | -6,803,219.00 |
| | 10% | -8,371,637.04 | 0.00 | -7,604,875.74 |
| Base Case | 0% | -5,802,423.38 | 0.00 | -7,204,047.37 |

The NPV values are in Brazilian Real (R$)

As presented above, even if the best scenario is applied, the project Net Present Value will be zero in all variations.

The figures below show the sensitivity analyses for all alternatives.





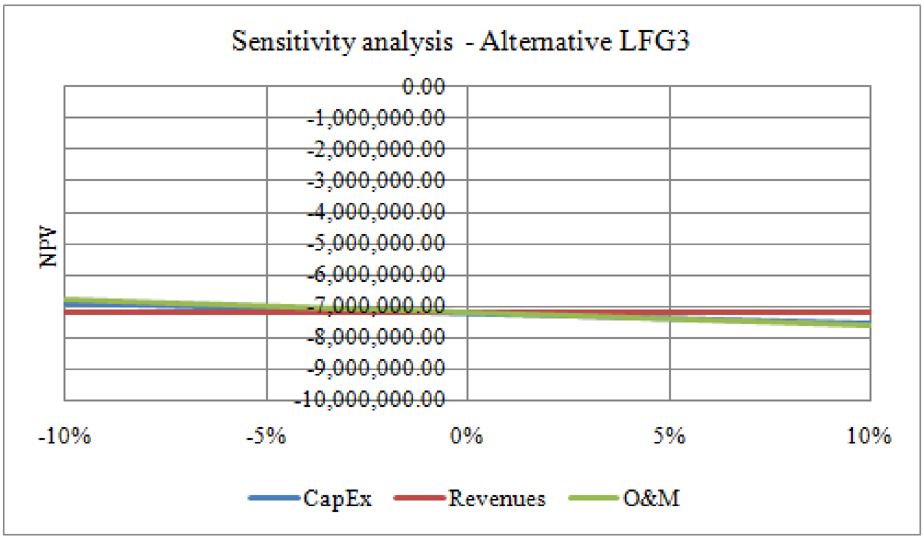




**Figure 11 - Sensitivity analyses (in R$ terms)**

It is presented below a short list raking the alternatives of the project activity according to the best NPV, taking into account the results of the sensitivity analysis.

| Alternatives | Results |
|---|---|
| LFG2 | Best scenario |
| LFG1 | Intermediate Scenario |
| LFG3 | Worst scenario |

As the investment analysis, supported by the sensitivity analysis, was conclusive, then the most financially attractive alternative scenario is considered as baseline scenario (LFG2).

**Breakeven point – LFG 1 (project activity scenario)**

To ensure the additionality of this project activity (LFG1), the PP varied the three identified parameters (CapEx, O&M and Revenues) until each of them reached the NPV=0. The results are presented below and the spreadsheet was provided to the audit team:

**Capital Expenditures (CapEx)** – To reach the NPV = 0, the Capital Expenditures should be reduced in 47.3%. This result is extremely unlikely to happen in the future, as this reduction is too large for any kind of project which has a reliable investment estimate (such as CGR Guatapara Landfill Project) and as usually the CapEx increases during the project implementation.

**O&M** – Also, to reach the discount rate, the O&M shall be reduced in 53.4%. This means that PPs should reduce a third of the O&M costs. Consequently, this scenario is unreal.

**Revenues** – this value should be increased in 37.9% to reach the discount rate. This means that the electricity tariff should reach R$ 204.04, deemed unrealistic as this value is far superior to the average values from the latest electricity sale auctions in Brazil.
The table below shows the electricity price in the auctions held in Brazil. The maximum electricity price was 156.23 R$/MWh. In addition, in Brazil the energy auctions are reverse auctions, therefore power is acquired at the lowest prices.

**Table 6 – Results of recent energy auctions held in Brazil**

| Date | Starting operation | Type | Length of the contract (years) | Electriciyt in contract (MWaverage) | Average electricity price (BRL/MWh) |
|---|---|---|---|---|---|
| 29/09/2006 (A - 3) | 2009 | Thermal | 15 | 644 | 142.59 |
| | 2009 | Hydro | 30 | 1,028 | 136.54 |
| 10/10/2006 (A - 5) | 2011 | Thermal | 15 | 535 | 148.03 |
| | 2011 | Hydro | 30 | 569 | 130.16 |
| 26/07/2007 (A - 3) | 2010 | Thermal | 15 | 1,304 | 145.05 |
| 16/10/2007 (A - 5) | 2012 | Thermal | 15 | 1,597 | 138.26 |
| | 2012 | Hydro | 30 | 715 | 139.10 |
| UHE Santo Antônio (10/12/2007) A - 5 | 2012 | Hydro | 30 | 1,554 | 84.95 |
| UHE Jirau 19/05/2008 (A - 5) | 2013 | Hydro | 30 | 1,383 | 76.86 |
| Energia Reserva (14/08/2008) | 2009 | Biomass | 15 | 35 | 65.56 |
| | 2010 | | | 513 | 63.23 |
| A - 3 (17/09/2008) | 2011 | Thermal | 15 | 1,076 | 149.23 |
| A - 5 (30/09/2008) | 2013 | Thermal | 15 | 3,004 | 156.43 |
| | 2013 | Hydro | 30 | 121 | 97.02 |

Source: Brazilian Ministry of Mining and Energy
http://www.mme.gov.br/mme

Thus, the PPs deemed this situation to be unlikely to happen in the future.

## Outcome of Step 2

As could be noted, this project activity (LFG1) lacks of financial attractiveness by giving an NPV without the CER revenue below zero.

Thus, it seems reasonable to conclude that the project activity is unlikely to be the most financially attractive scenario.

**Step 4. Common practice analysis**

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

Based on the documents below:

- The second Brazilian Greenhouse Gases Emissions Inventory Report[9]

  It states that between 1990-2002 the total amount of recovered methane in Brazilian landfills were considered zero. Furthermore, from 2003 onwards, all flared/recovered methane considered in the Inventory came from CDM landfill projects in Brazil.

- São Paulo State Greenhouse Gases Emissions Inventory Report in Waste Sector[10]

  It states that between 1990-2002 the total amount of recovered methane in São Paulo State landfills were considered zero. Furthermore, from 2003 onwards, all recovered methane considered in the State Inventory came from the $CH_4$ reductions of the CDM landfill projects in the State of São Paulo.

- Reducing the uncertainty of methane recovered (R) in greenhouse gas inventories from waste sector and of adjustment factor (AF) in landfill gas projects under the clean development mechanism[11].
  e
  It states that "all of Brazilian landfills with collection and destruction system (active system) are implemented projects under the CDM".

Thus, there are no similar activities[12] like the proposed project activity in Brazil operating or underway without CDM benefits, because all of the landfills that are developing capture and/or use of the LFG, are being developed as CDM project activities. The table below shows the landfill projects implemented or underway in Brazil.

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[9] Source: Ministry of Science and Technology. The second Brazilian Greenhouse Gases Emissions Inventory Report. Page 62. (http://www.mct.gov.br/upd_blob/0213/213909.pdf), accessed on 07/04/2011.

[10] Source: São Paulo State Environmental Company – CETESB. São Paulo State Greenhouse Gases Emissions Inventory Report in Waste Sector. Page 253. (http://www.cetesb.sp.gov.br/userfiles/file/mudancasclimaticas/geesp/file/docs/consulta/relatorios/residuos.pdf), accessed on 07/04/2011.

[11] Source: MAGALHÃES, G.HC.; ALVES, J.W.S.; SANTO FILHO. F.; COSTA, R.M.; KELSON. M. Reducing the uncertainty of methane recovered (R) in greenhouse gas inventories from waste sector and of adjustment factor (AF) in landfill gas projects under the clean development mechanism (2010). Page 174. (http://ghg.org.ua/fileadmin/user_upload/book/Proceedengs_UncWork.pdf), accessed on 07/04/2011.

| Project Title | Status | Source |
|---|---|---|
| NovaGerar Landfill Gas to Energy Project | Registered on 18/11/2004 | http://cdm.unfccc.int/Projects/DB/DNV-CUK1095236970.6/view |
| Salvador da Bahia Landfill Gas Management Project | Registered on 15/08/2005 | http://cdm.unfccc.int/Projects/DB/DNV-CUK1117823353.4/view |
| Onyx Landfill Gas Recovery Project – Trémembé, Brazil | Registered on 24/11/2005 | http://cdm.unfccc.int/Projects/DB/DNV-CUK1126082019.35/view |
| Brazil MARCA Landfill Gas to Energy Project | Registered on 23/01/2006 | http://cdm.unfccc.int/Projects/DB/DNV-CUK1132565688.17/view |
| Bandeirantes Landfill Gas to Energy Project (BLFGE) | Registered on 20/02/2006 | http://cdm.unfccc.int/Projects/DB/DNV-CUK1134130255.56/view |
| ESTRE's Paulínia Landfill Gas Project (EPLGP) | Registered on 03/03/2006 | http://cdm.unfccc.int/Projects/DB/DNV-CUK1134989999.25/view |
| Caieiras landfill gas emission reduction | Registered on 09/03/2006 | http://cdm.unfccc.int/Projects/DB/DNV-CUK1134509951.62/view |
| Landfill Gas to Energy Project at Lara Landfill, Mauá, Brazil | Registered on 15/05/2006 | http://cdm.unfccc.int/Projects/DB/DNV-CUK1138957573.9/view |
| São João Landfill Gas to Energy Project (SJ) | Registered on 02/07/2006 | http://cdm.unfccc.int/Projects/DB/DNV-CUK1145141778.29/view |
| Project Anaconda | Registered on 15/12/2006 | http://cdm.unfccc.int/Projects/DB/DNV-CUK1155134946.56/view |
| Central de Resíduos do Recreio Landfill Gas Project | Registered on 31/12/2006 | http://cdm.unfccc.int/Projects/DB/DNV-CUK1158844635.31/view |
| Canabrava Landfill Gas Project | Registered on 08/04/2007 | http://cdm.unfccc.int/Projects/DB/SGS-UKL1169669649.47/view |
| Aurá Landfill Gas Project | Registered on 30/04/2007 | http://cdm.unfccc.int/Projects/DB/SGS-UKL1169639070.69/view |
| Quitaúna Landfill Gas Project (QLGP) | Registered on 27/05/2007 | http://cdm.unfccc.int/Projects/DB/DNV-CUK1169931302.54/view |
| ESTRE Itapevi Landfill Gas Project (EILGP) | Registered on 17/09/2007 | http://cdm.unfccc.int/Projects/DB/DNV-CUK1169886803.63/view |
| URBAM/ARAUNA - Landfill Gas Project (UALGP) | Registered on 14/10/2007 | http://cdm.unfccc.int/Projects/DB/DNV-CUK1185017358.24/view |
| Embralixo/Araúna - Bragança Landfill Gas Project | Registered on | http://cdm.unfccc.int/Projects/DB/DNV-CUK1182151832.44/view |

[12] The "Tool for the demonstration and assessment of additionality" – version 5.2, states: "Projects are considered similar if they are in the same country/region and/or rely on a broadly similar technology, are of a similar scale, and take place in a comparable environment with respect to regulatory framework, investment climate, access to technology, access to financing, etc. Other CDM project activities (registered project activities and project activities which have been published on the UNFCCC website for global stakeholder consultation as part of the validation process) are not to be included in this analysis"

| | | |
|---|---|---|
| (EABLGP) | 15/10/2007 | |
| Alto-Tiete landfill gas capture project | Registered on 29/05/2008 | http://cdm.unfccc.int/Projects/DB/RWTUV1204280292.23/view |
| Probiogas - JP-João Pessoa Landfill Gas Project | Registered on 30/01/2008 | http://cdm.unfccc.int/Projects/DB/SGS-UKL1181685608.94/view |
| ESTRE Pedreira Landfill Gás Project (EPLGP) | Registered on 12/02/2008 | http://cdm.unfccc.int/Projects/DB/DNV-CUK1179394615.79/view |
| SANTECH – Saneamento & Tecnologia Ambiental Ltda. – SANTEC Resíduos landfill gas emission reduction Project Activity | Registered on 19/02/2009 | http://cdm.unfccc.int/Projects/DB/TUEV-SUED1214902532.06/view |
| Terrestre Ambiental Landfill Gás Project | Registered on 06/05/2008 | http://cdm.unfccc.int/Projects/DB/DNV-CUK1179391286.32/view |
| CTRVV Landfill emission reduction project | Registered on 28/05/2008 | http://cdm.unfccc.int/Projects/DB/SGS-UKL1198775230.25/view |
| Feira de Santana Landfill Gas Project | Registered on 12/08/2008 | http://cdm.unfccc.int/Projects/DB/DNV-CUK1203743009.45/view |
| Proactiva Tijuquinhas Landfill Gas Capture and Flaring project | Registered on 13/08/2008 | http://cdm.unfccc.int/Projects/DB/DNV-CUK1200058130.23/view |
| Natal Landfill Gas Recovery Project | Validation | http://cdm.unfccc.int/Projects/Validation/DB/K82DG9XUKVQ8IGUYJZMLMYLPQRAL1S/view.html |
| Projeto de Gas de Aterro TECIPAR – PROGAT | Validation | http://cdm.unfccc.int/Projects/Validation/DB/O7LXRYICDY6UWTAIEGYKIZXMEM2SMO/view.html |
| Marilia/Arauna Landfill Gas Project | Validation | http://cdm.unfccc.int/Projects/Validation/DB/FQBM6GP50MLPJPM39192IFGG9T783R/view.html |
| Laguna Landfill Methane Flaring | Validation | http://cdm.unfccc.int/Projects/Validation/DB/ZYNYNR7MAYN1HUBX6W98E7BWLMWOI4/view.html |
| Gramacho Landfill Gas Project | Validation | http://cdm.unfccc.int/Projects/Validation/DB/IOJKHC9RUXNKFXMF0GW8V7YS4BV4UU/view.html |
| Exploitation of the biogas from Controlled Landfill in Solid Waste Management Central-CTRS/BR.040 | Validation | http://cdm.unfccc.int/Projects/Validation/DB/MOYBL8JBAF6YGLLMXD0Q4EWLGPF9M7/view.html |
| Embralixo/Araúna - Bragança Landfill Gas Project (EABLGP) | Validation | http://cdm.unfccc.int/Projects/Validation/DB/BLH87CY04LN8PYLXEF6VS7X0PX8O60/view.html |
| Corpus/Araúna – Landfill Biogas Project. | Validation | http://cdm.unfccc.int/Projects/Validation/DB/XRCDRQ6VTVP6B8NFCCTH92OZI9D6B7/view.html |
| CTR Candeias Sanitary Landfill | Validation | http://cdm.unfccc.int/Projects/Validation/DB/N6QEYV2VTTLSA6IHMB5246UONLXAA3/view.html |
| Manaus Landfill Gas Project | Validation | http://cdm.unfccc.int/Projects/Validation/DB/UU28PRXBOC4Z6WHEUG6OM1EXXDBOW2/view.html |

Summarizing, there are no landfill projects in Brazil burning and/or using of the LFG without CDM revenues.

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

Not applicable. There are no similar options to the proposed project activity not being developed as a CDM project activity.

**Conclusion:**

Since all the criteria of the *"Tool for the demonstration and assessment of additionality" 5.2* are satisfied, the proposed project activity is additional.

**B.6. Emission reductions:**

**B.6.1. Explanation of methodological choices:**

The baseline emissions were calculated according to the following formula:

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

Where:

| | | |
|---|---|---|
| $BE_y$ | = | Baseline emissions in year *y* ($tCO_2e$); |
| $MD_{project,y}$ | = | The amount of methane that would have been destroyed/combusted during the year, in tonnes of methane ($tCH_4$) in project scenario; |
| $MD_{BL,y}$ | = | The amount of methane that would have been destroyed/combusted during the year in the absence of the project due to regulatory and/or contractual requirement, in tonnes of methane ($tCH_4$); |
| $GWP_{CH4}$ | = | Global Warming Potential value for methane for the first commitment period is 21 $tCO_2e/tCH_4$; |
| $EL_{LFG}$ | = | Net quantity of electricity produced using LFG which in the absence of the project activity would have been produced by power plants connected to the grid or by an on-site/off-site fossil fuel based captive power generation, during year *y*, in megawatt hours (MWh); |
| $CEF_{elec,BL,y}$ | = | $CO_2$ emissions intensity of the baseline source of electricity displaced, in $tCO_2e/MWh$; |
| $ET_{LFG,y}$ | = | The quantity of thermal energy produced utilizing the landfill gas, which in the absence of the project activity would have been produced from onsite/offsite fossil fuel fired boiler, during the year y in TJ; |
| $CEF_{ther,BL,y}$ | = | $CO_2$ emissions intensity of the fuel used by boiler to generate thermal energy which is displaced by LFG based thermal energy generation, in $tCO_2/TJ$. |

As the project only aims to flare and generate electricity, $ET_{LFG,y} = 0$, and the equation is changed as following:

$$BE_y = (MD_{project,y} - MD_{BL,y}) \times GWP_{CH4} + EL_{LFG,y} \times CEF_{elec,BL,y}$$

As in there is no regulatory or contractual requirements specifying $MD_{BL}$, do not exist historic data for LFG capture and destruction, an "Adjustment Factor" (AF) is used taking into account the project context, by using the following formula:

$$MD_{BL} = MD_{project,y} \times AF$$

Where the AF is estimated as following:

1. Percentage of methane vented through the passive system: the site operator has installed a simple passive venting system. As some experts say "The passive systems are not as efficient as the active systems". The collection efficiency is 65% for the CGR Guatapara. The IPCC 2006[13] measured in 11 closed landfill sites (where the collection efficiency is greater than in operational landfill site) an average collection efficiency of 37% for active systems. In order to be conservative, it's assumed 50% of collection efficiency in the baseline scenario (passive venting system).

2. Current methodologies estimate that the combustion efficiency of open proprietary flaring equipment is 50% (i.e. one half of the recoverable methane is combusted). As the passive vents at CGR Guatapara Landfill are not optimized for flaring LFG, for instance there is neither automatic ignition nor lambda adjustment, it is unlikely that they reach the 50% combustion efficiency normally attributed to engineered flaring equipment. Thus,

3. According to the landfill operator, the wells do not burn LFG constantly at the same time.

So, the formula used to calculate the Adjustment factor is presented below:

$$AF = \left(Q_{vents} \times \eta_{open\_flare} \times \eta_{vent} \times \%_{ingnited}\right) \div Q_{baseline}$$

Where:

| | | |
|---|---|---|
| AF | = | Adjustment Factor |
| $Q_{vents}$ | = | Average landfill biogas flow rate in the passive vents corrected to 50% methane; |
| $\eta_{openflares}$ | = | Combustion efficiency of the passive vents used the same as open flares; |
| $\%_{ignited}$ | = | Percentage of passive vents that are burning at any one time; |
| $Q_{baseline}$ | = | the estimated collection efficiency multiplied by the flare efficiency. |

Thus, the values used are:

$Q_{vents}$ = 50%, based on 2006 IPCC;
$\eta_{openflare}$ = 50%;
$\eta_{vent}$ = 50%;
$\%_{ignited}$ = 50%;
$Q_{baseline}$ = a collection efficiency of 65% multiplied by the flare efficiency of 99%;

[13] IPCC 2006, Volume 5, Chapter 3, page 3.19.

| | | | |
|---|---|---|---|
| Effectively burning wells | 50% | Collection Efficiency | 65% |
| Engineered Open Flare efficiency | 50% | Flare Efficiency | 99% |
| $\eta_{vents}$ | 50% | | |
| Collection efficiency | 50% | | |
| **Total** | **6.25%** | **Total** | **64.35%** |
| | | | |
| ***Adjustment Factor*** | | | ***9.71%*** |

So the adjustment factor of 10% was used and deemed conservative. AF = 10%.

According to the methodology ACM0001 version 11, the methane destroyed by the project activity ($MD_{project,y}$) during a year is determined by monitoring the quantity of methane actually flared and gas used to generate electricity a. The project activity aims to capture and flare LFG and in a second phase to generate electricity with LFG.

The sum of the quantities fed to the flare(s) and to the power plant(s)

$$MD_{project,y} = MD_{flared,y} + MD_{electricity,y};$$

Where:
$MD_{flared,y}$ = Quantity of methane destroyed by flaring ($tCH_4$);
$MD_{electricity,y}$ = Quantity of methane destroyed by generation of electricity ($tCH_4$);

$MD_{flared,y}$ is calculated as following:

$$MD_{flared,y} = (LFG_{flared,y} \times w_{CH4} \times D_{CH4}) - \frac{PE_{flare,y}}{GWP_{CH4}}$$

Where:

$LFG_{flare,y}$ = Quantity of landfill gas fed to the flare(s) during the year measured in ($m^3$);
$w_{CH4}$ = Average methane fraction of the landfill gas as measured during the given time period t in time intervals of not greater than one hour (typically every 2-3 minutes)and expressed as a fraction of $CH_4$ volume per LFG volume (in $m^3CH_4/m^3LFG$);
$D_{CH4}$ Methane density, expressed in tonnes of methane per cubic meter of methane ($tCH_4/m^3CH_4$), and measured at STP (0 degree Celsius and 1.013 bar), which is 0.0007168 $tCH4/m^3CH_4$ (as per consolidated methodology ACM0001 ver.11);
$PE_{flare,y}$ = Project emissions from flaring of the residual gas stream in year y ($tCO_2e$)[14];

And $MD_{electricity,y}$ is calculated as follows:

$$MD_{electricity,y} = LFG_{electricity,y} \times w_{CH4} \times D_{CH4}$$

Where:

[14] According to ACM0001, $PE_{flared,y}$ is considered in $MD_{flared,y}$

$LFG_{electricity,y}$ = Quantity of landfill gas fed into electricity generator ($m^3$).

The ex-ante emissions were calculated as described in item B.6.3.

**Project emissions:**

$$PE_y = PE_{EC,y} + PE_{FC,j,y}$$

Where:
$PE_{EC,y}$ = Emissions from consumption of electricity in the project case ($tCO_2$).
$PE_{FC,j,y}$ = Emission from consumption of heat in the project case ($tCO_2$).

There will not have any consumption of heat by this project activity ($PE_{FC,j,y}$=0), thus the formula becomes:

$$PE_y = PE_{EC,y}$$

However, the project emission from electricity consumption has two components. First ($PE_{EC1,y}$), it is due to electricity consumption from the grid. The second ($PE_{EC2,y}$) component is due to electricity from diesel generator.

Therefore, $PE_y = PE_{EC1,y} + PE_{EC2,y}$

$PE_{EC1,y}$ - electricity consumed from the grid
For electricity consumed from the grid, the *option A1* from "Tool to calculate baseline, project and/or leakage emissions from electricity consumption" will be used. In this case, the combined emission factor will be calculated using the "Tool to calculate the emission factor for an electricity system" ($EF_{EL,j1,y} = EF_{grid,CM,y}$).

$$PE_{EC1,y} = EC_{PJ,j1,y} \times EF_{grid,CM,y} \times \left(1 + TDL_{j1,y}\right)$$

Where:

$EC_{PJ,j1,y}$ = quantity of electricity consumed from the grid by the project activity during the year y (MWh);
$EF_{grid,CM,y}$ = the emission factor from the grid in year y ($tCO_2$/MWh);
$TDL_{j1,y}$ = average technical transmission and distribution losses in the grid in year y for the voltage level at which electricity is obtained from the grid at the project site.

$PE_{EC2,y}$ - electricity consumed from diesel generator

For electricity consumed from the diesel generator, the *option B1* from "Tool to calculate baseline, project and/or leakage emissions from electricity consumption" will be used.

$$PE_{EC2,y} = EC_{PJ,j2,y} \times EF_{EL,j2,y} \times \left(1 + TDL_{j2,y}\right)$$

Where:

$EC_{PJ,j2,y}$ = quantity of electricity generated by diesel generator in the project activity during the year y (MWh);
$EF_{EL,j2,y}$ = the emission factor from the diesel generator in year y ($tCO_2$/MWh);
$TDL_{j2,y}$ = average technical transmission and distribution losses in year y for the voltage level at which electricity is obtained from the diesel generator at the project site.

The diesel generator is located in LFG plant and thus, there are no technical transmission and distribution losses ($TDL_{j2,y} = 0$). Therefore, the formula is:

$$PE_{EC2,y} = EC_{PJ,j2,y} \times EF_{EL,j2,y}$$

The emission factor from the diesel generator is:

$$EF_{EL,j/k/l,y} = \frac{\sum_{n}\sum_{i} FC_{n,i,t} \times NCV_{i,t} \times EF_{CO2,i,t}}{\sum_{n} EG_{n,t}}$$

Where:

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

$FC_{n,i,t}$ = Quantity of fossil fuel type *i* fired in the captive power plant *n* in the time period *t* (mass or volume unit)

$NCV_{i,t}$ = Average net calorific value of fossil fuel type *i* used in the period *t* (GJ / mass or volume unit)

$EF_{CO2,i,t}$ = Average $CO_2$ emission factor of fossil fuel type *i* used in the period *t* ($tCO_2$ / GJ)

$EG_{n,t}$ = Quantity of electricity generated in captive power plant *n* in the time period *t* (MWh)

*i* = are the fossil fuel types fired in captive power plant *n* in the time period *t*
*j* = Sources of electricity consumption in the project
*n* = Fossil fuel fired captive power plants installed at the site of the electricity consumption source *j*, *k* or *l*
*t* = Time period for which the emission factor for electricity generation is determined

**Leakage:**

In accordance with the ACM0001 version 11, no leakage effects need to be accounted.

**Emission Reduction**

Emission reductions are calculated as follows:

$$ER_y = BE_y – PE_y,$$

Where:

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

Enclosed flare(s) will be installed in the project activity to increase the destruction efficiency. Those flares reach 99% of methane destruction efficiency.

To determine the project emissions from flaring gases were used the "Tool to determine project emissions from flaring gases containing methane". According to this tool, the project emissions should be calculated in 7 steps.

**STEP 1. Determination of the mass flow rate of the residual gas that is flared**

The density of the residual gas is determined based on the volumetric fraction of all components in the gas:

$$FM_{RG} = \rho_{RG,n,h} \times FV_{RG,h}$$

$FM_{RG,h}$ = Mass flow rate of the residual gas in hour h (kg/h);
$\rho_{RG,n,h}$ = Density of the residual gas at normal conditions in hour h ($kg/m^3$);
$FV_{RG,h}$ = Volumetric flow rate of the residual gas in dry basis at normal conditions in the hour h;

And

$$\rho_{RG,n,h} = \frac{P_n}{\frac{R_u}{MM_{RG,h}} \times T_n}$$

$P_n$ = Atmospheric pressure at normal conditions (101,325Pa);
$R_u$ = Universal ideal gas constant (8.314 $Pa.m^3/kmol.K$);
$MM_{RG,h}$ = Molecular mass of the residual gas in hour *h* (kg/kmol);
$T_n$ = Temperature at normal conditions (273.15K);

And,

$$MM_{RG,h} = \sum_i (fv_{i,h} \cdot MM_i)$$

$fv_{i,h}$ = Volumetric fraction of component *i* in the residual gas in the hour *h*;
$MM_i$ = Molecular mass of residual gas component *i* (kg/kmol/);
i = Gas components;

As permitted by the tool, the project participants will only measure the volumetric fraction of methane and consider the difference to 100% as being nitrogen ($N_2$).

**STEP 2. Determination of the mass fraction of carbon, hydrogen, oxygen and nitrogen in the residual gas**

$$fm_{j,h} = \frac{\sum_i fv_{i,h} \cdot AM_j \cdot NA_{j,i}}{MM_{RG,h}}$$

$fm_{j,h}$ = Mass fraction of element *j* in the residual gas in hour *h*;
$AM_j$ = Atomic mass of element *j* (kg/kmol);
$NA_{j,i}$ = Number of atoms of element *j* in component *i*;
$MM_{RG,h}$ = Molecular mass of the residual gas in hour *h*;
j = The elements carbon, hydrogen, oxygen and nitrogen;
i = The components $CH_4$ and $N_2$ (according to the simplification used);

**STEP 3. Determination of the volumetric flow rate of the exhaust gas on a dry basis**

$$TV_{n,FG,h} = V_{n,FG,h} \times FM_{RG,h}$$

Where:

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

$$V_{n,FG,h} = V_{n,CO2,h} + V_{n,O2,h} + V_{n,N2,h}$$

Where:

$V_{n,N2,h}$ = Quantity of $N_2$ volume free in the exhaust gas of the flare at normal conditions per kg of residual gas in the hour *h* ($m^3$/ kg residual gas);
$V_{n,O2,h}$ = Quantity of $O_2$ volume free in the exhaust gas of the flare at normal conditions per kg of residual gas in the hour *h* ($m^3$/ kg residual gas);
$V_{n,CO2,h}$ = Quantity of $CO_2$ volume free in the exhaust gas of the flare at normal conditions per kg of residual gas in the hour *h* ($m^3$/ kg residual gas);

$$V_{n,O2,h} = n_{O2,h} \times MV_n$$

$n_{O2,h}$ = Quantity of moles $O_2$ in the exhaust gas of the flare per kg residual gas flared in hour *h* ($m^3$/ kg residual gas);
$MV_n$ = Volume of one mole of any ideal gas at normal temperature and pressure (22.4 L/mol) (in $m^3$/kmol);

$$V_{n,CO2,h} = \frac{fm_{C,h}}{AM_C} \times MV_n$$

$fm_{C,h}$ = Mass fraction of carbon in the residual gas in the hour h ($m^3$/ kg residual gas);
$AM_C$ = Atomic mass of carbon (kg/kmol);
$MV_n$ = Volume of one mole of any ideal gas at normal temperature and pressure (22.4 L/mol) (in $m^3$/kmol);

And

$$V_{n,N2,h} = MV_n \cdot \left\{ \frac{fm_{N,h}}{200AM_n} + \left( \frac{1 - MF_{o_2}}{MF_{O_2}} \right) \cdot \left( F_h + n_{O_2,h} \right) \right\}$$

Where:

$fm_{N,h}$ = Mass fraction of nitrogen in the residual gas in the hour h
$AM_n$ = Atomic mass of nitrogen (kg/kmol);
$MF_{O2}$ = $O_2$ volumetric fraction of air;
$F_h$ = Stochiometric quantity of moles of $O_2$ required for a complete oxidation of one kg residual gas flared in hour h (kmol/kg residual gas);
$n_{O2,h}$ = Quantity of moles $O_2$ in the exhaust gas of the flare per kg residual gas flared in hour h (kmol/kg residual gas);

$$n_{O_2,h} = \frac{t_{O_2,h}}{(1 - (\frac{t_{O_2,h}}{MF_{O_2}}))} \times \left[ \frac{fm_{C,h}}{AM_C} + \frac{fm_{N,h}}{2AM_N} + \left( \frac{1 - MF_{O2}}{MF_{O2}} \right) \times F_h \right]$$

$t_{O2,h}$ = Volumetric fraction of $O_2$ in the exhaust gas in the hour *h*;
$MF_{O2}$ = $O_2$ volumetric fraction of air;
$F_h$ = Stochiometric quantity of moles of $O_2$ required for a complete oxidation of one kg residual gas in hour *h* (kmol/kg residual gas);
$AM_j$ = Atomic mass of element *j* (kg/kmol);
j = The elements carbon, hydrogen, oxygen and nitrogen;

$$F_h = \frac{fm_{C,h}}{AM_C} + \frac{fm_{H,h}}{4AM_H} + \frac{fm_{O,h}}{2AM_O}$$

Where:

$fm_{j,h}$ = Mass fraction of element *j* in the residual gas in hour *h*;

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

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

$$TM_{FG,h} = \frac{TV_{n,FG,h} \cdot fv_{CH4,FG,h}}{1000000}$$

Where:

$TV_{n,FG,h}$ = Volumetric flow rate of the exhaust gas in dry basis at normal conditions in hour *h* ($m^3$/h exhaust gas);
$fv_{CH4,FG,h}$ = Concentration of methane in the exhaust gas of the flare in dry basis at normal conditions in hour *h* ($mg/m^3$).

**STEP 5. Determination of methane mass flow rate in the residual gas on a dry basis**

The quantity of methane in the residual gas flowing into the flare is the product of the volumetric flow rate of the residual gas ($FV_{RG,h}$), the volumetric fraction of methane in the residual gas ($fv_{CH4,RG,h}$) and the density of methane ($\rho_{CH4,n,h}$) in the same reference conditions (normal conditions and dry or wet basis).

$$TM_{RG,h} = FV_{RG,h} \times fv_{CH4,RG,h} \times \rho_{CH4,n}$$

$FV_{RG,h}$ = Volume flow rate of the residual gas in dry basis at normal conditions in hour h ($m^3/h$);
$fv_{CH4,RG,h}$ = Concentration of methane in the exhaust gas of the flare in dry basis at normal conditions 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**

The determination of the hourly flare efficiency depends on the operation of flare (through temperature), the type of flare used (enclosed) and the approach selected (continuous).

For the project activity, the case of enclosed flares and continuous monitoring of the flare efficiency, the flare efficiency in the hour h is:

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

$$\eta_{flare,h} = 1 - \frac{TM_{FG,h}}{TM_{RG,h}}$$

Where:

$TM_{FG,h}$ = Methane mass flow rate in exhaust gas averaged in a period of time *t* (kg/h);
$TM_{RG,h}$ = Mass flow rate of methane in the residual gas in the hour *h* (kg/h);

**STEP 7. Calculation of annual project emissions from flaring**

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

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

$TM_{RG,h}$ = Mass flow rate of methane in the residual gas in the hour *h* (kg/h);
$\eta_{flare,h}$ = Flare efficiency in hour *h*;

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

| **Data / Parameter:** | Regulatory requirements relating to landfill gas |
|---|---|
| Data unit: | Text |
| Description: | Regulatory requirements relating to landfill gas |
| Source of data used: | Brazil's New National Solid Waste Policy (NSWP)[15]. Available on: http://www.planalto.gov.br/ccivil_03/_ato2007-2010/2010/lei/l12305.htm, accessed on 21/02/2011. |
| Value applied: | - |
| Justification of the choice of data or description of measurement methods and procedures actually applied : | - |
| Any comment: | The information though recorded annually, is used for changes to the adjustment factor (AF) or directly $MD_{BL,y}$ at renewal of the credit period.<br>Relevant regulations for LFG project activities shall be updated at renewal of each credit period. Changes to regulation should be converted to the amount of methane that would have been destroyed/combusted during the year in the absence of the project activity ($MD_{BL,y}$). In the presence of regulatory requirements related to landfill gas emissions, a comparative analysis would be carried out by the PP to define which landfill emission limit is larger between the regulatory and the company internal requirements (e.g. to guarantee operational security). The result of the analysis will define the new overall requirement to be translated into the amount of methane that would have been destroyed/combusted during the year in the absence of the project activity ($MD_{BL,y}$). |

| **Data / Parameter:** | $\varphi$ |
|---|---|
| Data unit: | - |
| Description: | Model correction factor to account for model uncertainties |
| Source of data used: | Oonk et el. (1994) have validated several landfill gas models based on 17 realized landfill gas projects. The mean relative error of multi-phase models was assessed to be 18%. Given the uncertainties associated with the model and in order to estimate emission reductions in a conservative manner, a discount of 10% is applied to the model results. |
| Value applied: | 0.9 |
| Justification of the choice of data or description of measurement methods and procedures actually applied : | Default value used |
| Any comment: | Used for projection of methane avoidance |

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| | |
|---|---|
| **Data / Parameter:** | OX |
| Data unit: | - |
| Description: | Oxidation factor (reflecting the amount of methane from SWDS that is oxidized in the soil or other material covering the waste) |
| Source of data used: | 2006 IPCC Guidelines for National Greenhouse Gas Inventories |
| Value applied: | 0.1 |
| Justification of the choice of data or description of measurement methods and procedures actually applied : | Default value used for managed solid waste disposal sites |
| Any comment: | Used for projection of methane avoidance |

| | |
|---|---|
| **Data / Parameter:** | F |
| Data unit: | - |
| Description: | Fraction of methane in the SWDS gas (volume fraction) |
| Source of data used: | 2006 IPCC Guidelines for National Greenhouse Gas Inventories |
| Value applied: | 0.5 |
| Justification of the choice of data or description of measurement methods and procedures actually applied : | This factor reflects the fact that some degradable organic carbon does not degrade, or degrades very slowly, under anaerobic conditions in the SWDS. A default value of 0.5 is recommended by IPCC. |
| Any comment: | Used for projection of methane avoidance |

| | |
|---|---|
| **Data / Parameter:** | $DOC_f$ |
| Data unit: | - |
| Description: | Fraction of degradable organic carbon that can decompose |
| Source of data used: | 2006 IPCC Guidelines for National Greenhouse Gas Inventories |
| Value applied: | 0.5 |
| Justification of the choice of data or description of measurement methods and procedures actually applied : | |
| Any comment: | Used for projection of methane avoidance |

| **Data / Parameter:** | MCF |
|---|---|
| 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 : | IPPC default value for anaerobic managed solid waste disposal site is applied. The landfill site has a controlled placement |
| Any comment: | Used for projection of methane avoidance |

| **Data / Parameter:** | $DOC_j$ |
|---|---|
| Data unit: | - |
| Description: | Fraction of degradable organic carbon (by weight) in the waste type j |
| Source of data used: | 2006 IPCC Guidelines for National Greenhouse Gas Inventories |
| Value applied: | see table below |
| Justification of the choice of data or description of measurement methods and procedures actually applied : | IPCC default value for anaerobic managed solid waste disposal site is applied. |
| Any comment: | Used for projection of methane avoidance |

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

<table>
<tr><td>Data / Parameter:</td><td>$k_j$</td></tr>
<tr><td>Data unit:</td><td>-</td></tr>
<tr><td>Description:</td><td>Decay rate for waste type j</td></tr>
<tr><td>Source of data used:</td><td>2006 IPCC Guidelines for National Greenhouse Gas Inventories</td></tr>
<tr><td>Value applied:</td><td>
<table>
<tr><td colspan="2" rowspan="2">Waste type j</td><td>Tropical (MAT > 20 °C)</td></tr>
<tr><td>Wet (MAP > 1000mm)</td></tr>
<tr><td rowspan="2">Slowly degrading</td><td>Pulp, paper, cardboard (other than sludge), textiles</td><td>0.07</td></tr>
<tr><td>Wood, wood products and straw</td><td>0.035</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>IPCC default value for anaerobic managed solid waste disposal site is applied.</td></tr>
<tr><td>Any comment:</td><td>Used for projection of methane avoidance. The climate data was provided from Instituto Agronômico de Campinas (IAC).</td></tr>
</table>

| **Data / Parameter:** | Waste composition |
|---|---|
| Data unit: | % |
| Description: | Waste composition |
| Source of data used: | Landfill waste characterization report |
| Value applied: | See table below |
| Justification of the choice of data or description of measurement methods and procedures actually applied : | The values are based on the site waste composition report. |
| Any comment: | Used for projection of methane avoidance |

| **Composition of the waste** | |
|---|---|
| A) Wood and wood products | 4.07% |
| B) Pulp, paper and cardboard (other than sludge) | 9.99% |
| C) Food, food waste, beverages and tobacco (other than sludge) | 48.70% |
| D) Textiles | 7.91% |
| E) Garden, yard and park waste | 1.15% |
| F) Glass, plastic, metal, other inert waste | 28.18% |
| **TOTAL** | 100.0% |

| **Data / Parameter:** | $D_{CH4}$ |
|---|---|
| Data unit: | $tCH_4/m^3CH_4$ |
| Description: | Methane density |
| Source of data used: | ACM0001 – version 11 |
| Value applied: | 0.0007168 |
| Description of measurement methods and procedures to be applied: | At standard temperature and pressure (0 degrees Celsius and 1,013 bar) the density of methane is 0.0007168 $tCH_4/m^3CH_4$ |
| Justification of the choice of data or description of measurement methods and procedures actually applied : | As per guidance in ACM0001 version 11 |
| Any comment: | |

| **Data / Parameter:** | $BE_{CH4,SWDS,y}$ |
|---|---|
| Data unit: | $tCO_2e$ |
| Description: | Methane generation from the landfill in the absence of the project activity at year y |
| Source of data used: | Emission reduction (ER) spreadsheet |
| Value applied: | <table><tr><th>Year</th><th>$BE_{CH4,SWDS,y}$ ($tCO_2$)</th></tr><tr><td>2012</td><td>260,742</td></tr><tr><td>2013</td><td>293,951</td></tr><tr><td>2014</td><td>319,662</td></tr><tr><td>2015</td><td>340,123</td></tr><tr><td>2016</td><td>372,262</td></tr><tr><td>2017</td><td>397,309</td></tr><tr><td>2018</td><td>417,376</td></tr></table> |
| Description of measurement methods and procedures to be applied: | As per the "Tool to determine methane emissions avoided from disposal of waste at a waste disposal site" version 5.1. |
| Justification of the choice of data or description of measurement methods and procedures actually applied : | - |
| Any comment: | Used for ex-ante estimation of the amount of methane that would have been destroyed/combusted during the year |

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

The emission reductions derived from the displacement of fossil fuels used for electricity generation from other sources are estimated for the Brazilian Interconnected System and strictly guided by ACM0001 ver. 11 which includes the "Tool to Calculate the Emission Factor for an Electricity System" version 2.2, as follows.

***Step 1. Identify the relevant electric power system***

For the purpose of 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 signification transmission constraints.

The Brazilian DNA published an official delineation of the project electricity system in Brazil, considering a national interconnected system.[16]

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

The Brazilian DNA is responsible for calculating the emission factors and it is not included in calculation the off-grid power plants.

***Step 3. Select a method to determined the operating margin (OM)***

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

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

The Brazilian DNA is responsible for calculating the OM emission factor in Brazil. It uses the method c) Dispatch 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 to update the emission factor annually during monitoring.

***Step 4. Calculate the operating margin emission factor according to the selected method***

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

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[16] DNA Resolution n.8 was published on 26/05/2008 on http://www.mct.gov.br/index.php/content/view/14797.html, accessed on 12/08/2010.

$$EF_{grid,OM-DD,y} = \frac{\sum_{m} EG_{PJ,h} \times EF_{EL,DD,h}}{EG_{PJ,y}}$$

Where:

| | | |
|---|---|---|
| $EF_{grid,OM-DD,y}$ | = | 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* m of year y (MWh) |
| $EF_{EL,DD,h}$ | = | $CO_2$ emission factor for 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) |
| h | = | hours in year y in which the project activity is displacing grid electricity |
| y | = | Year in **w**hich the project activity is displacing grid electricity |

The $EF_{EL,DD,h}$, $EF_{EL,DD,d}$ and $EF_{EL,DD,m}$ are displayed on the Brazilian DNA website[17], for the year 2009. However only the $EF_{EL,DD,m}$ will be used in order to calculate the emission reductions.

In order to estimate the emission reductions for the first crediting period the $EF_{EL,DD,2009}$ was calculated as a mean average of the $EF_{EL,DD,m}$. Then,

$EF_{grid,OM-DD,2009}$ = 0.2476 $tCO_2$/MWh.

***Step 5. Calculate the build margin (BM) emission factor***

The Brazilian DNA is responsible for calculating the BM emission factor in Brazil.

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 should 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 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* was chosen for the proposed project.

[17] Source: http://www.mct.gov.br/index.php/content/view/74689.html

The build margin emissions factor is the generation-weighted average emission factor ($tCO_2/MWh$) of all power units m during the most recent year y for which power generation data is available, calculated as follows:

$$EF_{grid,BM,y} = \frac{\sum_m EG_{m,y} \times EF_{EL,m,y}}{\sum_m EG_{m,y}}$$

$$EF_{grid,BM,2009} = 0.0794 \text{ } tCO_2/MWh$$

***Step 6. Calculate the combined margin emissions factor***

The calculation of the combined margin (CM) emission factor (EFgrid,CM,y) is based on one of the following methods:

(a) Weighted average CM; or
(b) Simplified CM

Following the tool recommendations, the weighted average CM method (Option A) was used.

Thus, the combined margin emissions factor is calculated as follows:

$EF_{grid,CM,y} = w_{OM} * EF_{grid,OM,y} + w_{BM} * EF_{grid,BM,y}$

The default weights are as follows: $w_{OM}$ = 0.5 and $w_{BM}$ = 0.5, fixed for the first crediting period. That gives:

$EF_{2009}$ = 0.2476 * 0.5 + 0.0794 * 0.5 = 0.1635 $tCO_2/MWh$

The build margin $CO_2$ emission factor and operating margin CO2 emission factor will be ex-post. Therefore, the combined margin CO2 emission factor will be ex-post.

**<u>Emission reduction</u>**

The total methane generation at the site has been estimated based on the waste tonnage of the landfill using the first order decay model presented in the *"Tool to determine methane emissions from disposal of waste at a solid waste disposal site"* and considering the following equation as mentioned previously.

The methane generation from the landfill in the absence of the project activity (ex-ante emissions) may be calculated as per the following equation in the "Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site" as stated in Section B.6.1:

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

Where:

- $BE_{CH4,SWDS,y}$ is the methane generation from the landfill in the absence of the project activity, measured in $tCO_2e$.
- $\phi$ is the model correction factor to account for model uncertainties (0.9);
- $GWP_{CH4}$ is the global warming potential of methane (21 $tCO_2e/tCH_4$);
- OX is the oxidation factor (0.1);

- F is the fraction of methane in the SWDS gas (0.5);
- $DOC_f$ is the fraction of degradable organic carbon that can decompose (0.5);
- MCF is the methane correction factor (1.0);
- $W_{j,x}$ is the amount of organic waste type j prevented from disposal in the SWDS , measured in tonnes;
- $DOC_j$ is the fraction of degradable organic carbon (by weight) in the waste type j; and
- $k_j$ is the decay rate constant for waste type j;

The assumptions used to calculate methane emissions are presented as follows:

Methane content in LFG = 50%;
LFG collection efficiency = 65%; and
Density of methane = 0.0007168 tonnes/$m^3$ (as per consolidated methodology ACM0001 ver. 11).

The landfill gas collection and utilization system will capture only a portion of the generated landfill gas. Thus, an estimate of 65% LFG collection was applied to the estimate of LFG produced. Under assumption that generated LFG is composed of 50% methane, table below illustrates the quantities of methane collected by the project activity during the crediting period.

**Table 7 - Estimated amount of methane captured by the project activity**

| Year | $MD_{project}$ (tCH4) |
|---|---|
| 2012 | 8,071 |
| 2013 | 9,098 |
| 2014 | 9,894 |
| 2015 | 10,528 |
| 2016 | 11,522 |
| 2017 | 12,298 |
| 2018 | 12,919 |

1. **<u>Leakage:</u>**

No leakage effects need to be accounted under methodology ACM0001 ver. 11.

2. **<u>Project emission:</u>**

As explain above (Section B.6.1), the project emission is:

$$PE_y = PE_{EC1,y} + PE_{EC2,y}$$

<u>$PE_{EC1,y}$ - electricity consumed from the grid</u>
For electricity consumed from the grid, the *option A1* from “Tool to calculate baseline, project and/or leakage emissions from electricity consumption” will be used. In this case, the combined emission factor will be calculated using the “Tool to calculate the emission factor for an electricity system” ($EF_{EL,j1,y}$ = $EF_{grid,CM,y}$).

$$PE_{EC1,y} = EC_{PJ,j1,y} \times EF_{grid,CM,y} \times \left(1 + TDL_{j1,y}\right)$$

Where:

$EC_{PJ,j1,y}$ = quantity of electricity consumed from the grid by the project activity during the year y (MWh);
$EF_{grid,CM,y}$ = the emission factor from the grid in year y ($tCO_2$/MWh);
$TDL_y$ = average technical transmission and distribution losses in the grid in year y for the voltage level at which electricity is obtained from the grid at the project site.

In the project activity, electrical consumption ($EC_{PJ,,j1,y}$) is associated with the equipment required to draw and process landfill gas. The electrical consumption from the grid is estimated around 657 MWh/year (as conservative approach, it was used the highest value for electrical consumption in the first credit period). Electrical requirements of the power plant can be satisfied by the generated electricity.

Option A1 of the "Tool to calculate baseline, project and/or leakage emissions from electricity consumption" ver. 1, states that a value of the combined margin emission factor ($EF_{grid,CM,y}$) may be used as the emission factor ($EF_{EL,j1,y} = EF_{grid,CM,y}$). Therefore a value of 0.1635 $tCO_2$/MWh will be used.

Finally the technical transmission and distribution losses ($TDL_{j1,y}$) value has been assumed to be 6%, according to BEN - 2006.[18] Table below summarizes the project emissions resulting from electrical consumption in the plant.

**Table 8 - Electricity consumption from the grid resulting due to project activity**

| **Year** | **Electricity consumption from the grid - $EC_{PJ,j1,y}$** (MWh/year) | **$PE_{EC1,y}$ ($tCO_2$/year)** |
|---|---|---|
| 2012 | 657 | 114 |
| 2013 | 657 | 114 |
| 2014 | 657 | 114 |
| 2015 | 657 | 114 |
| 2016 | 657 | 114 |
| 2017 | 657 | 114 |
| 2018 | 657 | 114 |

It is noted that in 2013, the first year of electrical generation utilizing LFG as a fuel, the power plant will be able to supply both the requirements of the power plant and of the blowers required to collect the LFG. As a result, the data contained in table above will be an overestimation of the actual emissions resulting from electrical consumption and should be seen as conservative estimate for the period prior to implementation of the power plant.

$PE_{EC2,y}$ - electricity consumed from diesel generator

For electricity consumed from diesel generator, the *option B1* from "Tool to calculate baseline, project and/or leakage emissions from electricity consumption" will be used.

$$PE_{EC2,y} = EC_{PJ,j2,y} \times EF_{EL,j2,y}$$

Where:

[18] National Energy Balance 2006 (base year 2005), page 21.

$EC_{PJ,j2,y}$ = quantity of electricity consumed from the diesel generator by the project activity during the year y (MWh);
$EF_{EL,j2,y}$ = the emission factor from the diesel generator in year y ($tCO_2$/MWh);

Project emissions will be generated from the occasional use of a standby generator located on site.eThe diesel generator consumption will be around 2 MWh/year.

The ACM0001 states in page 11 that: "In case the baseline is electricity generated by an on-site/off-site fossil fuel fired captive power plant in the baseline, project proponents may use a default value of 0.8 tCO2/MWh or estimate the emission factor". The project activity includes a captive on-site diesel generator and therefore, the value of 0.8 $tCO_2$/MWh was used for ex-ante estimation.

The following table represents the estimated project emissions from the use of the standby generator over the crediting period. Table below presents the project emissions associated with fossil fuel combustion at the project site.

**Table 9 - Project emissions from diesel generator**

| **Year** | **Electricity consumption from diesel generator - $EC_{PJ,j2,y}$** (MWh/year) | **$PE_{EC2,y}$ ($tCO_2$/year)** |
|---|---|---|
| 2012 | 2 | 2 |
| 2013 | 2 | 2 |
| 2014 | 2 | 2 |
| 2015 | 2 | 2 |
| 2016 | 2 | 2 |
| 2017 | 2 | 2 |
| 2018 | 2 | 2 |

## 3. <u>Estimated anthropogenic emissions by sources of greenhouse gases of the baseline:</u>

### 3.1. Emission Reductions Associated with Methane Destruction:

| **Year** | **$MD_{project}$** ($tCH_4$) |
|---|---|
| 2012 | 8,071 |
| 2013 | 9,098 |
| 2014 | 9,894 |
| 2015 | 10,528 |
| 2016 | 11,522 |
| 2017 | 12,298 |
| 2018 | 12,919 |

$ER_y = (EG_y \times EF_{grid,CM,y}) – PE_y – L_y$

Where:

- $ER_y$ are the emission reductions associated with the project activity (tonnes of $CO_2e$);

- $PE_y$ are the project activity emissions (tonnes of $CO_2e$); and
- $L_y$ are the emissions due to leakage (tonnes of $CO_2e$).

Since emissions due to leakage are not considered for landfill gas projects (ACM0001 ver. 11), the emission reductions for the electricity displacement are then simplified as:

$ER_y = (EG_y \times EF_{grid,CM,y}) - PE_y$

The baseline emissions was estimated and summarized as per table below.

| **Year** | **$MD_{project}$** (tCH4) | **$MD_{BL}$** (tCH4) | **BEy (tCO2)** | **PEy (tCO2)** | **Leakage (tCO2)** | **ERy (tCO2)** |
|---|---|---|---|---|---|---|
| 2012 | 8,071 | 807 | 152,533 | 116 | 0 | 152,417 |
| 2013 | 9,098 | 910 | 176,662 | 116 | 0 | 176,546 |
| 2014 | 9,894 | 989 | 191,704 | 116 | 0 | 191,588 |
| 2015 | 10,528 | 1,053 | 203,673 | 116 | 0 | 203,557 |
| 2016 | 11,522 | 1,152 | 223,650 | 116 | 0 | 223,534 |
| 2017 | 12,298 | 1,230 | 238,303 | 116 | 0 | 238,187 |
| 2018 | 12,919 | 1,292 | 250,042 | 116 | 0 | 249,926 |

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

| **Year** | **Estimation of project activity emission ($tCO_2e$)** | **Estimation of the baseline emissions ($tCO_2e$)** | **Estimation of leakage ($tCO_2e$)** | **Estimation of emission reductions ($tCO_2e$)** |
|---|---|---|---|---|
| 2012 | 116 | 152,533 | 0 | 152,417 |
| 2013 | 116 | 176,662 | 0 | 176,546 |
| 2014 | 116 | 191,704 | 0 | 191,588 |
| 2015 | 116 | 203,673 | 0 | 203,557 |
| 2016 | 116 | 223,650 | 0 | 223,534 |
| 2017 | 116 | 238,303 | 0 | 238,187 |
| 2018 | 116 | 250,042 | 0 | 249,926 |
| **Total (tonnes of $CO_2e$)** | **812** | **1,436,567** | **0** | **1,435,755** |

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

### B.7.1 Data and parameters monitored:

| **Data / Parameter:** | $EF_{grid,CM,y} = EF_{EL,j1,y}$ |
|---|---|
| Data unit: | $tCO_2$/MWh |
| Description: | $CO_2$ emission factor of the Brazilian grid electricity during the year y |

| | |
|---|---|
| Source of data to be used: | Brazilian DNA |
| Value of data applied for the purpose of calculating expected emission reductions in section B.5 | 0.1635 |
| Description of measurement methods and procedures to be applied: | The emission factor is calculated ex-post, as the weighted average of the dispatch data analysis OM (Operating Margin) and the BM (Build margin), as described in B.6.3. |
| QA/QC procedures to be applied: | Apply procedures in the "Tool to calculate the emission factor for an electricity system" Version 2.2. |
| Any comment: | All data and parameters to determine the grid electricity emission factor, as required by the "Tool to calculate the emission factor for an electricity system", Version 2.2, were included in the monitoring plan.<br><br>For more details, see Annex 3. |

| **Data / Parameter:** | $EF_{grid,BM,y}$ |
|---|---|
| Data unit: | $tCO_2$ /MWh |
| Description: | Build margin emission factor of the Brazilian grid |
| Source of data to be used: | Brazilian DNA |
| Value of data applied for the purpose of calculating expected emission reductions in section B.5 | 0.0794 |
| Description of measurement methods and procedures to be applied: | The emission factor is calculated *ex-post*, as described in B.6.3. |
| QA/QC procedures to be applied: | Apply procedures in the "Tool to calculate the emission factor for an electricity system" Version 2.2. |
| Any comment: | All data and parameters to determine the grid electricity emission factor, as required by the "Tool to calculate the emission factor for an electricity system", Version 2.2, were included in the monitoring plan.<br><br>For more details, see Annex 3. |

| **Data / Parameter:** | $EF_{grid,OM,y}$ |
|---|---|
| Data unit: | $tCO_2$ /MWh |
| Description: | Operating margin emission factor of the Brazilian grid |
| Source of data to be used: | Brazilian DNA |
| Value of data applied for the purpose of calculating expected | 0.2476 |

| | |
|---|---|
| emission reductions in section B.5 | |
| Description of measurement methods and procedures to be applied: | The operating margin emission factor is calculated ex-post, as described in B.6.3. |
| QA/QC procedures to be applied: | Apply procedures in the "Tool to calculate the emission factor for an electricity system" Version 2.2. |
| Any comment: | All data and parameters to determine the grid electricity emission factor, as required by the "Tool to calculate the emission factor for an electricity system", Version 2.2, were included in the monitoring plan.<br><br>For more details, see Annex 3. |

| **Data / Parameter:** | $LFG_{total,y}$ |
|---|---|
| Data unit: | $Nm^3$ |
| Description: | Total amount of landfill gas captured at normal temperature and pressure |
| Source of data to be used: | Project participants |
| Value of data applied for the purpose of calculating expected emission reductions in section B.5 | 22,518,339 (estimated to 2012) |
| Description of measurement methods and procedures to be applied: | The data will be collected continuously using a vortex flow meter. The data will be aggregated on a monthly and yearly basis using continuous monitoring average values in time intervals of not greater than one hour. The data will be archived for a minimum of two years after the end of the crediting period or the last issuance of CERs for this project activity, whichever occurs later. |
| QA/QC procedures to be applied: | Calibration of equipment as per manufacturer specifications to ensure validity of data measured. |
| Any comment: | - |

| **Data / Parameter:** | $LFG_{flare,y}$ |
|---|---|
| Data unit: | $Nm^3$ |
| Description: | Amount of landfill gas flared at Normal Temperature and Pressure |
| Source of data to be used: | Project Participants |
| Value of data applied for the purpose of calculating expected emission reductions in section B.5 | 100% for the first phase and around of 20% for the subsequent phase. However this value may vary according to the gensets availability. |
| Description of measurement methods and procedures to be applied: | During Phase 1 (flaring) the data will be collected continuously (average values in time intervals of not greater than one hour) using 1 vortex flow meter located in the piping leading to the flare. Upon completion of Phase 2 (electricity generation) an additional vortex flow meters will be installed with one being in the piping leading to the engine and the other on the main piping measuring the total collected landfill gas. The data will be aggregated monthly and yearly for the flare. The data will be archived for a minimum of two years after the end of the crediting period or the last issuance of CERs for this project activity, whichever occurs later. |
| QA/QC procedures to be applied: | Calibration of equipment as per manufacturer specifications to ensure validity of data measured. |
| Any comment: | - |

| **Data / Parameter:** | $LFG_{electricity,y}$ |
|---|---|
| Data unit: | $Nm^3$ |
| Description: | Amount of LFG combusted in power plant at Normal Temperature and Pressure |
| Source of data to be used: | Project participants |
| Value of data applied for the purpose of calculating expected emission reductions in section B.5 | 0% of the $LFG_{total}$ for the first year and 80% for the subsequent years. However this value will vary according to the gensets availability and operational schedule. |
| Description of measurement methods and procedures to be applied: | The data will be collected continuously (average values in time intervals of not greater than one hour) using a vortex flow meter. The data will be aggregated monthly and yearly for the power plant. The data will be archived for a minimum of two years after the end of the crediting period or the last issuance of CERs for this project activity, whichever occurs later. |
| QA/QC procedures to be applied: | Calibration of equipment as per manufacturer specifications to ensure validity of data measured. |
| Any comment: | - |

| **Data / Parameter:** | $\mathbf{w_{CH4}}$ |
|---|---|
| Data unit: | $m^3CH_4/m^3LFG$ |
| Description: | Methane fraction in the landfill gas |
| Source of data to be used: | Project participants |

| | |
|---|---|
| Value of data applied for the purpose of calculating expected emission reductions in section B.5 | 50% |
| Description of measurement methods and procedures to be applied: | Continuous measurements from gas quality analyzer. Data will be aggregated monthly and yearly, using an average value in a time interval not greater than an hour. |
| QA/QC procedures to be applied: | The gas analyzer should be subject to a regular maintenance and testing regime to ensure accuracy. |
| Any comment: | Monitoring under responsibility of the Project's operators (the team, the organizational structure and the management structure will be defined after the project's implementation). The data will be measure in dry basis.<br>The data will be archived for a minimum of two years after the end of the crediting period or the last issuance of CERs for this project activity, whichever occurs later. |

| | |
|---|---|
| **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: | This is a calculated parameter |
| Value of data applied for the purpose of calculating expected emission reductions in section B.5 | 1% of the total baseline emissions |
| Description of measurement methods and procedures to be applied: | Annual data will be recorded as per the most current version of the *"Tool to determine project emissions from flaring gases containing Methane"*. The data will be archived for a minimum of two years after the end of the crediting period or the last issuance of CERs for this project activity, whichever occurs later. |
| QA/QC procedures to be applied: | The parameters used for determining the project emissions from flaring of the residual gas stream in year y will use the QA/QC procedures as per the "*Tool to determine project emissions from flaring gases containing methane"*. |
| Any comment: | The value of 99% was based on the manufacturer specification |

| | |
|---|---|
| **Data / Parameter:** | $EL_{LFG}$ . |
| Data unit: | MWh |
| Description: | Net amount of electricity generated using LFG |
| Source of data to be used: | Project participants |
| Value of data applied for the purpose of calculating expected emission reductions in section B.5 | see table below |
| Description of measurement methods and procedures to be applied: | The data will be collected continuously using an electricity meter. The data will be archived for a minimum of two years after the end of the crediting period or the last issuance of CERs for this project activity, whichever occurs later. |
| QA/QC procedures to be applied: | Calibration of equipment as per manufacturer specifications to ensure validity of data measured. |
| Any comment: | - |

| **Year** | **Electricity generated in the plant (MWh)** |
|---|---|
| 2012 | 0 |
| 2013 | 28,761 |
| 2014 | 28,761 |
| 2015 | 28,761 |
| 2016 | 35,951 |
| 2017 | 35,951 |
| 2018 | 35,951 |

| **Data / Parameter:** | Operational of the energy plant |
|---|---|
| Data unit: | Hours |
| Description: | Operation of the energy plant |
| Source of data to be used: | Project participants |
| Value of data applied for the purpose of calculating expected emission reductions in section B.5 | 7,884 hours/year |
| Description of measurement methods and procedures to be applied: | Information will be monitored and reviewed on an annual basis. The information will be archived for a minimum of two years after the end of the crediting period or the last issuance of CERs for this project activity, whichever occurs later. |
| QA/QC procedures to be applied: | Reliable sources will be used. The information acquired will be peer reviewed. |
| Any comment: | The data will be archived for a minimum of two years after the end of the crediting period or the last issuance of CERs for this project activity, whichever occurs later. |

| **Data / Parameter:** | $EC_{PJ,j1,y}$ |
|---|---|
| Data unit: | MWh |
| Description: | Quantity of electricity consumed from the grid by the project activity during the year y |
| Source of data to be used: | Onsite measurements. Using electricity meters |
| Value of data applied for the purpose of calculating expected emission reductions in section B.5 | 657 MWh |
| Description of measurement methods and procedures to be applied: | Continuously, aggregated at least annually. |
| QA/QC procedures to be applied: | The meter will be sealed. |
| Any comment: | - |

| | |
|---|---|
| **Data / Parameter:** | $EC_{PJ,j2,y} = EG_{n,t}$ |
| Data unit: | MWh |
| Description: | Quantity of electricity generated by diesel generator by the project activity during the year y. |
| Source of data to be used: | Onsite measurements. Using electricity meters |
| Value of data applied for the purpose of calculating expected emission reductions in section B.5 | 2 MWh |
| Description of measurement methods and procedures to be applied: | Continuously, aggregated at least annually |
| QA/QC procedures to be applied: | The meter will be sealed. |
| Any comment: | - |

| | |
|---|---|
| **Data / Parameter:** | $FC_{n,diesel,t}$ |
| Data unit: | Mass or (normalized) volume unit per year (in $m^3$, ton or l ) |
| Description: | Quantity of fossil fuel type i fired in the captive power plant n in the time period t |
| Source of data to be used: | Annual data during the crediting period: Onsite measurements.<br>Historical data: Historical records / onsite measurements via LFG project's cost center. |
| Value of data applied for the purpose of calculating expected emission reductions in section B.5 | n/a |
| Description of measurement methods and procedures to be applied: | Use weight or volume meters. Continuously. |
| QA/QC procedures to be applied: | The consistency of metered fuel consumption quantities should be cross-checked with an annual energy balance that is based on purchased quantities and stock changes. |
| Any comment: | - |

| Data / Parameter: | $NCV_{diesel,y}$ |
|---|---|
| Data unit: | GJ per mass (GJ/ton) |
| Description: | Weighted average net calorific value of diesel in year y |
| Source of data to be used: | Regional or national default values and, in absence of such information, it will be used IPCC data. |
| Value of data applied for the purpose of calculating expected emission reductions in section B.5 | 42.2 |
| Description of measurement methods and procedures to be applied: | Measurements should be undertaken in line with national or international fuel standards. |
| QA/QC procedures to be applied: | Verify if the values are within the uncertainty range of the IPCC default values as provided in Table 1.2, Vol. 2 of the 2006 IPCC Guidelines. |
| Any comment: | The data was based on Brazilian Energy Balance -BEN (2009).<br>The data will be archived for a minimum of two years after the end of the crediting period or the last issuance of CERs for this project activity, whichever occurs later. |

| Data / Parameter: | $EF_{CO2,diesel,y}$ |
|---|---|
| Data unit: | $tCO_2$/GJ |
| Description: | Weighted average $CO_2$ emission factor of diesel in year y |
| Source of data to be used: | Regional or national default values and, in absence of such information, it will be used IPCC data. |
| Value of data applied for the purpose of calculating expected emission reductions in section B.5 | 0.0741 |
| Description of measurement methods and procedures to be applied: | Measurements should be undertaken in line with national or international fuel standards. |
| QA/QC procedures to be applied: | Review appropriateness of the values annually or any future revision of the IPCC Guidelines should be taken into account. |
| Any comment: | - |

| **Data / Parameter:** | f |
|---|---|
| Data unit: | - |
| Description: | Fraction of methane captured at the SWDS and flared, combusted or used in another manner. |
| Source of data to be used: | ACM0001, page 10 |
| 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: | - |
| QA/QC procedures to be applied: | - |
| Any comment: | ACM0001, version 11, page 10 states " As this is already accounted for in equation 2, "f" in the tool shall be assigned a value 0" |

| **Data / Parameter:** | $GWP_{CH4}$ |
|---|---|
| Data unit: | $tCO_2e/tCH_4$ |
| Description: | Global warming Potential (GWP) of methane, valid for the relevant commitment period |
| Source of data used: | Decisions under UNFCCC and the Kyoto Protocol |
| Value of data applied for the purpose of calculating expected emission reductions in section B.5 | 21 |
| Description of measurement methods and procedures to be applied: | 21 for the first commitment period. Shall be updated according to any future COP/MOP decisions. |
| QA/QC procedures to be applied: | As per "Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site" version 5.1. |
| Any comment: | |

| **Data / Parameter:** | $W_x$ |
|---|---|
| Data unit: | tons |
| Description: | Total amount of organic waste prevented from disposal in year x |
| Source of data to be used: | Project participants (measured at weigh scale on site) |
| Value of data applied for the purpose of calculating expected emission reductions in section B.5 | **Year** / **Waste disposal (t/yr)**: 2007: 73,370; 2008: 323,628; 2009: 413,531; 2010: 549,780; 2011: 561,600; 2012: 624,000; 2013: 624,000; 2014: 624,000; 2015: 624,000; 2016: 717,600; 2017: 717,600; 2018: 717,600; 2019: 717,600; 2020: 780,000; 2021: 780,000; 2022: 780,000 |
| Description of measurement methods and procedures to be applied: | Weigh scale logs are stored at site and summarised on a yearly basis. |
| QA/QC procedures to be applied: | As per "Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site" ver. 5.1 |
| Any comment: | - |

| **Year** | **Waste disposal (t/yr)** |
|---|---|
| 2007 | 73,370 |
| 2008 | 323,628 |
| 2009 | 413,531 |
| 2010 | 549,780 |
| 2011 | 561,600 |
| 2012 | 624,000 |
| 2013 | 624,000 |
| 2014 | 624,000 |
| 2015 | 624,000 |
| 2016 | 717,600 |
| 2017 | 717,600 |
| 2018 | 717,600 |
| 2019 | 717,600 |
| 2020 | 780,000 |
| 2021 | 780,000 |
| 2022 | 780,000 |

**Regarding Flare efficiency, according to "Tool to determine project emissions from flaring gases containing methane"**

| **Data / Parameter:** | $t_{O2,h}$ |
|---|---|
| Data unit: | - |
| Description: | Volumetric fraction of $O_2$ in the exhaust gas of the flare in the hour h |
| Source of data to be used: | Measurements by project participants using a continuous gas analyzer |
| 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: | Extractive sampling analyzers with water and particulates removal devices or in situ analyzers for wet basis determination. The point of measurement (sampling point) shall be in the upper section of the flare (80% of total flare height).<br>Sampling shall be conducted with appropriate sampling probes adequate to high temperature level. |
| QA/QC procedures to be applied: | Analyzers must be periodically calibrated according to the manufacturer’s recommendation. A zero check and a typical value check should be performed by comparison with a standard certified gas. |
| Any comment: | |

| **Data / Parameter:** | $fv_{CH4,FG,h}$ |
|---|---|
| Data unit: | $mg/m^3$ |
| Description: | Concentration of methane in the exhaust gas of the flare in dry basis at normal conditions in the hour h |
| Source of data to be used: | Measurements by project participants using a continuous gas analyzer |
| Value of data applied for the purpose of calculating expected emission reductions in section B.5 | n/a |
| Description of measurement methods and procedures to be applied: | Extractive sampling analyzers with water and particulates removal devices or in situ analyzers for wet basis determination. The point of measurement (sampling point) shall be in the upper section of the flare (80% of total flare height).<br>Sampling shall be conducted with appropriate sampling probes adequate to high temperature level. Data will be recorded continuously and values will be averaged hourly or at a shorter time interval |
| QA/QC procedures to be applied: | Analyzers must be periodically calibrated according to the manufacturer’s recommendation. A zero check and a typical value check should be performed by comparison with a standard certified gas. |
| Any comment: | Measurement instruments will be read ppmv values. |

| | |
|---|---|
| Data / Parameter: | $T_{flare}$ |
| Data unit: | º C |
| Description: | Temperature on the exhaust gas of the flare |
| Source of data to be used: | Measurements by project participants |
| 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: | Measure the temperature of the exhaust gas stream in the flare by a Type N thermocouple. A temperature above 500 $^{o}$C indicates that a significant amount of gases are still being burnt and that the flare is operating. Data will be recorded continuously and values will be averaged hourly or at a shorter time interval |
| QA/QC procedures to be applied: | Thermocouples will be replaced or calibrated every year |
| Any comment: | - |

| | |
|---|---|
| **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: | Measurements by project participants using a flow meter |
| Value of data applied for the purpose of calculating expected emission reductions in section B.5 | n/a |
| Description of measurement methods and procedures to be applied: | The residual gas flow rate is measured on wet basis. To convert it on dry basis will be used the “Tool to determine the mass flow of a greenhouse gas in a gaseous stream”.<br><br>Ensure that the same basis (wet or dry) is considered for this measurement and the measurement of volumetric fraction of all components in the residual gas. Data will be monitored continuously and values will be averaged hourly or a shorter time interval. |
| QA/QC procedures to be applied: | Flow meters must be periodically calibrated according to the manufacturer’s recommendation. |
| Any comment: | |

| **Data / Parameter:** | $fv_{i,,h}$ |
|---|---|
| Data unit: | |
| Description: | Volumetric fraction component i of the residual gas in dry basis at normal conditions in the hour h, where i = $CH_4$ and $N_2$ |
| Source of data to be used: | Measurements by project participants using a continuous gas analyzer |
| Value of data applied for the purpose of calculating expected emission reductions in section B.5 | 50% of methane |
| Description of measurement methods and procedures to be applied: | Ensure that the same basis (wet or dry) is considered for this measurement and the measurement of volumetric fraction of all components in the residual gas when the residual gas temperature exceeds 60 $^0$C. Data will be monitored continuously and values will be averaged hourly or a shorter time interval. |
| QA/QC procedures to be applied: | Analyzers must be periodically calibrated according to the manufacturer's recommendation. A zero check and a typical value check should be performed by comparison with a standard certified gas. |
| Any comment: | - |

| **Data / Parameter:** | $TDL_y$ |
|---|---|
| Data unit: | - |
| Description: | Average technical transmission and distribution losses in the grid in year *y* for the voltage level at which electricity is obtained from the grid at the project site. |
| Source of data to be used: | Regional or national default values |
| Value of data applied for the purpose of calculating expected emission reductions in section B.5 | 6% |
| Description of measurement methods and procedures to be applied: | The technical distribution losses do not contain grid losses other than technical transmission and distribution. |
| QA/QC procedures to be applied: | - |
| Any comment: | The data was based on National Energy Balance 2006, page 21. |

**B.7.2. Description of the monitoring plan:**

The monitoring plan will be done according to the methodology ACM0001 version 11 and the applicable tools. Details are available in section B.7.1 above. The monitoring equipments locations are presented in the picture below:

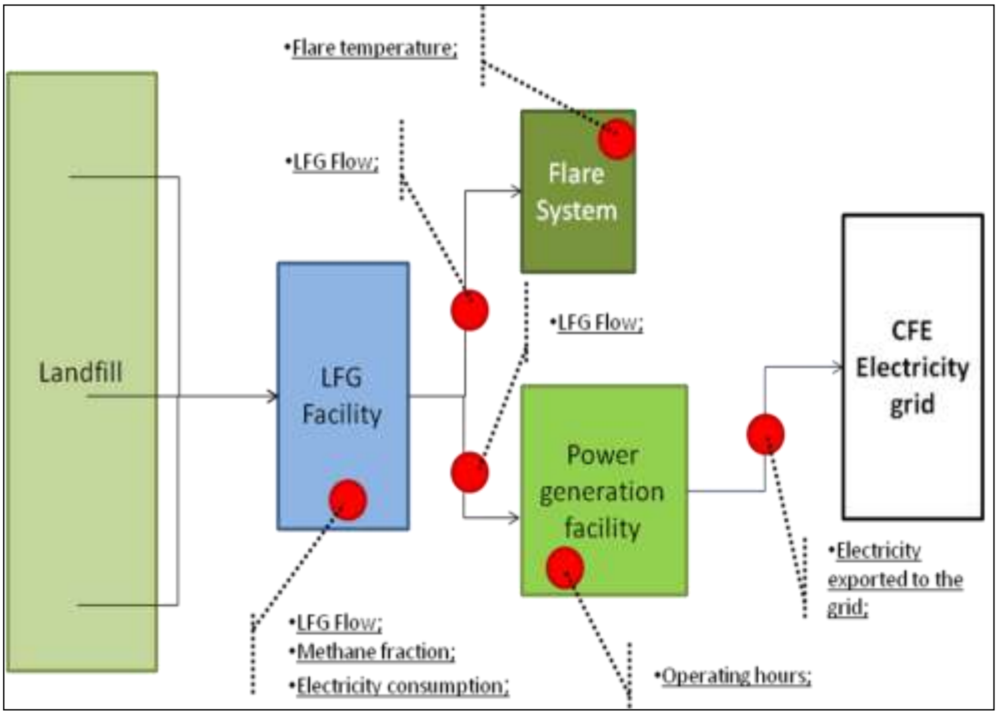


**Figure 12 - Monitoring equipments locations**

All continuously measured parameters (e.g. LFG flow, $CH_4$ concentration, flare temperature, flare operating hours, engine operating hours, and engine electrical output) will be recorded electronically via a datalogger, located within the site boundary which will have the capability to aggregate and print the collected data at the frequencies as specified above. It will be the responsibility of the Project Participant (CGR Guatapara) to provide all requested data logs which will be stored for a minimum of two years after the end of the crediting period or the last issuance of CERs for this project activity, whichever occurs later.

## 1. Management Structure

The operational data that is collected will be used to support the periodic verification report that will be required CER auditing. The monitoring plan discussed herein is designed to meet or exceed the UNFCCC requirements (approved monitoring methodology ACM0001 version 11).

The routine system monitoring program required for the determination of the emission reductions is discussed in section 2 below, while the additional system data that is collected to ensure the safe, correct, and efficient operation of the LFG management system is discussed in section 3.

### 1.1. Responsibility of the personnel involved

The personnel involved with monitoring will be responsible for carrying out the following tasks:

- Supervise and verify metering and recording: The staff will coordinate internally with other departments to ensure and verify adequate metering and recording of data.
- Collection of additional data, sales/billing receipts: The staff will collect sales receipts and additional data such as the daily operational reports of project.
- Calibration: The staff will coordinate internally to ensure that calibration of the metering instruments is carried out in accordance with the equipment manufacturers‟ specifications.

- Preparation of monitoring report: The staff will prepare the monitoring report for verification. . - Data Archives: The staff will be responsible for keeping all monitoring data, and making it available to the DOE for the verification of the emission reductions.

### 1.2. Installation of meters

All meters will be installed in order to fulfill the proposed monitoring plan.

## 2. Monitoring Work Program

The LFG monitoring program is a program designed to collect system operating data required to safely operate the system and for the verification of CERs. This data is collected in real time, and will provide a continuous record that is easy to monitor, review, and validate.

The following sections will outline and discuss the following key elements of the monitoring program:

- Flow measurement;
- Gas quality measurements;
- Uncombusted methane;
- Electrical Consumption;
- Project electricity output;
- Diesel purchased;
- Regulatory requirements;
- Data records; and
- Data assessment and reporting.

### 2.1. Flow Measurement

During Phase 1 (flaring) the data will be collected continuously using 1 vortex flow meter located in the piping leading to the flare. Upon completion of Phase 2 (electricity generation) an additional vortex flow meters will be installed with one being in the piping leading to the engine and the other on the main piping measuring the total collected landfill gas. The data will be aggregated monthly and yearly for the flare. The data will be archived for a minimum of two years after the end of the crediting period or the last issuance of CERs for this project activity, whichever occurs later.

The vortex meter will be provided with a normaliser unit which will normalize the flow rate at standard temperature and pressure.

The equipment selected for the project activity will utilize a continuous monitoring system as defined in ACM0001 version 11, which measures and aggregates flow data.

The residual gas flow rate is measured on wet basis. To convert it on dry basis will be used the “Tool to determine the mass flow of a greenhouse gas in a gaseous stream”.

### 2.2. Gas Quality

The concentration of methane will be measured via common sample line that is run to the main collection system piping and measured in real time. The equipment selected for the site aggregates gas composition as per the definition of a continuous monitoring system in ACM0001 version 11.

The regular calibration will be according to manufacturer specification.

### 2.3. Uncombusted Methane

The efficiency of the enclosed flare will be measured per the methodological "Tool to determine project emissions from flaring gases containing methane".

### 2.4. Electricity

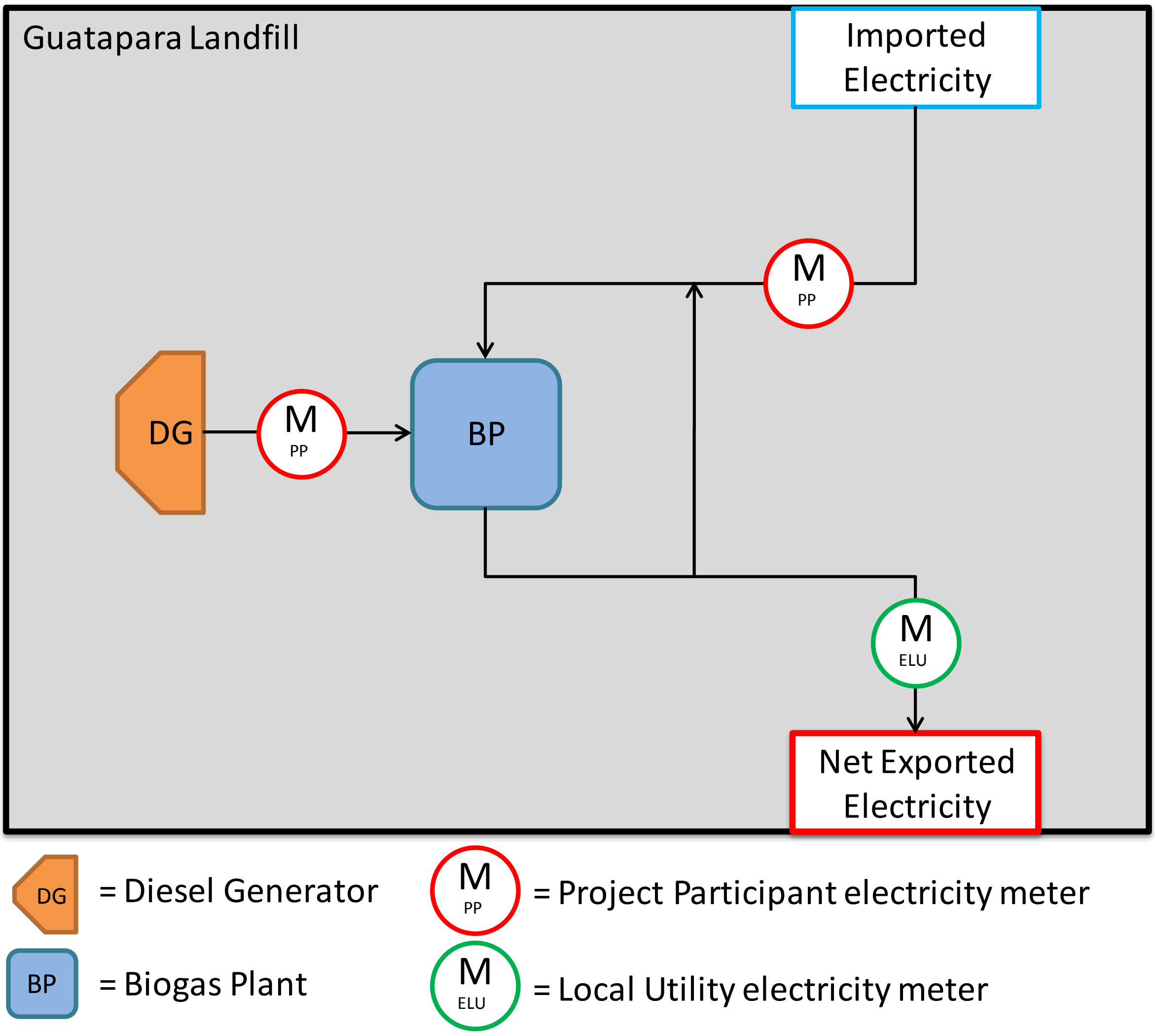


**Figure 13 – Electricity Monitoring**

#### 2.4.1 Electricity for self consumption

The electricity supplied by the grid and diesel generators will be continuously measured by the PP electricity meters to define energy self consumption due to project activity.

#### 2.4.2 Project Electricity Output

The net generated electricity supplied to the grid by the project activity will be continuously measured by a Local Electricity Utility Meter and the respective data will be electronically recorded.

### 2.5 Diesel purchased

Quantities of diesel used for the standby generator will be recorded via LFG project's cost center.

### 2.6 Regulatory Requirements

Regulatory requirements relating to LFG projects will be evaluated annually by investigating municipal, state and national regulations pertaining to LFG. This will be done through consultation with the appropriate regulatory bodies, ongoing discussion with regulators, and monitoring of publications delineating upcoming legislative changes governing landfills and LFG.

### 2.7 Data Records

Data collected from each of the parameter sensors is transmitted directly to an electronic database. Backup of the electronic data is conducted frequently. Calibration records will be kept for all instrumentation.

### 2.8 Data Assessment and Reporting

Assessment of the flow and composition data described above coupled with the operating hours of the engines/flare and engines/flare destruction efficiencies are used to determine the quantity of CERs to be generated. For electricity generation offsets, the appropriate emission factors will be applied.

The destruction efficiency of the flare is a function of the residual gas flow, methane fraction in residual gas, methane fraction in exhaust gas, oxygen fraction of exhaust gas. Destruction efficiency will be monitored continuously.

The flow data will be is normalized to standard temperature and pressure for reporting purposes. The data will be compiled and assessed to produce the required quantification and validation. The periodic monitoring report will contain the data required for the verification of the CERs, and additionally may contain operational data from the collection system and flaring system described above. Records of regular maintenance performed will also be a component of the annual report.

## 3 Corrective actions

The staff will log all corrective actions and will report these in the monitoring report. In case corrective actions are considered necessary, these actions will be implemented according to internal procedures.

## 4 Procedures for monitoring personnel training

The CGR Guatapara will conduct a training and quality control program to ensure that good management practices are carried out and implemented by all project operating personnel in terms of record-keeping, equipment calibration, overall maintenance, and procedures for corrective action. An operations manual will be developed for the operating personnel. The procedures for filing data and calculations to be performed by the LFG utilization operator will be included in a daily log to be placed in the main control room.

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

The date of completion the application of the methodology to the project activity study is 19/07/2010.

The person/entity determining the baseline is as follows:
Econergy Brasil Ltda, São Paulo, Brazil
Telephone: +55 (11) 3555-5700
Contact person: Mr. Francisco do Espirito Santo Filho and Mr. João Sprovieri
E-mail: francisco.santo@econergy.com.br and joao.sprovieri@econergy.com.br

Econergy Brasil Ltda is not a Project Participant.

## 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:

13/09/2011

The CGR Guatapara will decide to implement the project activity after to receive the Brazilian Letter of Approval. The forecast date of the Brazilian DNA meeting is 13/09/2011[19].

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

25 years

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

#### C.2.1. Renewable crediting period:

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

01/01/2012 or the date from registration of the project activity in the CDM Executive Board, the one that to happen later.

##### C.2.1.2. Length of the first crediting period:

7 years

[19] Source: http://www.mct.gov.br/index.php/content/view/327781.html, accessed on 21/02/2011.

### C.2.2. Fixed crediting period:

#### C.2.2.1. Starting date:

Left blank on purpose.

#### C.2.2.2. Length:

Left blank on purpose.

## SECTION D. Environmental impacts

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

According to the Brazilian laws, the possible environmental impacts are analyzed by the State Secretary of Environment (*Secretaria de Estado do Meio Ambiente*) through its executive branch CETESB (*Companhia de Tecnologia de Saneamento Ambiental*).

A complete Environmental Impact Assess (EIA) was submitted to CETESB (*Companhia de Tecnologia de Saneamento Ambiental*) and this document was concluded that the site selected presents the necessary conditions to the landfill's installation without any significant changes on their actual environmental quality. With the approval of the EIA, CGR Guatapara received, from CETESB, the Operational License no. 52000232, issued on 22/03/2009 and valid until 22/03/2014[20].

There will be no transboundary impacts resulting from this project activity. All the relevant impacts occur within Brazilian borders and have been mitigated to comply with the environmental requirements for project's 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:

All environmental assesses were analyzed by CETESB and CGR Guatapara has all pertinent Licenses for the operation. Thus, no significant environmental impact was identified.

## SECTION E. Stakeholders' comments

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

According to the Resolutions Number 1[21], 4[22] and 7[23] of the Brazilian Designed National Authority (CIMGC – Comissão Interministerial de Mudança Global do Clima / *Interministerial Commission on*

[20] The EIA and Operation License will be made available to DOE in validation visit.
[21] http://www.mct.gov.br/upd_blob/0002/2736.pdf (Art. 3º, II)
[22] http://www.mct.gov.br/upd_blob/0011/11780.pdf (Artº 5°, unique paragraph)
[23] http://www.mct.gov.br/upd_blob/0023/23744.pdf, accessed on July 21st, 2008.

*Global Climate Change*), project participants shall send letters to local stakeholders 15 days before the start of the validation period, in order to receive comments. It includes:

- Name and type of the activity project;
- PDD (translated to Portuguese), made available through a website;
- Description of the project's contribution to the sustainable development, also made available through a website.

Letters were sent to the following stakeholders involved and affected by the project activity:

- *Prefeitura municipal de Guatapara*/ Municipal Administration of Guatapara;
- *Câmara dos vereadores de Guatapara*/ Legislation Chamber of Guatapara;
- *Secretaria Municipal de Agricultura de Guatapara*[24]/Guatapara Agricultural Agency;
- *Companhia Ambiental do Estado de São Paulo (CETESB) Unificada de Jaboticabal* / Enviroment agency of São Paulo State;
- *Fórum Brasileiro das Organizações Não Governamentais e Movimentos Sociais para o Meio Ambiente e o Desenvolvimento - FBOMS* / Brazilian Forum of Non-Governmental Organizations and Social Movements for Environment and Development;
- Rotary Club / Local association;
- Associação Agro-cultural e Esportiva de Guatapará / Local association;
- Associação de Moradores do Bairro Jardim Maria Luiza I / Local association;
- *Ministério Público do Estado de São Paulo* / São Paulo Pr*osecutor's Office;*
- *Ministério Público Federal* / Federal Prosecutor's Office.

**E.2. Summary of the comments received:**

No comments were received.

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

No comments were received.

[24] The "• Secretaria Municipal de Agricultura de Guatapara" is responsible by environmental issues in Guatapara City.

## Annex 1

## CONTACT INFORMATION ON PARTICIPANTS IN THE PROJECT ACTIVITY

**Project Participant 1:**

| | |
|---|---|
| Organization: | CGR Guatapará – Centro de Gerenciamento de Resíduos Ltda. |
| Street/P.O.Box: | P.O.Box: Highway. Deputado Cunha Bueno (SP253) km183, P.O.Box 12 |
| Building: | - |
| City: | Guatapará |
| State/Region: | São Paulo |
| Postcode/ZIP: | ZIP: 14115-000 |
| Country: | Brazil |
| Telephone: | +55 (16) 3514-3800 |
| FAX: | +55 (16) 3514-3800 |
| E-Mail: | rsilveira@cgrguatapara.com.br |
| URL: | www.estre.com.br |
| Represented by: | Rafael Botelho Silveira |
| Title: | Environmental engineer |
| Salutation: | Mr. |
| Last name: | Botelho |
| Middle name: | Silveira |
| First name: | Rafael |
| Department: | Operational Management |
| Mobile: | - |
| Direct FAX: | +55 (16) 3514-3800 |
| Direct tel: | +55 (16) 3514-3800 |
| Personal e-mail: | rsilveira@cgrguatapara.com.br |

## Annex 2

## INFORMATION REGARDING PUBLIC FUNDING

There is no Annex I public funding involved in the project activity.

## Annex 3

## BASELINE INFORMATION

The baseline scenario for the project activity is the uncontrolled release of landfill gas to the atmosphere and also the generation of electricity from other sources.

The table below shows the key elements used for estimate the emissions of the baseline scenario.

### 1. Key Parameters

| | |
|---|---|
| Year landfilling operations started operator/historical logs | 2007 |
| Projected year for landfill closure estimated based on current filling rate | 2022 |
| GWP for methane (UNFCCC and Kyoto Protocol decisions) | 21 |
| Methane concentration in LFG (% by volume) typical assumption for baseline scenario | 50 |
| LFG collection efficiency (%) | 65 |
| Flare efficiencies (%) operational data from flare manufacturer | 99 |
| Electricity consumption from the grid due to the project activity (MWh/year) | 657 |
| Electricity consumption from the diesel generator due to the project activity (MWh/year) | 2 |
| Total accumulated waste from 2007 to 2009 (tonnes) operator/historical logs | 810,528 |
| Unit price of electricity sold to the grid (R$/kWh) | 148.00 |
| Combined margin emission factor for electricity displacement ($tCO_2$/MWh) calculated based on the Tool to calculate the emission factor for an electricity system, Version 2.2. | 0.1635 |
| Average capacity of Power Plant (MW) assumed based on available LFG quantities | 5.5 |

## Annex 3

## BASELINE INFORMATION

**Emission factors**

The table below shows the Brazilian emission factors according to determination of the Brazilian DNA. More information is available at the Brazilian DNA website.

| Combined Margin Emission Factor 2009 ($tCO_2/MWh$) | | |
|---|---|---|
| **1st crediting Period** | | **0.1635** |
| Build Margin - 2009 | | 0.0794 |
| Operating Margin 2009 | January | 0.2813 |
| | February | 0.2531 |
| | March | 0.2639 |
| | April | 0.2451 |
| | May | 0.4051 |
| | June | 0.3664 |
| | July | 0.2407 |
| | August | 0.1988 |
| | September | 0.1622 |
| | October | 0.1792 |
| | November | 0.1810 |
| | December | 0.1940 |
| | 2009 | 0.2476 |

Source: http://www.mct.gov.br/index.php/content/view/303076.html#ancora

## Annex 4

### MONITORING INFORMATION

The monitoring will be made as described in items B.7.1 and B.7.2.