PDD

（１）イタニャイン市

**CLEAN DEVELOPMENT MECHANISM**
**PROJECT DESIGN DOCUMENT FORM (CDM-PDD)**
**Version 02 - in effect as of: 1 July 2004)**

CONTENTS



Annexes



**ATTENTION PLEASE READ**

**This is a DRAFT version of the PDD. The ownership of the carbon credits has not been satisfactorily proven to the carbon advisors. There is as yet no engineering project. All numbers pertaining to the engineering part of the PDD are based on very rough estimates and CANNOT be submitted to the validators. No stakeholder meeting has yet been planned or held. No environmental licences have been submitted to the carbon advisor to date.**

**This DRAFT CANNOT yet be submitted for validation.**

## SECTION A. General description of project activity

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

Project Name: Landfill Gas Recovery and Flaring Project for Site Remediation at the Itanhaem Waste

Dump ("Lixão") in São Paulo

Version: 2.3

Date: Monday, 14 February 2006

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

The project partners are proposing a CDM project activity, which will result in reduced GHG emissions and contribute to local sustainable development in the Brazilian state of São Paulo. The project activity will involve the capture and flaring of methane, which is a major constituent of landfill gas (LFG). LFG capture and flaring is not mandated by Brazilian law nor is it a common practice to flare a large proportion of the produced gas. Customarily only a small fraction of LFG is flared to reduce risk of explosion. The Itanhaem landfill will therefore provide additional environmental benefits by flaring the majority of the gas produced. All revenues from the sale of CERs will go towards the remediation of the site.

The landfill in Itanhaem was opened in 1980 and will cease operations in early 2006. The site covers a total area of 100,000 m2 and at the beginning of 2005 contained a total of 800,000[60] tonnes of municipal solid waste. It is located in the municipality of Itanhaem in the state of São Paulo. To date the landfill has no leachate management system, no liner, no cover and no monitoring system. It is a largely unmanaged waste dump and as such presents a considerable environmental hazard that needs to be remediated.

The aim of this specific project activity is to install landfill gas collection and flaring equipment to reduce methane emissions to the atmosphere. At the present time electricity generation using captured landfill methane is not foreseen due to the unfavorable pricing regime currently prevailing in Brazil. However, all equipment used can be expanded to include electricity generation at a later stage to accommodate future changes in electricity tariffs. At present the ultimate rationale of the project is the combustion of methane to reduce anthropogenic greenhouse gas (GHG) emissions from the decomposition of organic waste in the landfill. These emissions reductions will be eligible for Certified Emissions Reductions (CERs) under the Kyoto Protocol's Clean Development Mechanism (CDM).

The project activity will have a series of positive social and environmental impacts, especially when compared to traditional Brazilian waste disposal sites. This is important in view of guidelines governing the CDM, which stipulate a contribution to sustainable development and local environmental protection. The Itanhaem project will flare the majority of generated methane and thus eliminate the negative impact of landfill gas emissions. In addition this project activity will generate enough income to pay for the remediation of the site according to high environmental standards.

Greenhouse gas emission reductions will result from the combustion of the recovered methane contained in the landfill gas. It is estimated that this project will generate **100,475CERs within the first 7-year crediting period (2006-2012)**.

There are several contributions to sustainable development.

*Environmental benefits:*
The local environment benefits from the highest European waste management standards that are applied to this site including:

[60] The total volume used in the LFG estimation is 799,989 tonnes by the beginning of 2005.

- The project will contribute to the continued environmental improvements by providing the infrastructure to reduce greenhouse gas emissions.

*Technology transfer:*
The project will be one of the first in Brazil to recover and flare landfill gas from a closed landfill operation to generate CERs. The proceeds will go towards the remediation of the site. This model could therefore serve as a model of similar sites where there are no resources for site remediation.

*Site Remediation:*
The Itanhaem LFG flaring project will generate revenue that the local prefecture will use to remediate the site. The existing waste site has no landfill daily cover, no bottom liner, no drainage or treatment of leachate and no methane capture and flaring equipment. Hence it represents a clear environmental hazard and needs to be cleaned up as soon as possible. CDM revenues would allow the prefecture to achieve this.

## A.3. Project participants:

| Please list project participants and Party(ies) involved and provide contact information in Annex 1. Information shall be in indicated using the following tabular format. | | |
|---|---|---|
| **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) | Prefecture of Itanhaem; MaxAmbiental; Xenex do Brasil 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. | | |

The Itanhaem landfill is owned by the Prefecture of Itanhaem and is operated by a private contractor. The gas-flaring project is being developed by MaxAmbiental, a Brazilian environmental finance company that specializes in greenhouse gas (GHG) mitigation activities, and Xenex do Brasil Ltda. Banco Sumitomo Mitsui Brasileiro SA is financing the baseline study and PDD as well as the project activity (For further details see Annex 1).

MaxAmbiental is an environmental finance company whose specialty lies in the preparation of carbon emissions reductions projects. Its staff has wide ranging experience in this area, including the successful registration of the first landfill gas CDM project, Nova Gerar.

## 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.:**

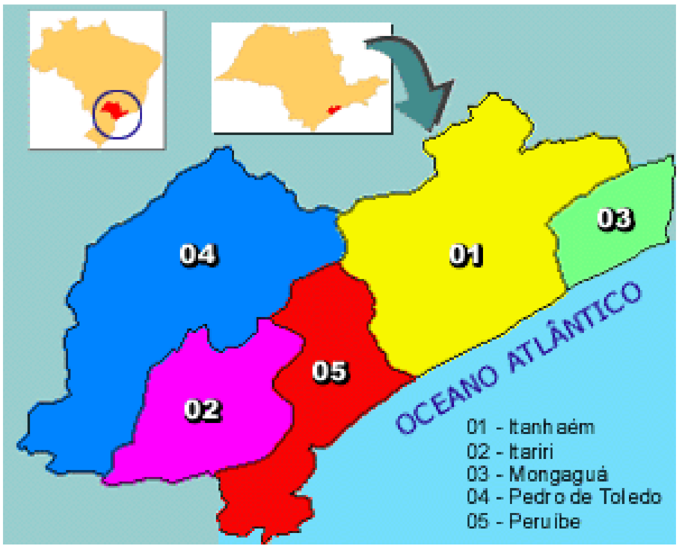
Itanhaem, São Paulo

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

Municipality of Itanhaem

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

The Municipality of Itanhaem lies on the northern coast of the state of São Paulo within the administrative region of Santos. It covers an area of 600 square kilometers. Itanhaem has a population of 85,438 inhabitants.




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

Sectoral scope: 13 - Waste handling and disposal

Project activity: Landfill gas capture and flaring project

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

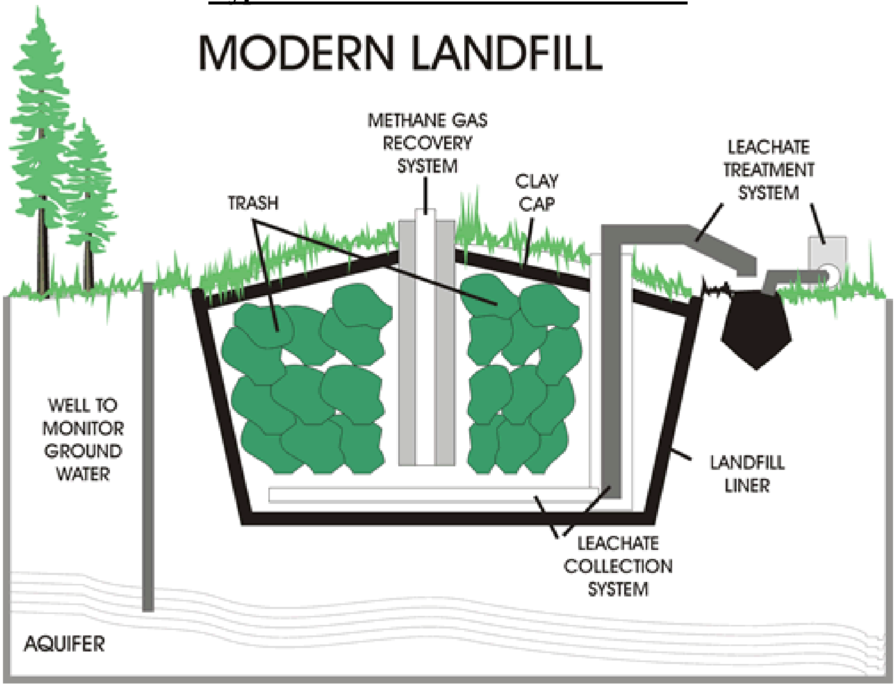
The project will involve proven technology and hardware for the extraction and treatment of landfill gas.

Below is a brief summary of the equipment and technology proposed for this project:

The landfill gas collection system consists of the following components:

- Vertical wells (perforated concrete pipes) to ensure connectivity of all layers. A high-density perforated pipe is installed within the center of the well, which is backfilled with gravel.
- Landfill gas extraction wells will also be drilled into the landfill once areas reach their final elevation and final cover has been applied. The vertical wells consist of a pipe perforated in its lower part, placed in a drilled borehole in the waste, backfilled with gravel and sealed at the surface. Both well types will be equipped with wellheads that enable monitoring of gas flow and quality. Also valves are provided to allow adjustment of the available vacuum at each well.
- In order to maximize the extraction capacity horizontal drains will also be installed in the waste mass. Preliminarily, the installation of a series of horizontal drains with a horizontal separation distance of 60 meters installed every 5 meters in waste lift height is envisioned. The horizontal drains will consist of perforated pipes surrounded gravel or equivalent drainage material. The drains will be interconnected to the vertical well system.
- The flaring equipment consists of an enclosed flare, 2 compressors to require the vacuum in the collection network, an online gas analyzer, and valves and tubes.
- A condensate extraction and storage system designed at strategic low points throughout the gas system.

**Typical Schematic of Modern Landfill**




**A.4.4. Brief explanation of how the anthropogenic emissions of anthropogenic greenhouse gas (GHGs) by sources are to be reduced by the proposed CDM project activity, including why the emission reductions would not occur in the absence of the proposed project activity, taking into account national and/or sectoral policies and circumstances:**

The project activity intends to collect and flare the methane generated by the anaerobic decomposition of the organic component of the municipal solid waste (MSW) landfilled at the Itanhaem landfill. The combustion of the methane produces carbon dioxide. Taking into account the respective Global Warming Potentials (GWP) of methane and $CO_2$ this combustion signifies a 21-fold reduction of GHG emissions.

The baseline scenario is defined as the most likely future scenario in the absence of the project activity. Based on the analysis of possible alternatives, the baseline scenario is the continued, uncontrolled release of landfill gas into the atmosphere.

The results of the financial analysis demonstrate that the project activity is not the most attractive course of action economically speaking and therefore this kind of project is not part of the baseline scenario. Hence the Itanhaem Project is considered to be additional.

**A.4.4.1. Estimated amount of emission reductions over the chosen crediting period:**

| YEAR | ESTIMATED ANNUAL EMISSION REDUCTIONS IN $TCO_2E$ |
|---|---|
| 2006 | 0 |
| 2007 | 21,192 |

| | |
|---|---|
| 2008 | 19,175 |
| 2009 | 17,350 |
| 2010 | 15,699 |
| 2011 | 14,205 |
| 2012 | 12,853 |
| **Total emission reductions 7 years (tCO2e)** | **100,475** |
| Renewable Crediting Period | 3 x 7 years = 21 years |
| Mean annual emission reductions (t CO2e) | 14,354 |

The combustion of the methane generated by the Itanhaem landfill during the chosen crediting period reduces anthropogenic GHG emissions by:

**100,475 tonnes of $CO_2$e between 2006-2012 (first 7 year crediting period)**

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

There is no Official Development Assistance used in this project activity.

## SECTION B. Application of a baseline methodology

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

ACM0001: Consolidated Methodology for Landfill Gas Project Activities

#### B.1.1. Justification of the choice of the methodology and why it is applicable to the project activity:

This consolidated methodology was developed specifically for landfill gas capture and flaring. The Itanhaem project is similar to the Nova Gerar project, which served as one of the examples included in the consolidated methodology ACM0001.

### B.2. Description of how the methodology is applied in the context of the project activity:

The project activity will flare a greater proportion of the landfill gas generated by the decomposition of organic waste in the Itanhaem landfill, than would have occurred in the absence of the project activity. In the baseline scenario (i.e. the absence of the project) only 20% of all gas generated are customarily flared for safety reasons. The project activity leads to higher collection and flaring efficiency through the installation of modern LFG collection and flaring equipment. Therefore the project activity will reduce total GHG emissions below the GHG emissions of the baseline scenario.

Baseline emissions are calculated using a first order decay model proposed by the US Environmental Protection Agency as recommended in the 1996 IPCC Guidelines. Using this model the methane emissions that would have been released to the atmosphere in the absence of the project activity are calculated. A fraction of those emissions need to be discounted to take account of a minimum amount of flaring that does customarily occur for safety reasons. In the case of Brazil this is usually less than 20%. Hence the use of 20% for baseline flaring is considered to be conservative.

For the determination of the baseline scenario a number of financial and market data had to be used. The various sources are listed in the table below.

| Key data for determining baseline scenario | Data Unit | Data Source |
|---|---|---|
| Project activity and plausible alternatives to it | - | Project Participants (PP), Industry data |
| National and local rules and regulations and policies | - | PP, Government |
| Baseline IRR | % | Calculated |
| Project IRR without Carbon | % | Calculated |
| Threshold for investment (IRR/NPV/payback period) | %, etc. | PP, Industry |
| Equipment costs | Brazilian Reais (R$) | Suppliers, PP |
| Operating costs | R$ | PP |
| Revenue from operations | R$ | PP |
| Market data (inflation, interest, tax, discount rate, etc.) | % | Relevant indices |
| Landfill gas generation parameters | 1/yr; $m^3$/tonne | Us EPA, Brazil specific data (SCS Engineers) |
| Methane collection parameters | % | IPCC, PP empirical data |
| Global Warming Potentials | - | IPCC |
| Proportion of methane flared in baseline | % | Industry Data |

**B.3. 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:**

The proposed project activity will result in the reduction of greenhouse gases that would not occur if the project were not implemented. The numerous barriers and risks associated with the implementation of the proposed project activity that are identified clearly demonstrate that this project activity is not the baseline as usual scenario.

The tool used to demonstrate the additionality is the "Consolidated tool for demonstration of additionality", which is part of methodology **ACM0001**: Consolidated Methodology for Landfill Gas Project Activities. This tool for assessing additionality follows a step-based approach. Explanation on how additionality for the proposed project activity is proven following the consolidated tool for additionality follows.

This description is divided into two parts:

D) The baseline approach and accompanying formulae described in ACM0001 are directly employed to the project activity under discussion.
E) The "Tool for the demonstration and assessment of additionality" is used to establish the additionality of the Itanhaem LFG Capture and Flaring project activity.

**A)**

***Applicability***
*This methodology is applicable to landfill gas capture project activities, where the baseline scenario is the partial or total atmospheric release of the gas and the project activities include situations such as:*

*a) The captured gas is flared; or*
*b) The captured gas is used to produce energy (e.g. electricity/thermal energy), but no emission reductions are claimed for displacing or avoiding energy from other sources1; or*
*c) The captured gas is used to produce energy (e.g. electricity/thermal energy), and emission reductions are claimed for displacing or avoiding energy generation from other sources. In this case a baseline methodology for electricity and/or thermal energy displaced shall be provided or an approved one used, including the ACM0002 "Consolidated Methodology for Grid-Connected Power Generation from Renewable". If capacity of electricity generated is less than 15MW, and/or thermal energy displaced is less than 54 TJ (15GWh), small-scale methodologies can be used.*

*This baseline methodology shall be used in conjunction with the approved monitoring methodology ACM0001 ("Consolidated monitoring methodology for landfill gas project activities").*

**Comments:**
As almost all of the LFG produced in the Itanhaem landfill will be captured and flared, the project activity meets situation "a)" described above; hence this methodology is applicable to the project activity.

***Emission Reduction***
*The greenhouse gas emission reduction achieved by the project activity during a given year "y" ($ER_y$) is the difference between the amount of methane actually destroyed/combusted during the year ($MD_{project,y}$) and the amount of methane that would have been destroyed/combusted during the year in the absence of the project activity ($MD_{reg,y}$) times the approved Global Warming Potential value for methane ($GWP_{CH4}$), plus the net quantity of electricity displaced during the year ($EG_y$) multiplied by the $CO_2$ emissions intensity of the electricity displaced ($CEF_{electricity,y}$) plus the quantity of thermal energy displaced during the year ($ET_y$) multiplied by the $CO_2$ emissions intensity of the thermal energy displaced ($CEF_{thermal,y}$). Electricity and thermal energy emission reductions apply to case (c) only.*

$$ER_y = (MD_{project,y} - MD_{reg,y}) \times GWP_{CH4} + EG_y \times CEF_{electricity,y} + ET_y \times CEF_{thermal,y} \quad \textbf{(1)}$$

*ERy is measured in tonnes of CO2 equivalents (tCO2e). $MD_{project,y}$ and $MD_{reg,y}$ are measured in tonnes of methane ($tCH_4$). The approved Global Warming Potential value for methane ($GWP_{CH4}$) for the first commitment period is 21 $tCO_2e/tCH_4$. $EG_y$ is measured in megawatt hours (MWh). The $CO_2$ emissions intensity, $CEF_{electricity,y}$, is measured in tonnes of $CO_2$ equivalents per megawatt hour (t $CO_2e$/MWh) and $ET_y$ is measured in TeraJoules (TJ) and $CEF_{thermal,y}$ is measured in terms of tonnes of $CO_2$ equivalents per TJ (t $CO_2e$/TJ).*
*In the case where the $MD_{reg,y}$ is given/defined as a quantity that quantity will be used.*
*In cases where regulatory or contractual requirements do not specify $MD_{reg,y}$ an "Adjustment Factor" (AF) shall be used and justified, taking into account the project context.*

$$MD_{reg,y} = MD_{project,y} \times AF \quad \textbf{(2)}$$

*The following examples provide guidance on how to estimate AF:*
*- In cases where a specific system for collection and destruction of methane is mandated by regulatory or contractual requirements, the ratio of the destruction efficiency of that system to the destruction efficiency of the system used in the project activity shall be used.*
*- In cases where a specific percentage of the "generated" amount of methane to be collected and destroyed is specified in the contract or mandated by regulations, this percentage divided by an assumed efficiency for the collection and destruction system used in the project activity shall be used.*

**Comments:**
In the case of this project activity there are neither regulatory nor contractual requirements for the combustion of the methane produced in the baseline scenario. The "Adjustment Factor" used for $MD_{reg,\,y}$ is 20%, a value that conservatively estimates the amount of gas that would be flared in the absence of the project activity to avoid explosion risks.

Also, this particular project does not intend to generate electricity or thermal energy from the captured LFG. Therefore, greenhouse gas emission reductions related to this source are not to be considered in the calculation of $ER_y$. Therefore Formula (1) can be re-written as:

$$ER_y = \left(MD_{project,y} - MD_{reg,y}\right) \times GWP_{CH4}$$

The approved Global Warming Potential (GWP) of Methane for the first commitment period is 21 t $CO_2$e/t$CH_4$.

*Project proponents should provide an ex ante estimate of emissions reductions, by projecting the future GHG emissions of the landfill. In doing so, verifiable methods should be used. Ex ante emission estimates may have an influence on $MD_{reg,y}$. $MD_{project,y}$ will be determined ex post by metering the actual quantity of methane captured and destroyed once the project activity is operational.*
*The methane destroyed by the project activity ($MD_{project,y}$) during a year is determined by monitoring the quantity of methane actually flared and gas used to generate electricity and/or produce thermal energy, if applicable.*

$$MD_{project,y} = MD_{flared,y} + MD_{electricity,y} + MD_{thermal,y} \quad \textbf{(3)}$$

$$MD_{flared,y} = LFG_{flared,y} \times w_{ch4} \times D_{ch4} \times FE \quad \textbf{(4)}$$

*Where $MD_{flared,y}$ is the quantity of methane destroyed by flaring, $LFG_{flared,y}$ is the quantity of landfill gas flared during the year measured in cubic meters ($m^3$), wCH4,y is the average methane fraction of the landfill gas as measured during the year and expressed as a fraction (in $m^3$ $CH_4$ / $m^3$ LFG), FE is the flare efficiency (the fraction of the methane destroyed) and $D_{CH4}$ is the methane density expressed in tonnes of methane per cubic meter of methane ($tCH_4/m^3CH_4$).*

$$MD_{electricity,y} = LFG_{electricity,y} \times w_{ch4} \times D_{ch4} \quad \textbf{(5)}$$

*Where $MD_{electricity,y}$ is the quantity of methane destroyed by generation of electricity and $LFG_{electricity,y}$ is the quantity of landfill gas fed into electricity generator.*

$$MD_{thermal,y} = LFG_{thermal,y} \times w_{ch4} \times D_{ch4} \quad \textbf{(6)}$$

*Where $MD_{thermal,y}$ is the quantity of methane destroyed for the generation of thermal energy and $LFG_{thermal,y}$ is the quantity of landfill gas fed into the boiler.*

**Comments:**
Again, since no electricity or thermal energy will be generated, the emission reductions will be equivalent to the amount of methane flared only, thus:

$$MD_{project,y} = MD_{flared,y}$$

Consequently equations (5) and (6) will not be used for this specific project activity.

For the purpose of estimating baseline emissions and overall emission reductions of the project activity the USEPA's First Order Decay Model has been used. A detailed description and formulae used are provided in Section D.2.1.4.

According to ACM0001 at standard temperature and pressure (0 degree Celsius and 1,013 bar) the density of methane is 0.000656 $tCH_4/m^3CH_4$.

***Project Boundary***
*The project boundary is the site of the project activity where the gas is captured and destroyed/used. Possible $CO_2$ emissions resulting from combustion of fuels other than the methane recovered should be accounted as project emissions. Such emissions may include fuel combustion due to pumping and collection of landfill gas or fuel combustion for transport of generated heat to the consumer locations.*
*In addition, electricity required for the operation of the project activity, including transport of heat, should be accounted and monitored. Where the project activity involves electricity generation, only the net quantity of electricity fed into the grid should be used in equation (1) above to account for emission reductions due to displacement of electricity in other power plants. Where the project activity does not involve electricity generation, project participants should account for $CO_2$ emissions by multiplying the quantity of electricity required with the $CO_2$ emissions intensity of the electricity displaced ($CEF_{electricity,y}$).*

Comments:
For more detailed information concerning the project boundary, please refer to Section B.4.

***Baseline***
*The baseline is the atmospheric release of the gas and the baseline methodology considers that some of the methane generated by the landfill may be captured and destroyed to comply with regulations or contractual requirements, or to address safety and odor concerns.*

Comments:
As mentioned above, flaring of landfill gas is not a common or required practice in Brazil. However, it is common to flare a small fraction (usually around 20%) of the produced gas to reduce the risk of explosion. Hence this fraction is deducted from the estimated total emissions of LFG from the landfill.

***Leakage***
*No leakage effects need to be accounted under this methodology.*

**B)**

***Additionality***
*The additionality of the project activity shall be demonstrated and assessed using the latest version of the "Tool for the demonstration and assessment of additionality" agreed by the CDM Executive Board, which is available on the UNFCCC CDM web site.*

Using the "Tool for demonstration and assessment of additionality":

Step 0: Preliminary screening based on the starting date of the project activity
Step 1: Identification of alternatives to the project activity consistent with the current laws and regulations
Step 2: Investment analysis
Step 4: Common practice analysis
Step 5: Impact of CDM registration

Step 1:

Sub-step 1a. Define alternatives to the project activity:
There are 3 possible baseline scenarios for the ITANHAEM landfill:

1) The landfill operator adheres to the business as usual practice of not collecting and flaring landfill gas from its waste operations or flaring just a small fraction of the gas, for safety reasons. This is in fact the approach taken by most waste management operations in Brazil. In this case, no power is generated at the site and the Brazilian power system remains unaffected.

2) The landfill operator invests in LFG collection and flaring but not in power generation (the proposed project activity). The Brazilian power system remains unaffected.

3) The landfill operator invests in power generation from LFG. The operation marginally reduces the generation of power from other grid-connected sources and hence avoids carbon emissions.

Sub-step 1b. Enforcement of applicable laws and regulations:
Current Brazilian legislation does not require that landfills collect and dispose of landfill gases, and there are very few landfills in operation in Brazil that have been designed to collect, flare or utilize the full amount of gas generated. Most of these, like the NovaGerar landfills, were designed and built in the last two years specifically as CDM projects. When LFG collection and flaring does happen, this occurs mainly on a voluntary basis to diminish explosion risk. Usually only a low proportion of methane is collected due to the utilization of unsophisticated collection systems and the occasional flooding of pipes with leachate.

The implementation of environmental protection legislation in Brazil has a relatively long lead-time, and the Ministry of the Environment has no immediate plans to introduce legislation requiring the collection and flaring of landfill gas from landfill sites. Historically in Brazil there also tends to be a gulf between stated regulations and practice with regards to the implementation of environmental protection legislation.

Step 2:

Sub-step 2a. Determine appropriate analysis method:
This project activity will not generate any financial or economic benefits other than CDM related income. Other than financial return from the carbon market, the only potential revenue to the project could come from the use of gas to produce electricity (Alternative 3 above). It is necessary to conduct a financial analysis to determine whether the project activity is an economically attractive course of action.

Historically, tariff levels have been relatively low due to a centralised pricing structure fixed by the government. The commercialisation and distribution of electricity is controlled by the government, through ANEEL (Electric Energy National Agency), by pre-establishing the contracts and the price range. While small tariff increases can be observed in the last few years, they are insignificant and not sufficient to indicate that this scenario is going to change now. The free electricity market is still very incipient in Brazil. These low tariffs make electricity generation from LFG economically unattractive at present.

Brazil's energy sector is already relatively clean and there is lack of governmental pricing policies to support and favour projects for the replacement of some non-renewable energy with new sources of clean electricity.

In parallel to the risks related to the sale of electricity, the exact amounts of landfill gas and the performance of the plants also concerns landfill operators. Given that the production of methane in the landfills can vary greatly and currently there isn't a single landfill site in Brazil generating electricity, this is seen as 'unproven' technology by local investors.

A sensitivity analysis was undertaken using assumptions that are highly conservative from the point of view of analysing environmental additionality, i.e. the best-case scenario IRR was calculated. It was assumed that the average daily waste placement rate at the Itanhaem Landfill would peak around 88 daily tonnes by the eighth year of operation. The volumes of landfill gas to be generated from the site were estimated using the US EPA First Order Decay Model. It was further assumed that the project has unlimited access to capital to invest in all the equipment necessary to use the increased amount of gas produced. The IRR (without carbon) is negative and still exposed to a series of risks (project, country, currency, etc.). These results show that even with the best possible conditions, which are obviously quite unrealistic, the project is still not an economically attractive course of action. Also, given that the Itanhaem waste site is an **unmanaged landfill that is deeper than 5m**, in accordance with the 1996 IPCC Guidelines a **Methane Correction Factor of 0.8** has been applied to the estimated methane volumes.

Sub-step 2b. Apply simple cost analysis
N/a

Step 4:

According to the National GHG Emissions Inventory conducted by CETESB in 1994, 84% of Brazil's methane emissions came from the deposition of waste in uncontrolled rubbish dumps. This source is still responsible for a large part of the methane emitted since not much has changed in the business as usual scenario in the country. Besides, the amount of waste produced in Brazil has been increasing and, as estimated in 2000, Brazilians were already producing an average of 0.52 kg of waste per person everyday.[61]

Nowadays 59% of the municipalities in Brazil still dispose of their waste in ‘rubbish dumps’ (“lixões”) with no management, gas collection, water treatment, or regulation by environmental authorities whatsoever. Among the other 30% that use landfills, only 13% invest in sanitary landfills with sophisticated leachate collection and treatment systems.

Although, until the present moment there are no regulatory requirements for flaring landfill gas, a number of landfills are collecting a small amount of LFG for safety reasons. To maintain the calculations’ conservatism and to assure the environmental integrity of the project, all emission reductions arising from the Itanhaem site will be discounted by 20% in the project model. This amount, as argued before, more than sufficiently covers the volume of gas that would be flared to follow the business-as usual scenario found in the landfills considered in this analysis.

Since there are no legislation requiring gas flaring in Brazilian landfills, besides the flaring of a small fraction for security (less than 20%), there is no reason to believe that an LFG system for the collection and flaring of all gas produced would be installed now, when the landfill is being built. The installation of even a rudimentary LFG collection system with passive venting or flaring would go beyond what is required by law and involve considerable expenses for the landfill operator without any offsetting revenues.

Given the regulatory situation in Brazil and the location and conditions of the landfill, the realization of alternative 2 is not required and would also not be an economically attractive course of action for the landfill owner and/or operator. It is therefore not considered a plausible alternative to the baseline scenario. Alternative 3 was also proven not to be financially feasible at Brazil’s present electricity tariff levels. Consequently the only remaining plausible option is Alternative 1 (i.e. Business- as-usual: the construction of a landfill without any LFG treatment).

Step 5: Impact of CDM Registration
As can be seen form the attached financial analysis, successful CDM registration adds an additional revenue stream (in fact the only revenue stream) to the project activity. At a price of **US$8 per CER** and a discount rate of 6%, the project has a **net present value of US$384,435 and an IRR of negative 2.3%** over the first 7 years.

Baseline development in time and description of baseline scenario:
It has been shown that the BAU baseline holds at the time of preparing the project. The main determinants of this baseline are:

[61] CETESB and IGBE Census

- Landfill regulations applicable to the site
- The economics of landfill gas utilization

It is possible that future regulatory requirements for landfills in Brazil will necessitate a higher level of LFG collection in the baseline scenario. If this occurs, the future baseline scenario will include compliance with such regulations.

It is also possible that the economics of LFG utilization for power generation may change at some time in the future. If such changes lead to a sufficient increase in the profitability of LFG utilization the proposed project could well be implemented without the help of carbon finance. If this occurs, the future baseline scenario will include an LFG to power project.

The baseline scenario for the proposed project can thus be described as follows:

No collection and treatment of LFG occurs at the Itanhaem landfill site and this allows the uncontrolled release of most of the LFG to the atmosphere until some future time when the collection and treatment of LFG will either be required by law or becomes an economically attractive course of action. The monitoring plan for the project will re-evaluate the baseline scenario, report any changes during the crediting period and determine the new baseline scenario.

This baseline scenario is the basis for the determination of the project's ERs as per the monitoring plans instructions.

The Itanhaem project baseline assumptions will be revisited every 7 years to ensure that the assumptions made in the baseline scenario still hold true, or they will be revised accordingly. In addition, the introduction of Brazilian legislation regarding the collection and flaring of landfill gas will be monitored **annually** as a part of the Monitoring Plan.

**B.4. Description of how the definition of the project boundary related to the baseline methodology selected is applied to the project activity:**

The following flow diagram describes the project boundary and includes those GHG emissions, which are "under the control of" the project participants, "significant" and "reasonably attributable".

In the light of these attributes, the following emissions have not been taken into account:

- Emissions from the transport of the waste to the landfill site, as these would occur even in the absence of the proposed project activity.
- Emissions from the vehicles used to compact and cover the waste, as these would also occur in the absence of the project activity.

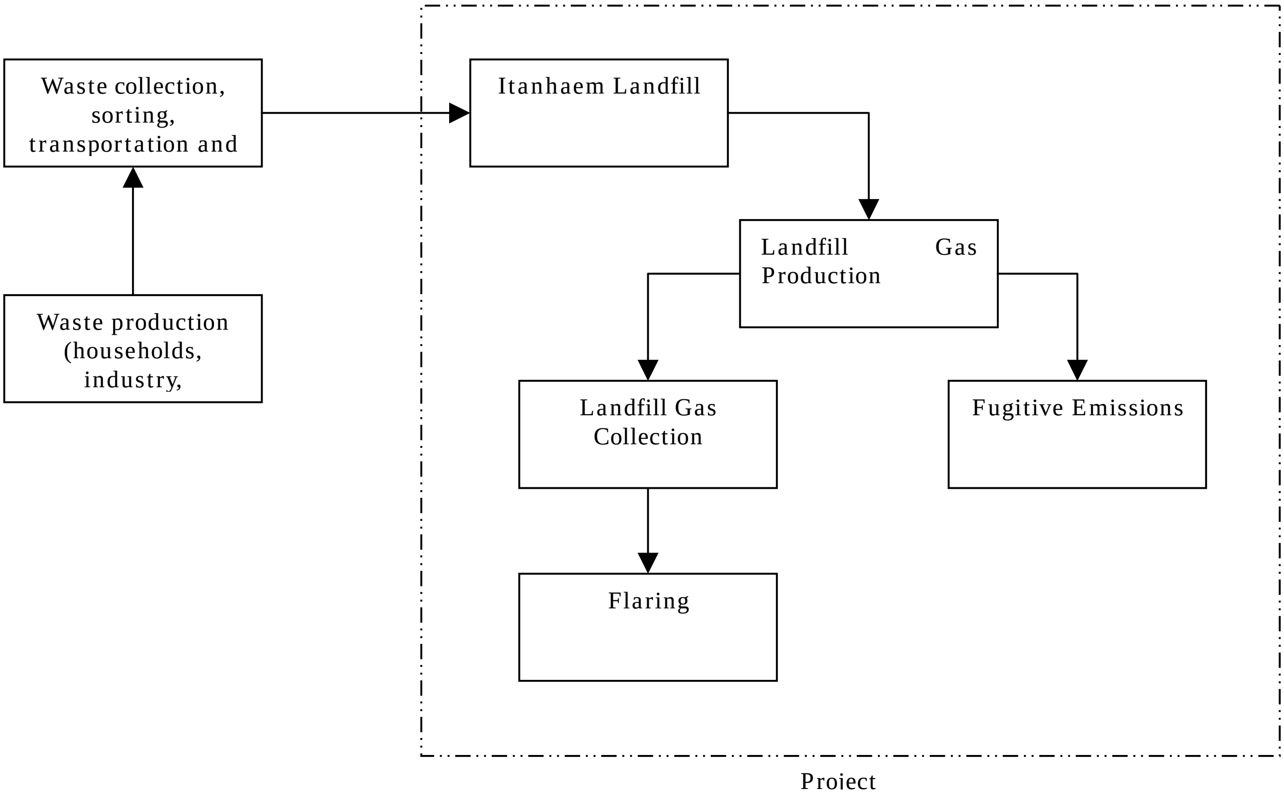



Figure B.4.1: Project Boundary

| Emissions | Project Scenario | Baseline Scenario |
|---|---|---|
| Direct On-site | Emissions associated with the inefficiency of the LFG capture and flaring process. MaxAmbiental estimates that only about 75% of total LFG produced will be collected and then combusted to $CO_2$. Hence 25% of the total gas production will be released as fugitive emissions. | Uncontrolled release of practically all LFG generated by the landfill. |
| Direct Off-site | Transportation of equipment to project site – excluded because deemed to be insignificant | None identified |
| Indirect On-site | NA | NA |
| Indirect Off-site | Transportation of waste to landfill site – excluded because would happen even in absence of project | Transportation of waste to landfill site – excluded because would happen even in absence of project |

Table B.4.2: System emissions

**B.5. Details of baseline information, including the date of completion of the baseline study and the name of person (s)/entity (ies) determining the baseline:**

The project is using **ACM0001**: Consolidated Methodology for Landfill Gas Project Activities

The baseline study was concluded in November 2005.

The entity determining the baseline and participating in the project, as the technical consultants are **MaxAmbiental** and **Xenex do Brasil Ltda** Brazil, listed in Annex 1 of this document.

## 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:

The project start date has been set for the second quarter of 2006.

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

The landfill will close in early 2006. The project activity is expected to last from 2006 to 2012 for the first crediting period. The actual project activity will have a renewable crediting period of 7 years. This period can be renewed twice.

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

The project activity will use a renewable crediting period as described below in the following section (C.2.1).

#### C.2.1. Renewable crediting period

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

The starting date is 1st January 2006

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

7 years duration per renewable period

#### C.2.2. Fixed crediting period:

##### C.2.2.1. Starting date:

NA

##### C.2.2.2. Length:

NA

## SECTION D. Application of a monitoring methodology and plan

### D.1. Name and reference of approved monitoring methodology applied to the project activity:

ACM0001: "Consolidated monitoring methodology for landfill gas project activities"

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

This monitoring methodology was specifically developed for landfill gas capture projects using baseline methodology ACM0001.

**D.2. 1. Option 1: Monitoring of the emissions in the project scenario and the baseline scenario**

**D.2.1.1. Data to be collected in order to monitor emissions from the project activity, and how this data will be archived:**

| ID number *(Please use numbers to ease cross-referencing to table D.3)* | Data variable | Source of data | Data unit | Measured (m), calculated (c), estimated (e), | Recording frequency | Proportion of data to be monitored | How will the data be archived? (electronic/ paper) | Comment |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |

Not applicable. Total project emissions are actually zero; there are neither project emissions nor leakage. The only discernable and significant difference between baseline and project emissions comes from the collection and destruction of methane contained in LFG, which is monitored and calculated directly. The only discernable yet insignificant (indirect) modification of emissions is associated with the physical construction of the project (see discussion under D.4 below). The monitoring methodology is based on direct measurement of the amount of landfill gas captured and destroyed at the flare platform.

**D.2.1.2. Description of formulae used to estimate project emissions (for each gas, source, formulae/algorithm, emissions units of $CO_2$ equ.)**

Not applicable, see D.2.1.1.

**D.2.1.3. Relevant data necessary for determining the baseline of anthropogenic emissions by sources of GHGs within the project boundary and how such data will be collected and archived:**

| ID number *(Please use numbers to ease cross-referencing to table D.3)* | Data variable | Source of data | Data unit | Measured (m), calculated (c), estimated (e), | Recording frequency | Proportion of data to be monitored | How will the data be archived? (electronic/ paper) | Comment |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |

The monitoring methodology is based on direct measurement of the amount of landfill gas captured and destroyed at the flare platform.

**D.2.1.4. Description of formulae used to estimate baseline emissions (for each gas, source, formulae/algorithm, emissions units of $CO_2$ equ.)**

Not applicable. The monitoring methodology is based on direct measurement of the amount of landfill gas captured and destroyed at the flare platform.

**D. 2.2. Option 2: Direct monitoring of emission reductions from the project activity (values should be consistent with those in section E).**

This is the Option chosen for the monitoring methodology of the Itanhaem landfill gas capture and flaring project. As stated in ACM0001: “*The monitoring methodology is based on direct measurement of the amount of landfill gas captured and destroyed at the flare platform.*”

**D.2.2.1. Data to be collected in order to monitor emissions from the project activity, and how this data will be archived:**

| ID number *(Please use numbers to ease cross-referencing to table D.3)* | Data variable | Source of data | Data unit | Measured (m), calculated (c), estimated (e), | Recording frequency | Proportion of data to be monitored | How will the data be archived? (electronic/ paper) | Comment |
|---|---|---|---|---|---|---|---|---|
| *D2-1* | *Annual Waste landfilled* | *Truck balance* | *Tonnes* | *M* | *Arrival of truck* | *100%* | *Electronic (spreadsheet)* | *Measured on site* |
| *D2-2* | *Flow of landfill gas to flares* | *Continuous Flow Meter* | *$m^3$* | *M* | *Continuous* | *100%* | *Electronic (spreadsheet)* | *Data will be aggregated monthly and yearly* |
| *D2-3* | *Flare efficiency determined by 1) operating hours And 2) Methane content in exhaust gas* | *Continuous methane analyser* | *%* | *M &C* | *1) Continuously 2) Quarterly* | *N/a* | *Electronic (spreadsheet)* | *Data will be used to test and, if necessary, correct the flare’s efficiency rating* |
| *D2-4* | *Methane fraction in LFG* | *Continuous methane analyser* | *%* | *M &C* | *Continuous* | *100%* | *Electronic (spreadsheet)* | *Data will be aggregated monthly and yearly* |
| *D2-5* | *Gas pressure* | *Pressure gauge* | *Pa* | *M* | *Continuous* | *100%* | *Electronic (spreadsheet)* | *Data will be used to calculate methane density* |
| *D2-6* | *Gas temperature* | *Thermometer* | *Deg. Celsius* | *M* | *Continuous* | *100%* | *Electronic (spreadsheet)* | *Data will be used to calculate methane density* |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| *D2-7* | *Amount of methane flared* | *N/a* | *Tonnes of $CH_4$* | *M & C* | *Daily* | *100%* | *Electronic (spreadsheet)* | *It can be measured or calculated with the following data: LFG flow to flare, methane fraction in LFG, LFG temperature and pressure, flare temperature, and flare working hours* |
| *D2-8* | *Amount of methane flaring required in baseline* | *N/a* | *Tonnes of $CH_4$* | *C* | *Daily* | *100%* | *Electronic (spreadsheet)* | *20% of the amount of methane flared* |
| *D2-9* | *Regulatory requirements relating to landfill gas projects* | *Legislation* | *N/a* | *N/a* | *Annually* | *100%* | *Electronic (spreadsheet)* | *Required for any changes to the adjustment factor (ID 8)* |

**D.2.2.2. Description of formulae used to calculate project emissions (for each gas, source, formulae/algorithm, emissions units of $CO_2$ equ.):**

Not applicable. Total project emissions are actually zero; there are neither project emissions nor leakage. The only discernable and significant difference between baseline and project emissions comes from the collection and destruction of methane contained in LFG, which is monitored and calculated directly. The only discernable yet insignificant (indirect) modification of emissions is associated with the physical construction of the project (see discussion under D.4 below). The monitoring methodology is based on direct measurement of the amount of landfill gas captured and destroyed at the flare platform.

The following formulae are used to calculate project emissions using the direct monitoring data measured and collected during the lifetime of the project:

$$MD_{project,y} = LFG_{flared,y} \times w_{ch4} \times D_{ch4} \times FE$$

Where:

$LFG_{flared,y}$ = Flow of landfill gas ($m^3$)

$w_{ch4}$ = Methane fraction in LFG (%)

$D_{ch4}$ = Temperature/(Pressure * R) (kg/m$^3$)

$FE$ = Flare efficiency (%)

**D.2.3. Treatment of leakage in the monitoring plan**

**D.2.3.1. If applicable, please describe the data and information that will be collected in order to monitor leakage effects of the project activity**

| ID number *(Please use numbers to ease cross-referencing to table D.3)* | Data variable | Source of data | Data unit | Measured (m), calculated (c) or estimated (e) | Recording frequency | Proportion of data to be monitored | How will the data be archived? (electronic/ paper) | Comment |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | |
| | | | | | | | | |

Not applicable, there is no significant leakage in the project. See comment under D.2.3.2. below.

**D.2.3.2. Description of formulae used to estimate leakage (for each gas, source, formulae/algorithm, emissions units of $CO_2$ equ.)**

Only the construction of the LFG collection and utilization system will lead to some GHG emissions that would not have occurred in the absence of the project. These emissions are, however, insignificant. No increased in emissions are discernable other than those targeted and directly monitored by the project. Moreover, because the project employs direct monitoring of emission reductions, indirect emissions will not distort their calculation.

**D.2.4. Description of formulae used to estimate emission reductions for the project activity (for each gas, source, formulae/algorithm, emissions units of $CO_2$ equ.)**

The following formulae are used to calculate emission reductions for the project activity using the direct monitoring data measured and collected during the lifetime of the project:

$$ER_y = \left(MD_{project,y} - MD_{reg,y}\right) \times GWP_{CH4}$$

Where:

$GWP_{CH4}$ = Global Warming Potential of methane (IPCC, 1996)

$$MD_{project,y} = LFG_{flared,y} \times w_{ch4} \times D_{ch4} \times FE$$

Where:

$MD_{project,y}$ = Amount of methane actually **flared/destroyed** during year y

$LFG_{flared,y}$ = Flow of landfill gas ($m^3$)

$w_{ch4}$ = Methane fraction in LFG (%)

$D_{ch4}$ = Temperature/(Pressure * R) ($kg/m^3$)

$FE$ = Flare efficiency (%)

$MD_{reg,y}$ = Amount of methane flaring required in baseline (or **customarily** carried out for safety reasons)

Where:

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

$AF$ = Adjustment factor based on the project context, i.e. what fraction of methane is customarily flared for safety considerations.

| **D.3.** **Quality control (QC) and quality assurance (QA) procedures are being undertaken for data monitored** | | |
|---|---|---|
| Data *(Indicate table and ID number e.g. 3.-1.; 3.2.)* | Uncertainty level of data (High/Medium/Low) | Explain QA/QC procedures planned for these data, or why such procedures are not necessary. |
| *D-1* | Low | All the arriving waste at the landfill will be immediately weighed using a truck balance, with regular maintenance, and all the values recorded for future calculations |
| *D2-2* | Low | Flow meters will be subject to a regular maintenance and testing regime to ensure accuracy |
| *D2-3* | Low | Regular maintenance will ensure optimal operation of flares. Flare efficiency will be calibrated annually or more often, if significant deviation from previous efficiency rating is observed. |
| *D2-4* | Low | Gas analyzer will be subject to a regular maintenance and testing regime to ensure accuracy |
| *D2-5* | Low | Meters will be subject to a regular maintenance and testing regime to ensure accuracy. |
| *D2-6* | Low | Meters will be subject to a regular maintenance and testing regime to ensure accuracy. |
| *D2-7* | Low | This value is going to be calculated and recorded using the data that is directly collected and monitored at the site |
| *D2-8* | Low | This data will be determined from current industry practice. |
| *D2-9* | Low | This data will be determined from current legislation. |

**D.4 Please describe the operational and management structure that the project operator will implement in order to monitor emission reductions and any leakage effects, generated by the project activity**

As described before, the flaring station, where the emission reductions will actually happen, will be equipped with a measurement chain, which will allow direct daily measurement of the real amount of methane flared.
The management structures implemented in the Itanhaem project are as follows:

**Daily Monitoring Records**: On the larger more active sites site staff takes daily gas field and engine readings. These readings are then checked for any anomalies before being filed for future reference. The readings can be taken at weekly or other set periods depending on the activity and consistency of the gas field and engine operation. All engines have telemetry links back to a central computer, which continually monitors the performance of the engine detecting problems and highlighting them for attention.

**Gas Field Monitoring Records**: Taken on a weekly basis or at periods to be determined. The Site Technician walks the gas field taking readings at each gas well and recording these on a form. These readings are then checked for any anomalies before being filed for future reference. A gas analyser will be installed in order to enable continuous accurate measurement of the methane content on the landfill gas. These gas field inspections will also observe occurrence of any unintended releases of landfill gas. In case unintended releases are observed, appropriate corrective action will be taken immediately.

**Routine Reminders for Site Technicians**: All Site Technicians are issued with a reminder list to guide them through their daily, weekly and monthly routine. The Engineering Manager, Operations Manager and Training and Health & Safety Co-ordinator go through this routine during site visits to ensure all aspects of the role are being performed. In addition monitoring records, oil sample reports and meter readings that are due, are checked to ensure they have arrived. Again, the telemetry link records a lot of the data automatically.

**Site Audits**: The Engineering Manager, Operations Manager and Training and Health & Safety Co-ordinator make regular site visits. In addition to ensuring the site routines are being performed any additional training needs are assessed and an audit is taken of any outstanding task on site.

**Outstanding Work Notice**: Following the Site Audit a 'Plant Outstanding Works Notice' is issued to the Site Technician listing all the jobs that the management team consider necessary to be undertaken. This is checked on subsequent site audits to ensure these jobs have been carried out.

**Calibration of measurement equipment:** Calibration of measurement equipment will be done monthly in accordance with the requirements of the National Measurement Regulation Agency, INMETRO (Instituto Nacional de Metrologia).

**Corrective Actions:** Management structure measures include procedures to handle and correct non-conformities in the implementation of the Project or this Monitoring Plan. In case such non-conformities are observed:

- An analysis of the nonconformity and its causes will be carried out immediately by landfill staff
- Landfill management will make a decision, in consultation with MaxAmbiental when needed, on appropriate corrective actions to eliminate the non-conformity and its causes.
- Corrective actions are implemented and reported back to Landfill management.

It will be assured that the landfill gas management team will receive support and appropriate training on the implementation of this Monitoring Plan and of the project

**D.5 Name of person/entity determining the monitoring methodology:**

**Paulo Braga, MaxAmbiental and**
**Xenex do Brasil, Ltda (see Annex 1)**

## SECTION E. Estimation of GHG emissions by sources

| | Emission Source | Greenhouse Gas | Validity | Quantity of Emissions (2006-2012) |
|---|---|---|---|---|
| Project Scenario | Landfill & LFG Flare | Methane | Yes. Due to collection and flaring inefficiencies some gas will not be destroyed. Hence there will still be emissions of LFG even after the project activity has been implemented. | **58,253 tonnes of $CO_2$e** |
| | LFG Flare | $CO_2$ | No. $CH_4$ emissions from the decay of biomass are not counted as anthropogenic GHG emissions | NA |
| | Equipment construction | Various | No. These are not considered to be “significant” in relation to overall emissions | NA |
| | On-site transportation | Various | No. On-site transportation of MSW would occur even in the absence of the project activity. | NA |
| Baseline Scenario | Landfill | Methane | Yes. Methane emissions from the anaerobic decomposition of MSW are considered to be additional. In the baseline scenario only 20% of LFG is captured and flared. | **229,862 tonnes of $CO_2$e** |

Figure E.1: Emission Sources

### E.1. Estimate of GHG emissions by sources:

Not applicable. Total project emissions are actually zero; there are neither project emissions nor leakage. The only discernable and significant difference between baseline and project emissions comes from the collection and destruction of methane contained in LFG, which is monitored and calculated directly. The only discernable yet insignificant (indirect) modification of emissions is associated with the physical construction of the project. To calculate emission reduction estimates baseline emissions only are estimated and then multiplied by the flaring inefficiencies and collection rates of the installed equipment.

### E.2. Estimated leakage:

Only the construction of the LFG collection and utilization system will lead to some GHG emissions that would not have occurred in the absence of the project. These emissions are, however, insignificant. No increased in emissions are discernable other than those targeted and directly monitored by the project. Moreover, because the project employs direct monitoring of emission reductions, indirect emissions will not distort their calculation.

### E.3. The sum of E.1 and E.2 representing the project activity emissions:

Project activity emissions are actually zero, as the project activity does not cause any GHG emissions by itself. Due to equipment inefficiencies it is estimated that there will still be a fraction of LFG released to the atmosphere. However, this is reflected in lower emissions reductions rather than in project activity emissions.

As the project aims to flare a large proportion of LFG produced, this percentage can be applied to the baseline emissions. In the case of the Itanhaem landfill and as explained above, a collection and flaring efficiency of 75% has been estimated. This plus further adjustments are then applied to the baseline emissions calculated in Section E.4 to arrive at total emission reductions.

**E.4. Estimated anthropogenic emissions by sources of greenhouse gases of the baseline:**

**General Assumptions**

| Parameter | Value | Source |
|---|---|---|
| Global Warming Potential (GWP) of $CH_4$ | 21 | IPCC, 2001 |
| Amount of methane flared in baseline (AF) | 20% for safety reasons | Industry common practice |
| MCF – Methane Correction Factor for landfill | **0.8** for unmanaged landfill | IPCC, 1996 |
| Density of methane | 0.000656 $tCH_4/m^3CH_4$ | Literature |
| Methane generation rate (k) | 0.1 $year^{-1}$ | US EPA/SCS Engineers |
| Potential methane generation capacity ($L_o$) | 164 $m^3$/tonne | US EPA/SCS Engineers |
| Methane content of LFG | 50% | IPCC, 1996 |
| Methane collection efficiency | 75% | Supplier |
| Insurance Adjustment Factor | 20% | MaxAmbiental |

**Waste Projections**

| Year | Daily Waste Disposal Rate (tonnes/day) | Waste added in Year (tonnes/yr) | Cumulative Waste-in-Place (tonnes) |
|---|---|---|---|
| 1980 | 88 | 32,000 | 0 |
| 1981 | 88 | 32,000 | 32,000 |
| 1982 | 88 | 32,000 | 63,999 |
| 1983 | 88 | 32,000 | 95,999 |
| 1984 | 88 | 32,000 | 127,998 |
| 1985 | 88 | 32,000 | 159,998 |
| 1986 | 88 | 32,000 | 191,997 |
| 1987 | 88 | 32,000 | 223,997 |
| 1988 | 88 | 32,000 | 255,996 |
| 1989 | 88 | 32,000 | 287,996 |
| 1990 | 88 | 32,000 | 319,996 |
| 1991 | 88 | 32,000 | 351,995 |
| 1992 | 88 | 32,000 | 383,995 |
| 1993 | 88 | 32,000 | 415,994 |
| 1994 | 88 | 32,000 | 447,994 |
| 1995 | 88 | 32,000 | 479,993 |
| 1996 | 88 | 32,000 | 511,993 |
| 1997 | 88 | 32,000 | 543,992 |
| 1998 | 88 | 32,000 | 575,992 |
| 1999 | 88 | 32,000 | 607,991 |
| 2000 | 88 | 32,000 | 639,991 |
| 2001 | 88 | 32,000 | 671,991 |

| | | | |
|---|---|---|---|
| 2002 | 88 | 32,000 | 703,990 |
| 2003 | 88 | 32,000 | 735,990 |
| 2004 | 88 | 32,000 | 767,989 |
| 2005 | 100 | 36,500 | 799,989 |

**USEPA First Order Decay Model**

The estimation of baseline emissions is principally carried out to determine approximate gas volumes and by deduction emissions reductions. The following model is NOT part of the monitoring methodology per se, but rather suited for the **ex ante calculation** of potential emission reductions.

An assessment of the landfill gas generation of the Itanhaem Landfill was carried out using the **USEPA's Landfill Air Emissions Estimation Model**, which is consistent with the more complex methodology recommended by the Intergovernmental Panel on Climate Change (IPCC) for calculating methane emissions from landfills. The assumptions applied were those successfully used by the Brazilian NovaGerar project, whose two landfills operate under similar conditions as the Itanhaem landfill.

Model Inputs

The US EPA first order exponential decay model equation from the US EPA manual 'Turning a Liability into an Asset: **A Landfill Gas to Energy Handbook for Landfill Owners and Operators' (December 1994)** is as follows:

$$LFG = 2 \times L_o \times R \times \left(e^{-kc} - e^{-kt}\right)$$

Where:

LFG = total landfill gas generated in current year (m3)
$L_o$ = theoretical potential amount of landfill gas generated (m3/tonne)
R = waste disposal rate (tonnes/year)
t = time since landfill opened (years)
c = time since landfill closed (years)
k = rate of landfill gas generation (1/year)
MCF – Methane Correction Factor of 0.8 is used because Itanhaem is an unmanaged waste facility (1996 IPCC guidelines).

The site-specific inputs used were:

Waste disposal rate (R):
The Itanhaem landfill received a total of 800,000[62] tonnes of MSW between **1980 and 2005**. These data forms the foundation of the gas volume projection. This implies that the gas volume projection will vary accordingly. Therefore, even though gas volumes may fluctuate over a period of time because of varying disposal rates, the ultimate total volume of gas projected for the site will remain constant. The values used for R are shown in the waste projections table above.

Gas Generation Rate (k):
The gas generation rate for this site was determined based on specific ranges given for Brazilian landfills. The gas generation rate is influenced by the temperature, humidity and composition of the waste. A figure

[62] The total volume used in the LFG estimation is **799,989 tonnes** by the beginning of 2005.

of **0.1** was used as recommended by SCS Engineers in a presentation on behalf of the US EPA in Sao Paulo, Brazil (Part 5: Evaluating Landfill Gas Potential, June 26 2001, Training Workshop for the US EPA Landfill Methane Outreach Program, Sao Paulo Brazil).

Theoretical Yield (Lo):

Another input into the computer model is theoretical maximum yield i.e. the total amount of landfill gas that one metric tonne of waste is expected to generate over its lifetime (cubic meters per tonne of MSW). Lo is a variable dependent on the type of waste deposited and its organic content. Again estimates recommended by SCS Engineers in a presentation on behalf of the US EPA in Sao Paulo, Brazil (Part 5: Evaluating Landfill Gas Potential, June 26 2001, Training Workshop for the US EPA Landfill Methane Outreach Program, Sao Paulo Brazil) were used, and the value chosen was **164 m3/tonne**.

Time since landfill opened (t): These values varied depending on which site was being investigated. In the case of the Itanhaem landfill the opening year was **1980**. Therefore the value used for t changed depending on which year landfill gas generation figures were being developed for.

Time since landfill closed (c): The landfill will be shut by early **2006**.

The USEPA model was then applied to the specific case of the CTRPE landfill and using the parameters detailed above gas volumes were estimated. The results are in the following table.

| Project Emissions for 1st Crediting Period | | | | |
|---|---|---|---|---|
| **Year** | **Methane Production ($tCH_4$/yr)** | **Baseline CO2e Emissions ($tCO_2e$/yr)** | **$CO_2e$ Emissions after project activity ($tCO_2e$/yr)** | **Net emissions reductions (tCO2e/yr)** |
| 2006 | 2,586 | 43,452 | 43,452 | 0 |
| 2007 | 2,340 | 39,317 | 12,286 | 21,192 |
| 2008 | 2,118 | 35,575 | 11,117 | 19,175 |
| 2009 | 1,916 | 32,190 | 10,059 | 17,350 |
| 2010 | 1,734 | 29,127 | 9,102 | 15,699 |
| 2011 | 1,569 | 26,355 | 8,236 | 14,205 |
| 2012 | 1,419 | 23,847 | 7,452 | 12,853 |
| **Total** | **13,682** | **229,862** | **101,705** | **100,475** |

**5. Difference between E.4 and E.3 representing the emission reductions of the project activity:**

After to accounting for registration fees and a 20% insurance factor, total emission reductions amount to **100,475 $tCO_2e$ over the first 7-year crediting period**. For a summary of estimated results please see the table in E.6 below.

**E.6. Table providing values obtained when applying formulae above:**

| **Year** | **Estimation of baseline emissions (tonnes of $CO_2e$)** | **Estimation of project activity emissions (tonnes of $CO_2e$)** | **Estimation of gross emission reductions (tonnes of $CO_2e$)** | **Estimation of net emission reductions (tonnes of $CO_2e$)** |
|---|---|---|---|---|
| 2006 | 43,452 | 43,452 | 0 | 0 |
| 2007 | 39,317 | 12,286 | 27,030 | 21,192 |
| 2008 | 35,575 | 11,117 | 24,458 | 19,175 |
| 2009 | 32,190 | 10,059 | 22,131 | 17,350 |

| | | | | |
|---|---|---|---|---|
| 2010 | 29,127 | 9,102 | 20,025 | 15,699 |
| 2011 | 26,355 | 8,236 | 18,119 | 14,205 |
| 2012 | 23,847 | 7,452 | 16,395 | 12,853 |
| **Total (tonnes of $CO_2e$)** | **229,862** | **101,705** | **128,157** | **100,475** |

## SECTION F. Environmental impacts

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

**This section needs to be completed with section that the project sponsor has yet to provide.**

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

The current Itanhaem waste site ("Lixão") exhibits minimal environmental impact control. The Itanhaem LFG flaring project will generate revenue that the local prefecture will use to remediate the site. The existing waste site has no landfill daily cover, no bottom liner, no drainage or treatment of leachate and no methane capture and flaring equipment. Hence it represents a clear environmental hazard and needs to be cleaned up as soon as possible. CDM revenues would allow the prefecture to achieve this.

The images of the actual site show that the location appears to be only rudimentarily managed. It also demonstrates that there are a sizeable number of waste collectors ("catadores") that survive on reselling waste with some residual value. It is therefore paramount that this project also takes into consideration the fate of the community of catadores that live close to the current site.

## SECTION G. Stakeholders' comments

As with any CDM project activity PDD, this section will only be completed during the validation phase of the project cycle by the chosen Designated operational entity (DOE) and in cooperation with the relevant project participants. This section will reflect comments submitted pertaining to the **ACTUAL** project engineering plans.

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

>>

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

>>

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

>>

## Annex 1

### CONTACT INFORMATION ON PARTICIPANTS IN THE PROJECT ACTIVITY

| | |
|---|---|
| Organization: | MaxAmbiental – Project Developer |
| Street/P.O.Box: | Avenida Brigadeiro Faria Lima, 2894 cj. 44 |
| Building: | |
| City: | São Paulo |
| State/Region: | SP |
| Postfix/ZIP: | 01452 938 |
| Country: | Brazil |
| Telephone: | +55 11 3709 3440 |
| FAX: | +55 11 3709 3446 |
| E-Mail: | |
| URL: | www.maxambiental.com.br |
| Represented by: | Paulo Braga |
| Title: | Director |
| Salutation: | |
| Last Name: | Braga |
| Middle Name: | |
| First Name: | Paulo |
| Department: | |
| Mobile: | +55 11 8271 3626 |
| Direct FAX: | +55 11 3709 3446 |
| Direct tel: | +55 11 3709 3440 |
| Personal E-Mail: | Paulo@maxambiental.com.br |

| | |
|---|---|
| Organization: | Xenex do Brasil, Ltda. – Project Developer |
| Street/P.O.Box: | Rua Manuel da Nobrega 354, cj. 82 |
| Building: | |
| City: | São Paulo, Paraiso |
| State/Region: | SP |
| Postfix/ZIP: | 04001 001 |
| Country: | Brazil |
| Telephone: | +55 11 3262 0854 |
| FAX: | |
| E-Mail: | xenexbr@nethall.com.br |
| URL: | |
| Represented by: | Junichi Ishihara |
| Title: | Director President |
| Salutation: | |
| Last Name: | Ishihara |
| Middle Name: | |
| First Name: | Junichi |
| Department: | |
| Mobile: | |
| Direct FAX: | |
| Direct tel: | |
| Personal E-Mail: | |

| | |
|---|---|
| Organization: | Banco Sumitomo Mitsui Brasileiro S.A.- Project Sponsor |
| Street/P.O.Box: | Avenida Paulista, 37 – 11th Floor |
| Building: | |
| City: | São Paulo |
| State/Region: | SP |
| Postfix/ZIP: | 01311 902 |
| Country: | Brazil |
| Telephone: | +55 11 3178 8129 |
| FAX: | +55 11 3178 8190 |
| E-Mail: | |
| URL: | www.smbcgroup.com.br |
| Represented by: | Hajime Uchida |
| Title: | Marketing Group – Japanese Corporate General Manager |
| Salutation: | |
| Last Name: | Uchida |
| Middle Name: | |
| First Name: | Hajime |
| Department: | |
| Mobile: | |
| Direct FAX: | |
| Direct tel: | |
| Personal E-Mail: | Hajime_uchida@smbcgroup.com.br |

## Annex 2

**INFORMATION REGARDING PUBLIC FUNDING**

The project will not receive any public funding from Parties listed in Annex I of the UNFCCC.

# ANNEX 3

## BASELINE INFORMATION

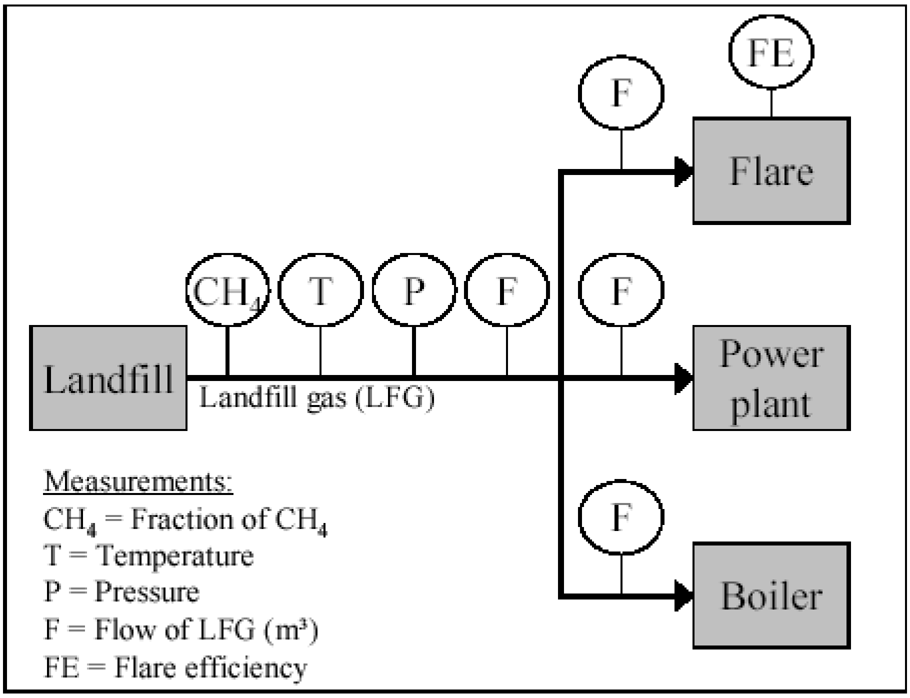
| | |
|---|---|
| **Project Cashflow 1** | |
| **Landfill/Project Name:** | **Itanhaem** |

| | Unit | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|---|---|
| | | 1st | 2nd | 3rd | 4th | 5th | 6th | 7th |
| Carbon Cashflow | | | | | | | | |
| Total LFG emitted | m3/h | 900 | 814 | 737 | 667 | 603 | 546 | 494 |
| Carbon CF | | | | | | | | |
| Total Adj. Net Emission Reductions | Tonnes CO2e/yr | 0 | 21,192 | 19,175 | 17,350 | 15,699 | 14,205 | 12,853 |
| Cost | | | | | | | | |
| Annual Operation Cost | | -12,552 | -12,552 | -12,552 | -12,552 | -12,552 | -12,552 | -12,552 |
| Annual Mentenace Cost | | -18,000 | -18,000 | -18,000 | -18,000 | -18,000 | -18,000 | -18,000 |
| Validation & Verification Cost | | | -5,000 | -5,000 | -5,000 | -5,000 | -5,000 | -5,000 |
| Adaptation Fee/CER | US$0.2 | | -4,238 | -3,835 | -3,470 | -3,140 | -2,841 | -2,571 |
| Electricity Generation Cost | US$70.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Depreciation | | -49,191 | -49,191 | -49,191 | -49,191 | -49,191 | -49,191 | -49,191 |
| Interest | | -32,794 | -30,306 | -27,669 | -24,873 | -21,910 | -18,769 | -15,439 |
| Total Cost | | -112,538 | -119,288 | -116,247 | -113,087 | -109,793 | -106,353 | -102,753 |
| | | | | | | | | |
| Income | | | | | | | | |
| Price of CER | US$/tCO2 | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 |
| CER Sales | US$8.0 | 0 | 169,534 | 153,401 | 138,803 | 125,594 | 113,642 | 102,828 |
| Electricity Tariff | US$/MWh | 50.0 | 50.0 | 50.0 | 50.0 | 50.0 | 50.0 | 50.0 |
| Electricity Sales | US$50.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Income | | 0 | 169,534 | 153,401 | 138,803 | 125,594 | 113,642 | 102,828 |
| | | | | | | | | |
| Balance | | -112,538 | 50,246 | 37,153 | 25,716 | 15,801 | 7,289 | 74 |
| Income Tax | | 0 | -17,084 | -12,632 | -8,743 | -5,372 | -1,749 | -18 |
| Current Income | | -112,538 | 33,162 | 24,521 | 16,973 | 10,428 | 5,539 | 56 |
| | | | | | | | | |
| NPV(21years) | 494,338 | | | | | | | |
| IRR(21years) | 4.0% | | | | | | | |

**Annex 4**

**MONITORING PLAN**

The monitoring plan for the Carapicuíba LFG Flaring project activity is based on the monitoring methodology of ACM0001. The following diagram is provided.




Please note that for this project activity there is no boiler or power plant but only a flare.

The principal variables that need to be calculated for monitoring purposes are as follows:

1. $MD_{project, y}$ for every project year
2. $MD_{reg, y}$ for every project year

The input data required for this will be stored in the following spreadsheet and archived for at least two years after the end of the crediting period or the last issuance of CERs for this project activity whatever occurs later.

## Monitoring Plan for Itanhaem Landfill gas capture and flaring project

| Year | Units | Measurement | 2006 |
|---|---|---|---|
| **Project Year** | | | **1** |
| | | | |
| **Total amount of LFG flared** | **m3** | **Flow Meter** | |
| | | | |
| Methane content of exhaust gas | m3 CH4/m3 ExGas | Gas analyzer | |
| Operation time of flare | hours | Flare | |
| **Flare Combustion Efficiency** | **%** | **Calculated** | |
| | | | |
| **Methane content of landfill gas** | **m3 CH4/m3 LFG** | **Gas analyzer** | |
| | | | |
| Temperature of LFG | Degree Celsius | Manifold | |
| Pressure of LFG | Pa | Manifold | |
| **Density of methane** | **tonnes CH4/m3 CH4** | **Calculated** | |
| | | | |
| **Regulatory requirements relating to LFG projects** | | | |

## Annex 5

## ELECTRICITY GENERATING OPTION

### Annex 5: Electricity Generation Potential – Itanhaem Landfill

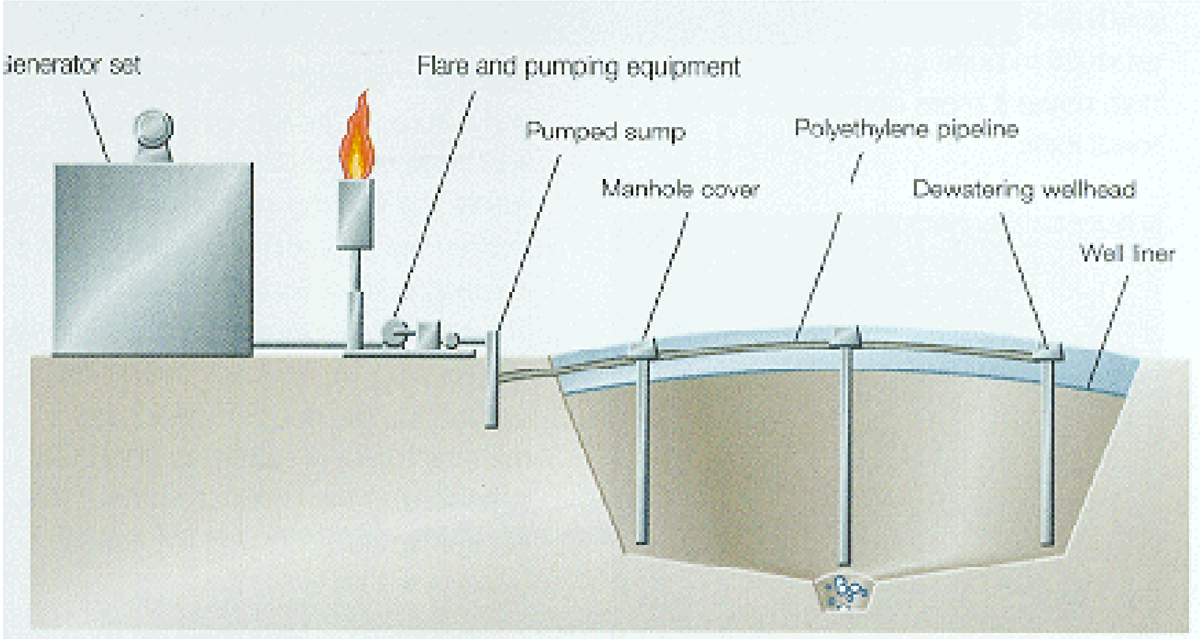
| Electricity Generation | Itanhaem |
|---|---|

| | Unit | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|---|---|
| | | 1st | 2nd | 3rd | 4th | 5th | 6th | 7th |
| Carbon Cashflow | | | | | | | | |
| Total LFG emitted | m3/h | 900 | 814 | 737 | 667 | 603 | 546 | 494 |
| Carbon CF | | | | | | | | |
| Total Adj. Net Emission Reductions | Tonnes CO2e/yr | 0 | 21,192 | 19,175 | 17,350 | 15,699 | 14,205 | 12,853 |
| Electricity Generation(MWh) | | 0 | 3,189 | 3,189 | 3,189 | 3,189 | 3,189 | 3,189 |
| | | | | | | | | |
| Cost | | | | | | | | |
| Annual Operation Cost | | -12,552 | -12,552 | -12,552 | -12,552 | -12,552 | -12,552 | -12,552 |
| Annual Mentenace Cost | | -18,000 | -18,000 | -18,000 | -18,000 | -18,000 | -18,000 | -18,000 |
| Validation & Verification Cost | | | -5,000 | -5,000 | -5,000 | -5,000 | -5,000 | -5,000 |
| Adaptation Fee/CER | US$0.2 | | -4,238 | -3,835 | -3,470 | -3,140 | -2,841 | -2,571 |
| Electricity Generation Cost | US$70.0 | 0 | -223,205 | -223,205 | -223,205 | -223,205 | -223,205 | -223,205 |
| Depreciation | | -49,191 | -49,191 | -49,191 | -49,191 | -49,191 | -49,191 | -49,191 |
| Interest | | -32,794 | -30,306 | -27,669 | -24,873 | -21,910 | -18,769 | -15,439 |
| Total Cost | | -112,538 | -342,493 | -339,452 | -336,291 | -332,998 | -329,558 | -325,958 |
| | | | | | | | | |
| Income | | | | | | | | |
| Price of CER | US$/tCO2 | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 |
| CER Sales | US$8.0 | 0 | 169,534 | 153,401 | 138,803 | 125,594 | 113,642 | 102,828 |
| Electricity Tariff | US$/MWh | 50.0 | 50.0 | 50.0 | 50.0 | 50.0 | 50.0 | 50.0 |
| Electricity Sales | US$50.0 | 0 | 159,432 | 159,432 | 159,432 | 159,432 | 159,432 | 159,432 |
| Total Income | | 0 | 328,966 | 312,833 | 298,235 | 285,026 | 273,074 | 262,260 |
| | | | | | | | | |
| Balance | | -112,538 | -13,527 | -26,619 | -38,057 | -47,972 | -56,484 | -63,699 |
| Income Tax | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Current Income | | -112,538 | -13,527 | -26,619 | -38,057 | -47,972 | -56,484 | -63,699 |
| | | | | | | | | |
| NPV(21years) | -27,448 | | | | | | | |
| IRR(21years) | #DIV/0! | | | | | | | |

**Electricity Market Situation in Brazil**

Other than financial return from the carbon market, the only potential revenue to the project derives from the use of gas to produce electricity. The feasibility of this project is, thus, dependent on factors related to energy sector. It is necessary to conduct a financial analysis to determine whether the project is an economically attractive course of action.

Historically, tariff levels in Brazil have been relatively low due to a centralized pricing structure fixed by the government. The government agency ANEEL (Electric Energy National Agency) controls the commercialisation and distribution of through pre-established contracts and prices. While small tariff increases have been observed in the last few years, they are insignificant and not enough to indicate that this scenario is going to change significantly. A free electricity market in Brazil is still in its infancy.



Typical landfill gas extraction and flaring plant arrangement

Source: http://europa.eu.int/comm/energy_transport/atlas/assets/images/Image71.gif

In addition to this electricity generation using landfill gas cannot rely on offsetting carbon income. Due to its enormous hydropower capacity Brazil's energy sector already has low carbon intensity and a correspondingly low carbon emission factor. There is also a lack of governmental pricing policies to support projects that replace fossil energy with new sources of clean energy.

The generation of electricity from landfill gas in Brazil carries several risks. There are clear managerial risks owing to the fact that few landfill operators have the requisite skills and expertise to negotiate long-term power purchase agreements. Moreover, there is considerable uncertainty attached to the production of landfill gas and hence to the reliability of electricity supply. Several external factors such as precipitation levels, waste composition and temperatures can severely impact gas production levels. Most of the required generation technology needs to be imported from international companies, which exposes the project to potential adverse changes in the exchange rate. Given these risks, electricity generation from landfill gas is seen as 'unproven' technology by local investors.

**Itanhaem Generation Potential and Financial Analysis**

A financial analysis was undertaken using assumptions that are highly conservative from the point of view of gas production. It needs to be noted that the landfill gas generation model used, the US EPA First Order Decay Model, has an inherent error up to 50%. A value of 4.95 kWh/m3 was used for the energy content of landfill gas. This number presents an accepted average and was also used in the calculation of the energy potential of the NovaGerar CDM project. According to the estimates used, the Itanhaem landfill will produce **41,714,201** $m^3$ of landfill gas between the start of the project in 2006 and the end of the first Kyoto Commitment Period in 2012. It is important to bear in mind that this number is purely an **estimate** and actual volumes could be considerably lower.

Taking into account a generator efficiency of 38%[63] (industry average for LFGTE generator sets from companies such as Caterpillar and Jenbacher), a methane collection efficiency of 75%, and insurance factor of 20%, a parasitic loss factor of 5% and 91% generator availability, it is estimated that between 2006 and 2012, approximately **40,699 MWh** of electricity will be produced by the Itanhaem landfill.

Source: **www.dti.gov.uk/.../nr47/html/landfill_gas.htm**

The US EPA estimates that levelized capital and O&M costs per kWh of landfill gas derived electricity are about 7 cents or US$70/MWh[64]. This is of course only an estimate, but to arrive at more accurate numbers it would be necessary to undertake a more detailed study. For the purpose of this assessment it was deemed to be sufficient to use a generally accepted factor. Given that LFGTE is already an established industry in the US, it is likely that costs in Brazil would be even higher as they would have to factor in importation costs as well as FOREX risk and additional expenses related to lack of experience. At the same time the price currently offered to small producer of electricity by the Brazilian regulatory authority (ANEEL) is only U$58.4/MWh (as of November 2005 the tariff was fixed at R$ 146.00 and assuming a long-term exchange rate of 2.50 R$/US$). Comparing the costs and revenue per MWh it becomes clear that at the current time it is not financially viable to undertake Landfill gas to Energy projects in Brazil.

In addition to this the CERs that could be earned from the displacement of fossil-derived electricity through the generation of carbon neutral LFG energy are not sufficient to offset the estimated losses. The

63 http://www.ge-energy.com/prod_serv/products/recip_engines/en/downloads/type2_en.pdf

64 http://www.forester.net/mw_0401_retail.html

South-Southeast-Midwest electricity grid has a generally accepted Carbon Emission Factor of 0.249 $tCO_2e/MWh$[65], which is relatively low. Between 2006 and 2012 the Itanhaem landfill project is hence estimated to generate a net amount of **10,134 tCO2e**. At a price of **US$10/CER**, the electricity-related carbon component is not sufficient to offset the high generating costs/low electricity tariffs.

Therefore for the Itanhaem landfill the NPV of the electricity and related carbon components over 7 years comes to **negative US$1,000,473**. Thus the generation of electricity is currently not considered to be an option for the Itanhaem CDM project.

[65] This CEF has been approved by the Brazilian Designated National Authority

## PDD

## (２)カラピクイバ市

**CLEAN DEVELOPMENT MECHANISM**
**PROJECT DESIGN DOCUMENT FORM (CDM-PDD)**
**Version 02 - in effect as of: 1 July 2004)**

CONTENTS



Annexes



ATTENTION PLEASE READ

**This is a DRAFT version of the PDD. The ownership of the carbon credits has not been satisfactorily proven to the carbon advisors. There is as yet no engineering project. All numbers pertaining to the engineering part of the PDD are based on very rough estimates and CANNOT be submitted to the validators. No stakeholder meeting has yet been planned or held. No environmental licences have been submitted to the carbon advisor to date.**

**This DRAFT CANNOT yet be submitted for validation.**

## SECTION A. General description of project activity

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

Project Name: Landfill Gas Recovery and Flaring Project at Carapicuíba Landfill in São Paulo

Version: 2.2

Date: Monday, 14 February 2006

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

The project partners are proposing a CDM project activity, which will result in reduced GHG emissions and contribute to local sustainable development in the Brazilian state of São Paulo. The project activity will involve the capture and flaring of methane, which is a major constituent of landfill gas (LFG). LFG capture and flaring is not mandated by Brazilian law nor is it a common practice to flare a large proportion of the produced gas. Customarily only a small fraction of LFG is flared to reduce risk of explosion. The Carapicuíba will therefore provide additional environmental benefits by flaring the majority of the gas produced.

The landfill in Carapicuíba was opened in **1965** and ceased operations in **2001**. The site covers a total of 110,000 m2 and contains a total waste volume of approximately 1,800,000 m3 (equivalent to approximately 600,000[66] tonnes of municipal solid waste). It is located in the municipality of Carapicuíba in the state of São Paulo. To date the landfill has no leachate management system, no liner and no monitoring system and is only sporadically covered with a sand and clay mixture.

The aim of this specific project activity is to install landfill gas collection and flaring equipment to reduce methane emissions to the atmosphere. At the present time electricity generation using captured landfill methane is not foreseen due to the unfavorable pricing regime currently prevailing in Brazil. However, all equipment used can be expanded to include electricity generation at a later stage to accommodate future changes in electricity tariffs. At present the ultimate rationale of the project is the combustion of methane to reduce anthropogenic greenhouse gas (GHG) emissions from the decomposition of organic waste in the landfill. These emissions reductions will be eligible for Certified Emissions Reductions (CERs) under the Kyoto Protocol's Clean Development Mechanism (CDM).

The project activity will have a series of positive social and environmental impacts, especially when compared to traditional Brazilian waste disposal sites. This is important in view of guidelines governing the CDM, which stipulate a contribution to sustainable development and local environmental protection. The Carapicuíba project will flare the majority of generated methane and thus eliminate the negative impact of landfill gas emissions. In addition this project provides additional jobs in the municipality and is a step in the right direction towards sustainable management of municipal waste. There will be, for example, proper control over leachate collection, which is necessary to ensure reliable gas collection and avoid the flooding of gas collection pipes with leachate. At a later stage, some electricity may be generated with the LFG, although the generated electricity will be used only for onsite usage. This has not been taken into account for the proposed CDM project activity.

[66] The total volume used in the LFG estimation is 616,665 tonnes by the end of 2001. This number was used, as there is uncertainty in what month the landfill opened and closed.

Greenhouse gas emission reductions will result from the combustion of the recovered methane contained in the landfill gas. It is estimated that this project will generate **45,537 CERs within the first 7-year** crediting period (2006-2012).

There are several contributions to sustainable development.

*Environmental benefits:*
The local environment benefits from the highest European waste management standards that are applied to this site including:

- The project will contribute to the continued environmental improvements by providing the infrastructure to reduce greenhouse gas emissions.

*Technology transfer:*
The project will be one of the first in Brazil to recover and flare landfill gas from a closed landfill operation. As such it will act as a showcase project for landfill owners and operators as well as other CDM project developers.

## A.3. Project participants:

Please list project participants and Party(ies) involved and provide contact information in Annex 1. Information shall be in indicated using the following tabular format.

| 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) | Prefecture of Carapicuíba; MaxAmbiental; Xenex do Brasil 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. | | |

The Prefecture of Carapicuíba owns the Carapicuíba landfill. The carbon advisors are MaxAmbiental and Xenex do Brasil Ltda. Banco Sumitomo Mitsui Brasileiro SA is financing the baseline study and PDD as well as the project activity (For further details see Annex 1).

## 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.:

Carapicuíba, São Paulo

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

Municipality of Carapicuíba

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

The Municipality of Carapicuíba lies 23 km from the center of the city of São Paulo and borders the cities of Barueri in the north, Cotia in the south, Osasco in the east, and Jandira in the west. It covers an area of 34 square kilometers. It can be reached by road via the following motorways: Presidente Castelo Branco in the north, Raposo Tavares in the south, and Avenida dos Autonomistas in the east (Osasco). It belongs to the First Administrative Region of Greater São Paulo.

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

Sectoral scope: 13 - Waste handling and disposal

Project activity: Landfill gas capture and flaring project

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

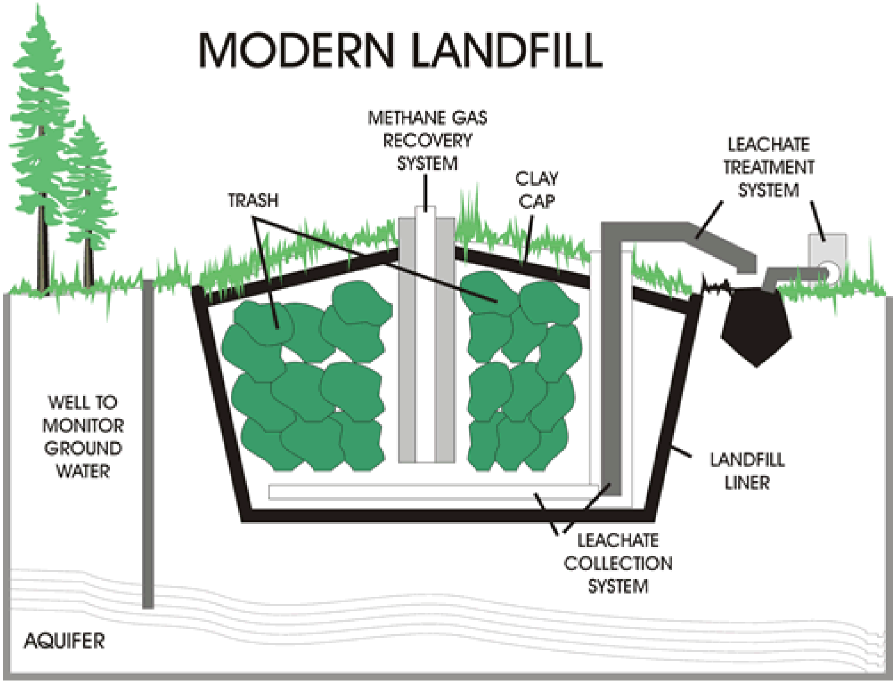
The project will involve proven technology and hardware for the extraction and treatment of landfill gas.

Below is a brief summary of the equipment and technology proposed for this project:

The landfill gas collection system consists of the following components:

- Vertical wells (perforated concrete pipes) to ensure connectivity of all layers. A high-density perforated pipe is installed within the center of the well, which is backfilled with gravel.
- Surface runoffs as well as percolate are collected and then channeled to wastewater treatment plant.
- Landfill gas extraction wells will also be drilled into the landfill once areas reach their final elevation and final cover has been applied. The vertical wells consist of a pipe perforated in its lower part, placed in a drilled borehole in the waste, backfilled with gravel and sealed at the surface. Both well types will be equipped with wellheads that enable monitoring of gas flow and quality. Also valves are provided to allow adjustment of the available vacuum at each well.
- In order to maximize the extraction capacity horizontal drains will also be installed in the waste mass. Preliminarily, the installation of a series of horizontal drains with a horizontal separation distance of 60 meters installed every 5 meters in waste lift height is envisioned. The horizontal drains will consist of perforated pipes surrounded gravel or equivalent drainage material. The drains will be interconnected to the vertical well system.
- The flaring equipment consists of an enclosed flare, 2 compressors to require the vacuum in the collection network, an online gas analyzer, and valves and tubes.
- A condensate extraction and storage system designed at strategic low points throughout the gas system.

**Typical Schematic of Modern Landfill**




**A.4.4. Brief explanation of how the anthropogenic emissions of anthropogenic greenhouse gas (GHGs) by sources are to be reduced by the proposed CDM project activity, including why the emission reductions would not occur in the absence of the proposed project activity, taking into account national and/or sectoral policies and circumstances:**

The project activity intends to collect and flare the methane generated by the anaerobic decomposition of the organic component of the municipal solid waste (MSW) landfilled at the Carapicuíba landfill. The combustion of the methane produces carbon dioxide. Taking into account the respective Global Warming Potentials (GWP) of methane and $CO_2$ this combustion signifies a 21-fold reduction of GHG emissions.

The baseline scenario is defined as the most likely future scenario in the absence of the project activity. Based on the analysis of possible alternatives, the baseline scenario is the continued, uncontrolled release of landfill gas into the atmosphere.

The results of the financial analysis demonstrate that the project activity is not the most attractive course of action economically speaking and therefore this kind of project is not part of the baseline scenario. Hence the Carapicuíba Project is considered to be additional.

**A.4.4.1. Estimated amount of emission reductions over the chosen crediting period:**

| YEAR | ESTIMATED ANNUAL EMISSION REDUCTIONS IN $TCO_2E$ |
|---|---|
| 2006 | 0 |
| 2007 | 9,604 |
| 2008 | 8,690 |
| 2009 | 7,863 |
| 2010 | 7,115 |
| 2011 | 6,438 |
| 2012 | 5,825 |
| **Total emission reductions 7 years (tCO2e)** | **45,537** |
| Renewable Crediting Period | 3 x 7 years = 21 years |
| Mean annual emission reductions (t CO2e) | 6,505 |

The estimate of total reductions from the project is **45,537 tonnes of $CO_2$e** over the first 7-year crediting period.

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

There is no Official Development Assistance used in this project activity.

## SECTION B. Application of a baseline methodology

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

ACM0001: Consolidated Methodology for Landfill Gas Project Activities

**B.1.1. Justification of the choice of the methodology and why it is applicable to the project activity:**

This consolidated methodology was developed specifically for landfill gas capture and flaring. The Carapicuíba project is similar to the Nova Gerar project, which served as one of the examples included in the consolidated methodology ACM0001.

### B.2. Description of how the methodology is applied in the context of the project activity:

The project activity will flare a greater proportion of the landfill gas generated by the decomposition of organic waste in the Carapicuíba landfill, than would have occurred in the absence of the project activity. In the baseline scenario (i.e. the absence of the project) only 20% of all gas generated are customarily flared for safety reasons. The project activity leads to higher collection and flaring efficiency through the installation of modern LFG collection and flaring equipment. Therefore the project activity will reduce total GHG emissions below the GHG emissions of the baseline scenario.

Baseline emissions are calculated using a first order decay model proposed by the US Environmental Protection Agency as recommended in the 1996 IPCC Guidelines. Using this model the methane emissions that would have been released to the atmosphere in the absence of the project activity are calculated. A fraction of those emissions need to be discounted to take account of a minimum amount of flaring that does customarily occur for safety reasons. In the case of Brazil this is usually less than 20%. Hence the use of 20% for baseline flaring is considered to be conservative.

For the determination of the baseline scenario a number of financial and market data had to be used. The various sources are listed in the table below.

| **Key data for determining baseline scenario** | **Data Unit** | **Data Source** |
|---|---|---|
| Project activity and plausible alternatives to it | - | Project Participants (PP), Industry data |
| National and local rules and regulations and policies | - | PP, Government |
| Baseline IRR | % | Calculated |
| Project IRR without Carbon | % | Calculated |
| Threshold for investment (IRR/NPV/payback period) | %, etc. | PP, Industry |
| Equipment costs | Brazilian Reais (R$) | Suppliers, PP |
| Operating costs | R$ | PP |
| Revenue from operations | R$ | PP |
| Market data (inflation, interest, tax, discount rate, etc.) | % | Relevant indices |
| Landfill gas generation parameters | 1/yr; $m^3$/tonne | Us EPA, Brazil specific data (SCS Engineers) |
| Methane collection parameters | % | IPCC, PP empirical data |
| Global Warming Potentials | - | IPCC |
| Proportion of methane flared in baseline | % | Industry Data |

**B.3. 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**:

The proposed project activity will result in the reduction of greenhouse gases that would not occur if the project were not implemented. The numerous barriers and risks associated with the implementation of the proposed project activity that are identified clearly demonstrate that this project activity is not the baseline as usual scenario.

The tool used to demonstrate the additionality is the "Consolidated tool for demonstration of additionality", which is part of methodology **ACM0001**: Consolidated Methodology for Landfill Gas Project Activities. This tool for assessing additionality follows a step-based approach. Explanation on how additionality for the proposed project activity is proven following the consolidated tool for additionality follows.

F) The baseline approach and accompanying formulae described in ACM0001 are directly employed to the project activity under discussion.

G) The "Tool for the demonstration and assessment of additionality" is used to establish the additionality of the Carapicuíba LFG Capture and Flaring project activity.

**A)**

***Applicability***
*This methodology is applicable to landfill gas capture project activities, where the baseline scenario is the partial or total atmospheric release of the gas and the project activities include situations such as:*

*a) The captured gas is flared; or*
*b) The captured gas is used to produce energy (e.g. electricity/thermal energy), but no emission reductions are claimed for displacing or avoiding energy from other sources1; or*
*c) The captured gas is used to produce energy (e.g. electricity/thermal energy), and emission reductions are claimed for displacing or avoiding energy generation from other sources. In this case a baseline methodology for electricity and/or thermal energy displaced shall be provided or an approved one used, including the ACM0002 "Consolidated Methodology for Grid-Connected Power Generation from Renewable". If capacity of electricity generated is less than 15MW, and/or thermal energy displaced is less than 54 TJ (15GWh), small-scale methodologies can be used.*

*This baseline methodology shall be used in conjunction with the approved monitoring methodology ACM0001 ("Consolidated monitoring methodology for landfill gas project activities").*

**Comments:**
As almost all of the LFG produced in the Carapicuíba landfill will be captured and flared, the project activity meets situation "a)" described above; hence this methodology is applicable to the project activity.

***Emission Reduction***
*The greenhouse gas emission reduction achieved by the project activity during a given year "y" ($ER_y$) is the difference between the amount of methane actually destroyed/combusted during the year ($MD_{project,y}$) and the amount of methane that would have been destroyed/combusted during the year in the absence of the project activity ($MD_{reg,y}$) times the approved Global Warming Potential value for methane ($GWP_{CH4}$), plus the net quantity of electricity displaced during the year ($EG_y$) multiplied by the $CO_2$ emissions intensity of the electricity displaced ($CEF_{electricity,y}$) plus the quantity of thermal energy displaced during the year ($ET_y$) multiplied by the $CO_2$ emissions intensity of the thermal energy displaced ($CEF_{thermal,y}$). Electricity and thermal energy emission reductions apply to case (c) only.*

$$ER_y = \left(MD_{project,y} - MD_{reg,y}\right) \times GWP_{CH4} + EG_y \times CEF_{electricity,y} + ET_y \times CEF_{thermal,y} \quad \textbf{(1)}$$

*ERy is measured in tonnes of CO2 equivalents (tCO2e). $MD_{project,y}$ and $MD_{reg,y}$ are measured in tonnes of methane ($tCH_4$). The approved Global Warming Potential value for methane ($GWP_{CH4}$) for the first commitment period is 21 $tCO_2e/tCH_4$. $EG_y$ is measured in megawatt hours (MWh). The CO2 emissions intensity, $CEF_{electricity,y}$, is measured in tonnes of $CO_2$ equivalents per megawatt hour (t $CO_2e$/MWh) and $ET_y$ is measured in TeraJoules (TJ) and $CEF_{thermal,y}$ is measured in terms of tonnes of $CO_2$ equivalents per TJ (t $CO_2e$/TJ).*
*In the case where the $MD_{reg,y}$ is given/defined as a quantity that quantity will be used.*

*In cases where regulatory or contractual requirements do not specify $MD_{reg,y}$ an "Adjustment Factor" (AF) shall be used and justified, taking into account the project context.*

$$MD_{reg,y} = MD_{project,y} \times AF \quad \textbf{(2)}$$

*The following examples provide guidance on how to estimate AF:*
*- In cases where a specific system for collection and destruction of methane is mandated by regulatory or contractual requirements, the ratio of the destruction efficiency of that system to the destruction efficiency of the system used in the project activity shall be used.*
*- In cases where a specific percentage of the "generated" amount of methane to be collected and destroyed is specified in the contract or mandated by regulations, this percentage divided by an assumed efficiency for the collection and destruction system used in the project activity shall be used.*

**Comments:**
In the case of this project activity there are neither regulatory nor contractual requirements for the combustion of the methane produced in the baseline scenario. The "Adjustment Factor" used for $MD_{reg,\,y}$ is 20%, a value that conservatively estimates the amount of gas that would be flared in the absence of the project activity to avoid explosion risks.

Also, this particular project does not intend to generate electricity or thermal energy from the captured LFG. Therefore, greenhouse gas emission reductions related to this source are not to be considered in the calculation of $ER_y$. Therefore Formula (1) can be re-written as:

$$ER_y = \left(MD_{project,y} - MD_{reg,y}\right) \times GWP_{CH4}$$

The approved Global Warming Potential (GWP) of Methane for the first commitment period is 21 t $CO_2$e/t$CH_4$.

*Project proponents should provide an ex ante estimate of emissions reductions, by projecting the future GHG emissions of the landfill. In doing so, verifiable methods should be used. Ex ante emission estimates may have an influence on $MD_{reg,y}$. $MD_{project,y}$ will be determined ex post by metering the actual quantity of methane captured and destroyed once the project activity is operational.*
*The methane destroyed by the project activity ($MD_{project,y}$) during a year is determined by monitoring the quantity of methane actually flared and gas used to generate electricity and/or produce thermal energy, if applicable.*

$$MD_{project,y} = MD_{flared,y} + MD_{electricity,y} + MD_{thermal,y} \quad \textbf{(3)}$$

$$MD_{flared,y} = LFG_{flared,y} \times w_{ch4} \times D_{ch4} \times FE \quad \textbf{(4)}$$

*Where $MD_{flared,y}$ is the quantity of methane destroyed by flaring, $LFG_{flared,y}$ is the quantity of landfill gas flared during the year measured in cubic meters ($m^3$), wCH4,y is the average methane fraction of the landfill gas as measured during the year and expressed as a fraction (in $m^3$ $CH_4$ / $m^3$ LFG), FE is the flare efficiency (the fraction of the methane destroyed) and $D_{CH4}$ is the methane density expressed in tonnes of methane per cubic meter of methane ($tCH_4/m^3CH_4$).*

$$MD_{electricity,y} = LFG_{electricity,y} \times w_{ch4} \times D_{ch4} \quad \textbf{(5)}$$

*Where $MD_{electricity,y}$ is the quantity of methane destroyed by generation of electricity and $LFG_{electricity,y}$ is the quantity of landfill gas fed into electricity generator.*

$$MD_{thermal,y} = LFG_{thermal,y} \times w_{ch4} \times D_{ch4} \quad \textbf{(6)}$$

*Where $MD_{thermal,y}$ is the quantity of methane destroyed for the generation of thermal energy and $LFG_{thermal,y}$ is the quantity of landfill gas fed into the boiler.*

**Comments:**
Again, since no electricity or thermal energy will be generated, the emission reductions will be equivalent to the amount of methane flared only, thus:

$$MD_{project,y} = MD_{flared,y}$$

Consequently equations (5) and (6) will not be used for this specific project activity.

For the purpose of estimating baseline emissions and overall emission reductions of the project activity the USEPA's First Order Decay Model has been used. A detailed description and formulae used are provided in Section D.2.1.4.

According to ACM0001 at standard temperature and pressure (0 degree Celsius and 1,013 bar) the density of methane is 0.000656 $tCH_4/m^3CH_4$.

***Project Boundary***
*The project boundary is the site of the project activity where the gas is captured and destroyed/used.*
*Possible $CO_2$ emissions resulting from combustion of fuels other than the methane recovered should be accounted as project emissions. Such emissions may include fuel combustion due to pumping and collection of landfill gas or fuel combustion for transport of generated heat to the consumer locations.*
*In addition, electricity required for the operation of the project activity, including transport of heat, should be accounted and monitored. Where the project activity involves electricity generation, only the net quantity of electricity fed into the grid should be used in equation (1) above to account for emission reductions due to displacement of electricity in other power plants. Where the project activity does not involve electricity generation, project participants should account for $CO_2$ emissions by multiplying the quantity of electricity required with the $CO_2$ emissions intensity of the electricity displaced ($CEF_{electricity,y}$).*

Comments:
For more detailed information concerning the project boundary, please refer to Section B.4.

***Baseline***
*The baseline is the atmospheric release of the gas and the baseline methodology considers that some of the methane generated by the landfill may be captured and destroyed to comply with regulations or contractual requirements, or to address safety and odor concerns.*

Comments:

As mentioned above, flaring of landfill gas is not a common or required practice in Brazil. However, it is common to flare a small fraction (usually around 20%) of the produced gas to reduce the risk of explosion. Hence this fraction is deducted from the estimated total emissions of LFG from the landfill. Total estimated LFG emissions are calculated in Section D.2.1.4.

***Leakage***
*No leakage effects need to be accounted under this methodology.*

**B)**

***Additionality***
*The additionality of the project activity shall be demonstrated and assessed using the latest version of the "Tool for the demonstration and assessment of additionality" agreed by the CDM Executive Board, which is available on the UNFCCC CDM web site.*

Using the "Tool for demonstration and assessment of additionality":

Step 0: Preliminary screening based on the starting date of the project activity
Step 1: Identification of alternatives to the project activity consistent with the current laws and regulations
Step 2: Investment analysis
Step 4: Common practice analysis
Step 5: Impact of CDM registration

Step 1:

Sub-step 1a. Define alternatives to the project activity:
There are 3 possible baseline scenarios for the Carapicuíba landfill:

1) The landfill operator adheres to the business as usual practice of not collecting and flaring landfill gas from its waste operations or flaring just a small fraction of the gas, for safety reasons. This is in fact the approach taken by most waste management operations in Brazil. In this case, no power is generated at the site and the Brazilian power system remains unaffected.

2) The landfill operator invests in LFG collection and flaring but not in power generation (the proposed project activity). The Brazilian power system remains unaffected.

3) The landfill operator invests in power generation from LFG. The operation marginally reduces the generation of power from other grid-connected sources and hence avoids carbon emissions.

Sub-step 1b. Enforcement of applicable laws and regulations:
Current Brazilian legislation does not require that landfills collect and dispose of landfill gases, and there are very few landfills in operation in Brazil that have been designed to collect, flare or utilize the full amount of gas generated. Most of these, like the NovaGerar landfills, were designed and built in the last two years specifically as CDM projects. When LFG collection and flaring does happen, this occurs mainly on a voluntary basis to diminish explosion risk. Usually only a low proportion of methane is collected due to the utilization of unsophisticated collection systems and the occasional flooding of pipes with leachate.

The implementation of environmental protection legislation in Brazil has a relatively long lead-time, and the Ministry of the Environment has no immediate plans to introduce legislation requiring the collection and flaring of landfill gas from landfill sites. Historically in Brazil there also tends to be a gulf between stated regulations and practice with regards to the implementation of environmental protection legislation.

Step 2:

Sub-step 2a. Determine appropriate analysis method:
This project activity will not generate any financial or economic benefits other than CDM related income. Other than financial return from the carbon market, the only potential revenue to the project could come from the use of gas to produce electricity (Alternative 3 above). It is necessary to conduct a financial analysis to determine whether the project activity is an economically attractive course of action.

Historically, tariff levels have been relatively low due to a centralised pricing structure fixed by the government. The commercialisation and distribution of electricity is controlled by the government, through ANEEL (Electric Energy National Agency), by pre-establishing the contracts and the price range. While small tariff increases can be observed in the last few years, they are insignificant and not sufficient to indicate that this scenario is going to change now. The free electricity market is still very incipient in Brazil. These low tariffs make electricity generation from LFG economically unattractive at present.

Brazil's energy sector is already relatively clean and there is lack of governmental pricing policies to support and favour projects for the replacement of some non-renewable energy with new sources of clean electricity.

In parallel to the risks related to the sale of electricity, the exact amounts of landfill gas and the performance of the plants also concerns landfill operators. Given that the production of methane in the landfills can vary greatly and currently there isn't a single landfill site in Brazil generating electricity, this is seen as 'unproven' technology by local investors.

A sensitivity analysis was undertaken using assumptions that are highly conservative from the point of view of analysing environmental additionality, i.e. the best-case scenario IRR was calculated. It was assumed that the average daily waste placement rate at the Carapicuíba Landfill was around 46 daily tonnes culminating in a total of approximately **600,000 tonnes by 2001**[67]. The volumes of landfill gas to be generated from the site were estimated using the US EPA First Order Decay Model. It was further assumed that the project has unlimited access to capital to invest in all the equipment necessary to use the increased amount of gas produced. The IRR (without carbon) is negative and still exposed to a series of risks (project, country, currency, etc.). These results show that even with the best possible conditions, which are obviously quite unrealistic, the project is still not an economically attractive course of action.

Sub-step 2b. Apply simple cost analysis
N/a

Step 4:

[67] The total volume used in the LFG estimation is 616,665 tonnes by the end of 2001. This number was used, as there is uncertainty in what month the landfill opened and closed.

According to the National GHG Emissions Inventory conducted by CETESB in 1994, 84% of Brazil's methane emissions came from the deposition of waste in uncontrolled rubbish dumps. This source is still responsible for a large part of the methane emitted since not much has changed in the business as usual scenario in the country. Besides, the amount of waste produced in Brazil has been increasing and, as estimated in 2000, Brazilians were already producing an average of 0.52 kg of waste per person everyday.[68]

Nowadays 59% of the municipalities in Brazil still dispose of their waste in 'rubbish dumps' ("lixões") with no management, gas collection, water treatment, or regulation by environmental authorities whatsoever. Among the other 30% that use landfills, only 13% invest in sanitary landfills with sophisticated leachate collection and treatment systems.

Although, until the present moment there are no regulatory requirements for flaring landfill gas, a number of landfills are collecting a small amount of LFG for safety reasons. To maintain the calculations' conservatism and to assure the environmental integrity of the project, all emission reductions arising from the Carapicuíba site will be discounted by 20% in the project. This amount, as argued before, more than sufficiently covers the volume of gas that would be flared to follow the business-as usual scenario found in the landfills considered in this analysis.

Since there are no legislation requiring gas flaring in Brazilian landfills, besides the flaring of a small fraction for security (less than 20%), there is no reason to believe that an LFG system for the collection and flaring of all gas produced would be installed now, when the landfill is being built. The installation of even a rudimentary LFG collection system with passive venting or flaring would go beyond what is required by law and involve considerable expenses for the landfill operator without any offsetting revenues.

Given the regulatory situation in Brazil and the location and conditions of the landfill, the realization of alternative 2 is not required and would also not be an economically attractive course of action for the landfill owner and/or operator. It is therefore not considered a plausible alternative to the baseline scenario. Alternative 3 was also proven not to be financially feasible at Brazil's present electricity tariff levels. Consequently the only remaining plausible option is Alternative 1 (i.e. Business- as-usual: the construction of a landfill without any LFG treatment).

Step 5: Impact of CDM Registration

As can be seen form the attached financial analysis, successful CDM registration adds an additional revenue stream (in fact the only revenue stream) to the project activity. At a price of **US$8 per CER** the project has a **net present value of US$384,435** and an **IRR of negative 16.4%** over the first 7 years.

Baseline development in time and description of baseline scenario:
It has been shown that the BAU baseline holds at the time of preparing the project. The main determinants of this baseline are:

- Landfill regulations applicable to the site
- The economics of landfill gas utilization

It is possible that future regulatory requirements for landfills in Brazil will necessitate a higher level of

[68] CETESB and IGBE Census

LFG collection in the baseline scenario. If this occurs, the future baseline scenario will include compliance with such regulations.

It is also possible that the economics of LFG utilization for power generation may change at some time in the future. If such changes lead to a sufficient increase in the profitability of LFG utilization the proposed project could well be implemented without the help of carbon finance. If this occurs, the future baseline scenario will include an LFG to power project.

The baseline scenario for the proposed project can thus be described as follows:

No collection and treatment of LFG occurs at the Carapicuíba landfill site and this allows the uncontrolled release of most of the LFG to the atmosphere until some future time when the collection and treatment of LFG will either be required by law or becomes an economically attractive course of action. The monitoring plan for the project will re-evaluate the baseline scenario, report any changes during the crediting period and determine the new baseline scenario.

This baseline scenario is the basis for the determination of the project's ERs as per the monitoring plans instructions.

The Carapicuíba project baseline assumptions will be revisited every 7 years to ensure that the assumptions made in the baseline scenario still hold true, or they will be revised accordingly. In addition, the introduction of Brazilian legislation regarding the collection and flaring of landfill gas will be monitored **annually** as a part of the Monitoring Plan.

**B.4. Description of how the definition of the project boundary related to the baseline methodology selected is applied to the project activity:**

The following flow diagram describes the project boundary and includes those GHG emissions, which are "under the control of" the project participants, "significant" and "reasonably attributable".

In the light of these attributes, the following emissions have not been taken into account:

- Emissions from the transport of the waste to the landfill site, as these would occur even in the absence of the proposed project activity.
- Emissions from the vehicles used to compact and cover the waste, as these would also occur in the absence of the project activity.

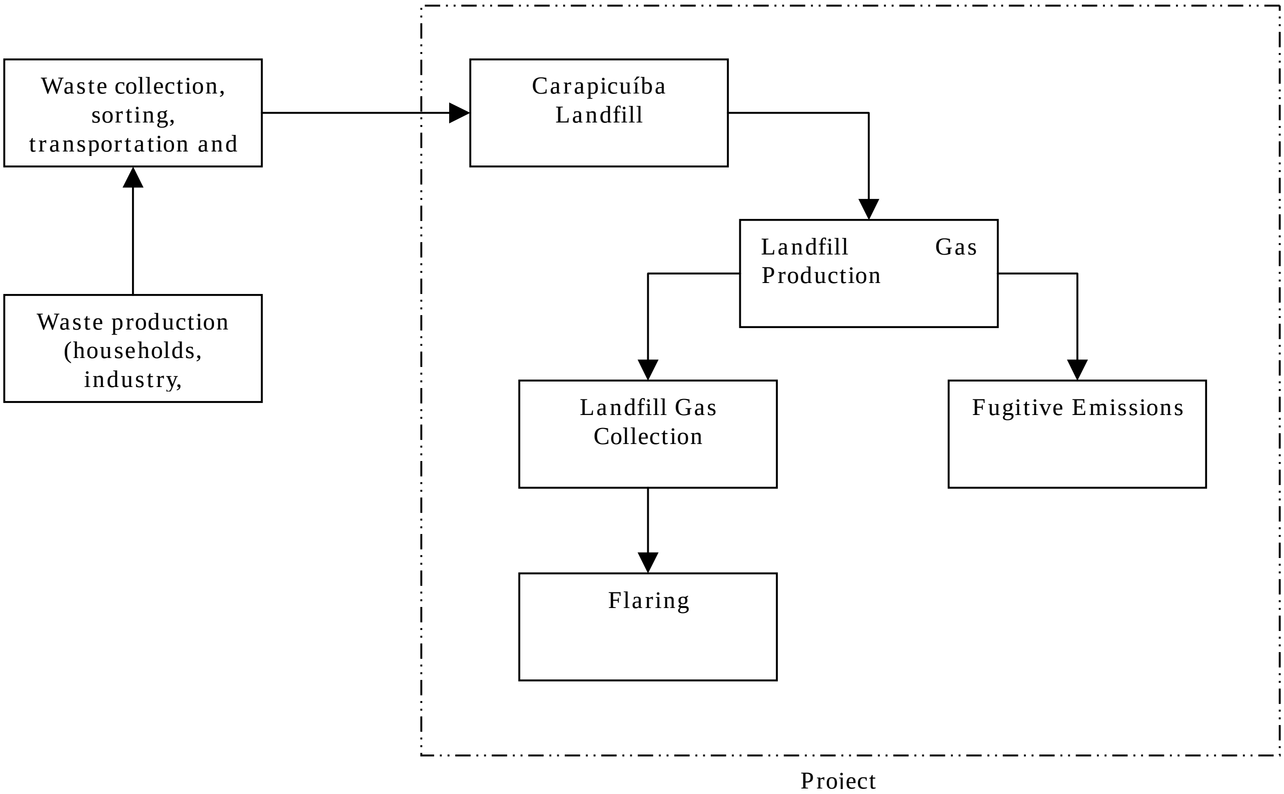



Figure B.4.1: Project Boundary

| Emissions | Project Scenario | Baseline Scenario |
|---|---|---|
| Direct On-site | Emissions associated with the inefficiency of the LFG capture and flaring process. MaxAmbiental estimates that only about 75% of total LFG produced will be collected and then combusted to $CO_2$. Hence 25% of the total gas production will be released as fugitive emissions. | Uncontrolled release of practically all LFG generated by the landfill. |
| Direct Off-site | Transportation of equipment to project site – excluded because deemed to be insignificant | None identified |
| Indirect On-site | NA | NA |
| Indirect Off-site | Transportation of waste to landfill site – excluded because would happen even in absence of project | Transportation of waste to landfill site – excluded because would happen even in absence of project |

Table B.4.2: System emissions

**B.5. Details of baseline information, including the date of completion of the baseline study and the name of person (s)/entity (ies) determining the baseline:**

The project is using **ACM0001**: Consolidated Methodology for Landfill Gas Project Activities

The baseline study was concluded in November 2005.

The entity determining the baseline and participating in the project, as the technical consultants are **MaxAmbiental** and **Xenex do Brasil Ltda** Brazil, listed in Annex 1 of this document.

## 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:

The project start date has been set for the second quarter of 2006.

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

The landfill **closed in 2001**. The project activity is expected to last from 2006 to 2012. The actual project activity will have a renewable crediting period of 7 years. This period can be renewed twice.

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

The project activity will use a renewable crediting period as described below in the following section (C.2.1).

### C.2.1. Renewable crediting period

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

The starting date is 1st January 2006

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

7 years duration per renewable period

### C.2.2. Fixed crediting period:

#### C.2.2.1. Starting date:

NA

#### C.2.2.2. Length:

NA

## SECTION D. Application of a monitoring methodology and plan

### D.1. Name and reference of approved monitoring methodology applied to the project activity:

ACM0001: "Consolidated monitoring methodology for landfill gas project activities"

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

This monitoring methodology was specifically developed for landfill gas capture projects using baseline methodology ACM0001.

**D.2. 1. Option 1: Monitoring of the emissions in the project scenario and the baseline scenario**

| **D.2.1.1. Data to be collected in order to monitor emissions from the project activity, and how this data will be archived:** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| ID number *(Please use numbers to ease cross-referencing to table D.3)* | Data variable | Source of data | Data unit | Measured (m), calculated (c), estimated (e), | Recording frequency | Proportion of data to be monitored | How will the data be archived? (electronic/ paper) | Comment |

Not applicable. Total project emissions are actually zero; there are neither project emissions nor leakage. The only discernable and significant difference between baseline and project emissions comes from the collection and destruction of methane contained in LFG, which is monitored and calculated directly. The only discernable yet insignificant (indirect) modification of emissions is associated with the physical construction of the project (see discussion under D.4 below). The monitoring methodology is based on direct measurement of the amount of landfill gas captured and destroyed at the flare platform.

**D.2.1.2. Description of formulae used to estimate project emissions (for each gas, source, formulae/algorithm, emissions units of $CO_2$ equ.)**

Not applicable, see D.2.1.1.

| **D.2.1.3. Relevant data necessary for determining the baseline of anthropogenic emissions by sources of GHGs within the project boundary and how such data will be collected and archived:** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| ID number *(Please use numbers to ease cross-referencing to table D.3)* | Data variable | Source of data | Data unit | Measured (m), calculated (c), estimated (e), | Recording frequency | Proportion of data to be monitored | How will the data be archived? (electronic/ paper) | Comment |

The monitoring methodology is based on direct measurement of the amount of landfill gas captured and destroyed at the flare platform.

**D.2.1.4. Description of formulae used to estimate baseline emissions (for each gas, source, formulae/algorithm, emissions units of $CO_2$ equ.)**

Not applicable. The monitoring methodology is based on direct measurement of the amount of landfill gas captured and destroyed at the flare platform.

**D. 2.2. Option 2: Direct monitoring of emission reductions from the project activity (values should be consistent with those in section E).**

This is the Option chosen for the monitoring methodology of the Igarassu landfill gas capture and flaring project. As stated in ACM0001: *"The monitoring methodology is based on direct measurement of the amount of landfill gas captured and destroyed at the flare platform."*

**D.2.2.1. Data to be collected in order to monitor emissions from the project activity, and how this data will be archived:**

| ID number *(Please use numbers to ease cross-referencing to table D.3)* | Data variable | Source of data | Data unit | Measured (m), calculated (c), estimated (e), | Recording frequency | Proportion of data to be monitored | How will the data be archived? (electronic/ paper) | Comment |
|---|---|---|---|---|---|---|---|---|
| *D2-1* | *Annual Waste landfilled* | *Truck balance* | *Tonnes* | *M* | *Arrival of truck* | *100%* | *Electronic (spreadsheet)* | *Measured on site* |
| *D2-2* | *Flow of landfill gas to flares* | *Continuous Flow Meter* | $m^3$ | *M* | *Continuous* | *100%* | *Electronic (spreadsheet)* | *Data will be aggregated monthly and yearly* |
| *D2-3* | *Flare efficiency determined by 1) operating hours And 2) Methane content in exhaust gas* | *Continuous methane analyser* | *%* | *M &C* | *1) Continuously 2) Quarterly* | *N/a* | *Electronic (spreadsheet)* | *Data will be used to test and, if necessary, correct the flare's efficiency rating* |
| *D2-4* | *Methane fraction in LFG* | *Continuous methane analyser* | *%* | *M &C* | *Continuous* | *100%* | *Electronic (spreadsheet)* | *Data will be aggregated monthly and yearly* |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| *D2-5* | *Gas pressure* | *Pressure gauge* | *Pa* | *M* | *Continuous* | *100%* | *Electronic (spreadsheet)* | *Data will be used to calculate methane density* |
| *D2-6* | *Gas temperature* | *Thermometer* | *Deg. Celsius* | *M* | *Continuous* | *100%* | *Electronic (spreadsheet)* | *Data will be used to calculate methane density* |
| *D2-7* | *Amount of methane flared* | *N/a* | *Tonnes of $CH_4$* | *M & C* | *Daily* | *100%* | *Electronic (spreadsheet)* | *It can be measured or calculated with the following data: LFG flow to flare, methane fraction in LFG, LFG temperature and pressure, flare temperature, and flare working hours* |
| *D2-8* | *Amount of methane flaring required in baseline* | *N/a* | *Tonnes of $CH_4$* | *C* | *Daily* | *100%* | *Electronic (spreadsheet)* | *20% of the amount of methane flared* |
| *D2-9* | *Regulatory requirements relating to landfill gas projects* | *Legislation* | *N/a* | *N/a* | *Annually* | *100%* | *Electronic (spreadsheet)* | *Required for any changes to the adjustment factor (ID 2-8)* |

**D.2.2.2. Description of formulae used to calculate project emissions (for each gas, source, formulae/algorithm, emissions units of $CO_2$ equ.):**

Not applicable. Total project emissions are actually zero; there are neither project emissions nor leakage. The only discernable and significant difference between baseline and project emissions comes from the collection and destruction of methane contained in LFG, which is monitored and calculated directly. The only discernable yet insignificant (indirect) modification of emissions is associated with the physical construction of the project (see discussion under D.4 below). The monitoring methodology is based on direct measurement of the amount of landfill gas captured and destroyed at the flare platform.

**D.2.3. Treatment of leakage in the monitoring plan**

**D.2.3.1. If applicable, please describe the data and information that will be collected in order to monitor leakage effects of the project activity**

| ID number *(Please use numbers to ease cross-referencing to table D.3)* | Data variable | Source of data | Data unit | Measured (m), calculated (c) or estimated (e) | Recording frequency | Proportion of data to be monitored | How will the data be archived? (electronic/ paper) | Comment |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | |
| | | | | | | | | |

Not applicable, there is no significant leakage in the project. See comment under D.2.3.2 below.

**D.2.3.2. Description of formulae used to estimate leakage (for each gas, source, formulae/algorithm, emissions units of $CO_2$ equ.)**

Only the construction of the LFG collection and utilization system will lead to some GHG emissions that would not have occurred in the absence of the project. These emissions are, however, insignificant. No increased in emissions are discernable other than those targeted and directly monitored by the project. Moreover, because the project employs direct monitoring of emission reductions, indirect emissions will not distort their calculation.

**D.2.4. Description of formulae used to estimate emission reductions for the project activity (for each gas, source, formulae/algorithm, emissions units of $CO_2$ equ.)**

The following formulae are used to calculate emission reductions for the project activity using the direct monitoring data measured and collected during the lifetime of the project:

$$ER_y = \left(MD_{project,y} - MD_{reg,y}\right) \times GWP_{CH4}$$

Where:

$GWP_{CH4}$ = Global Warming Potential of methane (IPCC, 1996)

$$MD_{project,y} = LFG_{flared,y} \times w_{ch4} \times D_{ch4} \times FE$$

Where:

$MD_{project,y}$ = Amount of methane actually **flared/destroyed** during year y

$LFG_{flared,y}$ = Flow of landfill gas ($m^3$)

$w_{ch4}$ = Methane fraction in LFG (%)

$D_{ch4}$ = Temperature/(Pressure * R) ($kg/m^3$)

$FE$ = Flare efficiency (%)

$MD_{reg,y}$ = Amount of methane flaring required in baseline (or **customarily** carried out for safety reasons)

Where:

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

$AF$ = Adjustment factor based on the project context, i.e. what fraction of methane is customarily flared for safety considerations.

| **D.3. Quality control (QC) and quality assurance (QA) procedures are being undertaken for data monitored** | | |
|---|---|---|
| Data *(Indicate table and ID number e.g. 3.-1.; 3.2.)* | Uncertainty level of data (High/Medium/Low) | Explain QA/QC procedures planned for these data, or why such procedures are not necessary. |

| | | |
|---|---|---|
| *D-1* | Low | All the arriving waste at the landfill will be immediately weighed using a truck balance, with regular maintenance, and all the values recorded for future calculations |
| *D2-2* | Low | Flow meters will be subject to a regular maintenance and testing regime to ensure accuracy |
| *D2-3* | Low | Regular maintenance will ensure optimal operation of flares. Flare efficiency will be calibrated annually or more often, if significant deviation from previous efficiency rating is observed. |
| *D2-4* | Low | Gas analyzer will be subject to a regular maintenance and testing regime to ensure accuracy |
| *D2-5* | Low | Meters will be subject to a regular maintenance and testing regime to ensure accuracy. |
| *D2-6* | Low | Meters will be subject to a regular maintenance and testing regime to ensure accuracy. |
| *D2-7* | Low | This value is going to be calculated and recorded using the data that is directly collected and monitored at the site |
| *D2-8* | Low | This data will be determined from current industry practice. |
| *D2-9* | Low | This data will be determined from current legislation. |

**D.4 Please describe the operational and management structure that the project operator will implement in order to monitor emission reductions and any leakage effects, generated by the project activity**

As described before, the flaring station, where the emission reductions will actually happen, will be equipped with a measurement chain, which will allow direct daily measurement of the real amount of methane flared.
The management structures implemented in the Carapicuíba project are as follows:

**Daily Monitoring Records**: On the larger more active sites site staff takes daily gas field and engine readings. These readings are then checked for any anomalies before being filed for future reference. The readings can be taken at weekly or other set periods depending on the activity and consistency of the gas field and engine operation. All engines have telemetry links back to a central computer, which continually monitors the performance of the engine detecting problems and highlighting them for attention.

**Gas Field Monitoring Records**: Taken on a weekly basis or at periods to be determined. The Site Technician walks the gas field taking readings at each gas well and recording these on a form. These readings are then checked for any anomalies before being filed for future reference. A gas analyser will be installed in order to enable continuous accurate measurement of the methane content on the landfill gas. These gas field inspections will also observe occurrence of any unintended releases of landfill gas. In case unintended releases are observed, appropriate corrective action will be taken immediately.

**Routine Reminders for Site Technicians**: All Site Technicians are issued with a reminder list to guide them through their daily, weekly and monthly routine. The Engineering Manager, Operations Manager and Training and Health & Safety Co-ordinator go through this routine during site visits to ensure all aspects of the role are being performed. In addition monitoring records, oil sample reports and meter readings that are due, are checked to ensure they have arrived. Again, the telemetry link records a lot of the data automatically.

**Site Audits**: The Engineering Manager, Operations Manager and Training and Health & Safety Co-ordinator make regular site visits. In addition to ensuring the site routines are being performed any additional training needs are assessed and an audit is taken of any outstanding task on site.

**Outstanding Work Notice**: Following the Site Audit a ‘Plant Outstanding Works Notice’ is issued to the Site Technician listing all the jobs that the management team consider necessary to be undertaken. This is checked on subsequent site audits to ensure these jobs have been carried out.

**Calibration of measurement equipment:** Calibration of measurement equipment will be done monthly in accordance with the requirements of the National Measurement Regulation Agency, INMETRO (Instituto Nacional de Metrologia).

**Corrective Actions:** Management structure measures include procedures to handle and correct non-conformities in the implementation of the Project or this Monitoring Plan. In case such non-conformities are observed:

- An analysis of the nonconformity and its causes will be carried out immediately by landfill staff
- Landfill management will make a decision, in consultation with MaxAmbiental when needed, on appropriate corrective actions to eliminate the non-conformity and its causes.
- Corrective actions are implemented and reported back to Landfill management.

It will be assured that the landfill gas management team will receive support and appropriate training on the implementation of this Monitoring Plan and of the project

**D.5 Name of person/entity determining the monitoring methodology:**

**Paulo Braga, MaxAmbiental**

**Xenex do Brasil, Ltda**

**(see Annex 1)**

## SECTION E. Estimation of GHG emissions by sources

| | Emission Source | Greenhouse Gas | Validity | Quantity of Emissions (2006-2012) |
|---|---|---|---|---|
| Project Scenario | Landfill & LFG Flare | Methane | Yes. Due to collection and flaring inefficiencies some gas will not be destroyed. Hence there will still be emissions of LFG even after the project activity has been implemented. | **46.095 tonnes of $CO_2$e** |
| | LFG Flare | $CO_2$ | No. $CH_4$ emissions from the decay of biomass are not counted as anthropogenic GHG emissions | NA |
| | Equipment construction | Various | No. These are not considered to be “significant” in relation to overall emissions | NA |
| | On-site transportation | Various | No. On-site transportation of MSW would occur even in the absence of the project activity. | NA |
| Baseline Scenario | Landfill | Methane | Yes. Methane emissions from the anaerobic decomposition of MSW are considered to be additional. In the baseline scenario only 20% of LFG is captured and flared. | **104,178 tonnes of $CO_2$e** |

Figure E.1: Emission Sources

### E.1. Estimate of GHG emissions by sources:

Not applicable. Total project emissions are actually zero; there are neither project emissions nor leakage. The only discernable and significant difference between baseline and project emissions comes from the collection and destruction of methane contained in LFG, which is monitored and calculated directly. The only discernable yet insignificant (indirect) modification of emissions is associated with the physical construction of the project. To calculate emission reduction estimates baseline emissions only are estimated and then multiplied by the flaring inefficiencies and collection rates of the installed equipment.

### E.2. Estimated leakage:

Only the construction of the LFG collection and utilization system will lead to some GHG emissions that would not have occurred in the absence of the project. These emissions are, however, insignificant. No increased in emissions are discernable other than those targeted and directly monitored by the project. Moreover, because the project employs direct monitoring of emission reductions, indirect emissions will not distort their calculation.

### E.3. The sum of E.1 and E.2 representing the project activity emissions:

Project activity emissions are actually zero, as the project activity does not cause any GHG emissions by itself. Due to equipment inefficiencies it is estimated that there will still be a fraction of LFG released to the atmosphere. However, this is reflected in lower emissions reductions rather than in project activity emissions.

As the project aims to flare a large proportion of LFG produced, this percentage can be applied to the baseline emissions. In the case of the Igarassu landfill and as explained above, a collection and flaring efficiency of 75% has been estimated. This plus further adjustments are then applied to the baseline emissions calculated in Section E.4 to arrive at total emission reductions.

## E.4. Estimated anthropogenic emissions by sources of greenhouse gases of the baseline:

**General Assumptions**

| Parameter | Value | Source |
|---|---|---|
| Global Warming Potential (GWP) of $CH_4$ | 21 | IPCC, 2001 |
| Amount of methane flared in baseline (AF) | 20% for safety reasons | Industry common practice |
| MCF – Methane Correction Factor for landfill | 1 for managed landfill | IPCC, 1996 |
| Density of methane | 0.000656 $tCH_4/m^3CH_4$ | Literature |
| Methane generation rate (k) | 0.1 $year^{-1}$ | US EPA/SCS Engineers |
| Potential methane generation capacity ($L_o$) | 164 $m^3$/tonne | US EPA/SCS Engineers |
| Methane content of LFG | 50% | IPCC, 1996 |
| Methane collection efficiency | 75% | Supplier |
| Insurance Adjustment Factor | 20% | MaxAmbiental |

**Waste Projections**

| Year | Daily Waste Disposal Rate (tonnes/day) | Waste added in Year (tonnes/yr) | Cumulative Waste-in-Place at Start of Year (tonnes) |
|---|---|---|---|
| 1965 | 46 | 16,667 | 0 |
| 1966 | 46 | 16,667 | 16,667 |
| 1967 | 46 | 16,667 | 33,333 |
| 1968 | 46 | 16,667 | 50,000 |
| 1969 | 46 | 16,667 | 66,667 |
| 1970 | 46 | 16,667 | 83,333 |
| 1971 | 46 | 16,667 | 100,000 |
| 1972 | 46 | 16,667 | 116,666 |
| 1973 | 46 | 16,667 | 133,333 |
| 1974 | 46 | 16,667 | 150,000 |
| 1975 | 46 | 16,667 | 166,666 |
| 1976 | 46 | 16,667 | 183,333 |
| 1977 | 46 | 16,667 | 200,000 |
| 1978 | 46 | 16,667 | 216,666 |
| 1979 | 46 | 16,667 | 233,333 |
| 1980 | 46 | 16,667 | 249,999 |
| 1981 | 46 | 16,667 | 266,666 |
| 1982 | 46 | 16,667 | 283,333 |
| 1983 | 46 | 16,667 | 299,999 |
| 1984 | 46 | 16,667 | 316,666 |
| 1985 | 46 | 16,667 | 333,333 |
| 1986 | 46 | 16,667 | 349,999 |

| | | | |
|---|---|---|---|
| 1987 | 46 | 16,667 | 366,666 |
| 1988 | 46 | 16,667 | 383,332 |
| 1989 | 46 | 16,667 | 399,999 |
| 1990 | 46 | 16,667 | 416,666 |
| 1991 | 46 | 16,667 | 433,332 |
| 1992 | 46 | 16,667 | 449,999 |
| 1993 | 46 | 16,667 | 466,666 |
| 1994 | 46 | 16,667 | 483,332 |
| 1995 | 46 | 16,667 | 499,999 |
| 1996 | 46 | 16,667 | 516,666 |
| 1997 | 46 | 16,667 | 533,332 |
| 1998 | 46 | 16,667 | 549,999 |
| 1999 | 46 | 16,667 | 566,665 |
| 2000 | 46 | 16,667 | 583,332 |
| 2001 | 46 | 16,667 | 599,999 |
| 2002 | 0 | 0 | 616,665 |

**USEPA First Order Decay Model**

The estimation of baseline emissions is principally carried out to determine approximate gas volumes and by deduction emissions reductions. The following model is NOT part of the monitoring methodology per se, but rather suited for the **ex ante calculation** of potential emission reductions.

An assessment of the landfill gas generation of the Carapicuíba Landfill was carried out using the **USEPA's Landfill Air Emissions Estimation Model**, which is consistent with the more complex methodology recommended by the Intergovernmental Panel on Climate Change (IPCC) for calculating methane emissions from landfills. The assumptions applied were those successfully used by the Brazilian NovaGerar project, whose two landfills operate under similar conditions as the Carapicuíba landfill.

Model Inputs

The US EPA first order exponential decay model equation from the US EPA manual ‘Turning a Liability into an Asset: A Landfill Gas to Energy Handbook for Landfill Owners and Operators' (December 1994) is as follows:

$$LFG = 2 \times L_o \times R \times \left(e^{-kc} - e^{-kt}\right)$$

Where:

LFG = total landfill gas generated in current year (m3)
$L_o$ = theoretical potential amount of landfill gas generated (m3/tonne)
R = waste disposal rate (tonnes/year)
t = time since landfill opened (years)
c = time since landfill closed (years)
k = rate of landfill gas generation (1/year)

The site-specific inputs used were:

Waste disposal rate (R):

The Carapicuíba landfill received a total of approximately **600,000 tonnes of MSW between 1965 and 2001**[69] when the facility was finally closed. These data forms the foundation of the gas volume projection. This implies that the gas volume projection will vary accordingly. Therefore, even though gas volumes may fluctuate over a period of time because of varying disposal rates, the ultimate total volume of gas projected for the site will remain constant. The values used for R are shown in the waste projections table above.

Gas Generation Rate (k):

The gas generation rate for this site was determined based on specific ranges given for Brazilian landfills. The gas generation rate is influenced by the temperature, humidity and composition of the waste. A figure of **0.1** was used as recommended by SCS Engineers in a presentation on behalf of the US EPA in Sao Paulo, Brazil (Part 5: Evaluating Landfill Gas Potential, June 26 2001, Training Workshop for the US EPA Landfill Methane Outreach Program, Sao Paulo Brazil).

Theoretical Yield (Lo):

Another input into the computer model is theoretical maximum yield i.e. the total amount of landfill gas that one metric tonne of waste is expected to generate over its lifetime (cubic meters per tonne of MSW). Lo is a variable dependent on the type of waste deposited and its organic content. Again estimates recommended by SCS Engineers in a presentation on behalf of the US EPA in Sao Paulo, Brazil (Part 5: Evaluating Landfill Gas Potential, June 26 2001, Training Workshop for the US EPA Landfill Methane Outreach Program, Sao Paulo Brazil) were used, and the value chosen was **164 m3/tonne**.

Time since landfill opened (t): These values varied depending on which site was being investigated. In the case of the Carapicuíba landfill the opening year was **1965**. Therefore the value used for t changed depending on which year landfill gas generation figures were being developed for.

Time since landfill closed (c): The landfill shut in **2001**.

The USEPA model was then applied to the specific case of the CTRPE landfill and using the parameters detailed above gas volumes were estimated. The results are in the following table.

| **Project Emissions for 1st Crediting Period** | | | | |
|---|---|---|---|---|
| **Year** | **Methane Production ($tCH_4$/yr)** | **Baseline CO2e Emissions ($tCO_2e$/yr)** | **$CO_2e$ Emissions after project activity ($tCO_2e$/yr)** | **Net emissions reductions (tCO2e/yr)** |
| 2006 | 1,172 | 19,693 | 19,693 | 0 |
| 2007 | 1,061 | 17,819 | 5,568 | 9,604 |
| 2008 | 960 | 16,123 | 5,039 | 8,690 |
| 2009 | 868 | 14,589 | 4,559 | 7,863 |
| 2010 | 786 | 13,201 | 4,125 | 7,115 |
| 2011 | 711 | 11,944 | 3,733 | 6,438 |
| 2012 | 643 | 10,808 | 3,377 | 5,825 |
| **Total** | **6,201** | **104,178** | **46,095** | **45,537** |

**5. Difference between E.4 and E.3 representing the emission reductions of the project activity:**

69 The total volume used in the LFG estimation is **616,665 tonnes** by the end of 2001. This number was used, as there is uncertainty in what month the landfill opened and closed.

After to accounting for registration fees and a 20% insurance factor, total emission reductions amount to **45,537 $tCO_2e$ over the first 7-year crediting period**. For a summary of estimated results please see the table in E.6 below.

**E.6. Table providing values obtained when applying formulae above:**

| Year | Estimation of baseline emissions (tonnes of $CO_2e$) | Estimation of project activity emissions (tonnes of $CO_2e$) | Estimation of gross emission reductions (tonnes of $CO_2e$) | Estimation of net emission reductions (tonnes of $CO_2e$) |
|---|---|---|---|---|
| 2006 | 19,693 | 19,693 | 0 | 0 |
| 2007 | 17,819 | 5,568 | 12,251 | 9,604 |
| 2008 | 16,123 | 5,039 | 11,085 | 8,690 |
| 2009 | 14,589 | 4,559 | 10,030 | 7,863 |
| 2010 | 13,201 | 4,125 | 9,075 | 7,115 |
| 2011 | 11,944 | 3,733 | 8,212 | 6,438 |
| 2012 | 10,808 | 3,377 | 7,430 | 5,825 |
| **Total (tonnes of $CO_2e$)** | **104,178** | **46,095** | **58,083** | **45,537** |

## SECTION F. Environmental impacts

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

**This section needs to be completed with section that the project sponsor has yet to provide.**

**F.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:**

>>

## SECTION G. Stakeholders' comments

As with any CDM project activity PDD, this section will only be completed during the validation phase of the project cycle by the chosen Designated operational entity (DOE) and in cooperation with the relevant project participants. This section will reflect comments submitted pertaining to the **ACTUAL** project engineering plans.

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

>>

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

>>

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

>>

## Annex 1

**CONTACT INFORMATION ON PARTICIPANTS IN THE PROJECT ACTIVITY**

| | |
|---|---|
| Organization: | MaxAmbiental – Project Developer |
| Street/P.O.Box: | Avenida Brigadeiro Faria Lima, 2894 cj. 44 |
| Building: | |
| City: | São Paulo |
| State/Region: | SP |
| Postfix/ZIP: | 01452 938 |
| Country: | Brazil |
| Telephone: | +55 11 3709 3440 |
| FAX: | +55 11 3709 3446 |
| E-Mail: | |
| URL: | www.maxambiental.com.br |
| Represented by: | Paulo Braga |
| Title: | Director |
| Salutation: | |
| Last Name: | Braga |
| Middle Name: | |
| First Name: | Paulo |
| Department: | |
| Mobile: | +55 11 8271 3626 |
| Direct FAX: | +55 11 3709 3446 |
| Direct tel: | +55 11 3709 3440 |
| Personal E-Mail: | Paulo@maxambiental.com.br |

| | |
|---|---|
| Organization: | Xenex do Brasil, Ltda. – Project Developer |
| Street/P.O.Box: | Rua Manuel da Nobrega 354, cj. 82 |
| Building: | |
| City: | São Paulo, Paraiso |
| State/Region: | SP |
| Postfix/ZIP: | 04001 001 |
| Country: | Brazil |
| Telephone: | +55 11 3262 0854 |
| FAX: | |
| E-Mail: | xenexbr@nethall.com.br |
| URL: | |
| Represented by: | Junichi Ishihara |
| Title: | Director President |
| Salutation: | |
| Last Name: | Ishihara |
| Middle Name: | |
| First Name: | Junichi |
| Department: | |
| Mobile: | |
| Direct FAX: | |
| Direct tel: | |
| Personal E-Mail: | |

| | |
|---|---|
| Organization: | Banco Sumitomo Mitsui Brasileiro S.A.- Project Sponsor |
| Street/P.O.Box: | Avenida Paulista, 37 – 11th Floor |
| Building: | |
| City: | São Paulo |
| State/Region: | SP |
| Postfix/ZIP: | 01311 902 |
| Country: | Brazil |
| Telephone: | +55 11 3178 8129 |
| FAX: | +55 11 3178 8190 |
| E-Mail: | |
| URL: | www.smbcgroup.com.br |
| Represented by: | Hajime Uchida |
| Title: | Marketing Group – Japanese Corporate General Manager |
| Salutation: | |
| Last Name: | Uchida |
| Middle Name: | |
| First Name: | Hajime |
| Department: | |
| Mobile: | |
| Direct FAX: | |
| Direct tel: | |
| Personal E-Mail: | Hajime_uchida@smbcgroup.com.br |

**Annex 2**

## INFORMATION REGARDING PUBLIC FUNDING

The project will not receive any public funding from Parties listed in Annex I of the UNFCCC.

# ANNEX 3

## BASELINE INFORMATION

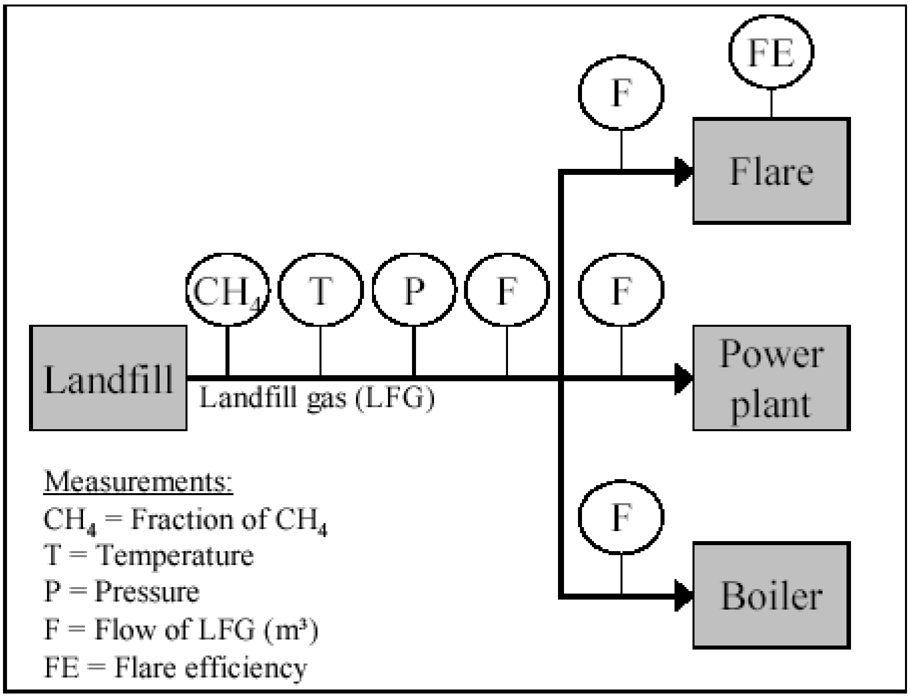
| | | |
|---|---|---|
| **Project Cashflow 1** | | |
| **Landfill/Project Name:** | | **Carapicuiba** |

| | Unit | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|---|---|
| | | 1st | 2nd | 3rd | 4th | 5th | 6th | 7th |
| Carbon Cashflow | | | | | | | | |
| Total LFG emitted | m3/h | 408 | 369 | 334 | 302 | 273 | 247 | 224 |
| Carbon CF | | | | | | | | |
| Total Adj. Net Emission Reductions | Tonnes CO2e/yr | 0 | 9,604 | 8,690 | 7,863 | 7,115 | 6,438 | 5,825 |
| Cost | | | | | | | | |
| Annual Operation Cost | | -12,552 | -12,552 | -12,552 | -12,552 | -12,552 | -12,552 | -12,552 |
| Annual Mentenace Cost | | -9,000 | -9,000 | -9,000 | -9,000 | -9,000 | -9,000 | -9,000 |
| Validation & Verification Cost | | | -5,000 | -5,000 | -5,000 | -5,000 | -5,000 | -5,000 |
| Adaptation Fee/CER | US$0.2 | | -1,921 | -1,738 | -1,573 | -1,423 | -1,288 | -1,165 |
| Electricity Generation Cost | US$70.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Depreciation | | -35,246 | -35,246 | -35,246 | -35,246 | -35,246 | -35,246 | -35,246 |
| Interest | | -23,497 | -21,715 | -19,825 | -17,822 | -15,699 | -13,448 | -11,062 |
| Total Cost | | -80,295 | -85,433 | -83,361 | -81,192 | -78,920 | -76,534 | -74,025 |
| | | | | | | | | |
| Income | | | | | | | | |
| Price of CER | US$/tCO2 | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 |
| CER Sales | US$8.0 | 0 | 76,836 | 69,524 | 62,908 | 56,921 | 51,505 | 46,603 |
| Electricity Tariff | US$/MWh | 50.0 | 50.0 | 50.0 | 50.0 | 50.0 | 50.0 | 50.0 |
| Electricity Sales | US$50.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Income | | 0 | 76,836 | 69,524 | 62,908 | 56,921 | 51,505 | 46,603 |
| | | | | | | | | |
| Balance | | -80,295 | -8,597 | -13,837 | -18,285 | -21,998 | -25,029 | -27,422 |
| Income Tax | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Current Income | | -80,295 | -8,597 | -13,837 | -18,285 | -21,998 | -25,029 | -27,422 |
| | | | | | | | | |
| NPV(21years) | 128,009 | | | | | | | |
| IRR(21years) | #NUM! | | | | | | | |

## ANNEX 4

**MONITORING PLAN**

The monitoring plan for the Carapicuíba LFG Flaring project activity is based on the monitoring methodology of ACM0001. The following diagram is provided.




Please note that for this project activity there is no boiler or power plant but only a flare.

The principal variables that need to be calculated for monitoring purposes are as follows:

1. $MD_{project, y}$ for every project year
2. $MD_{reg, y}$ for every project year

The input data required for this will be stored in the following spreadsheet and archived for at least two years after the end of the crediting period or the last issuance of CERs for this project activity whatever occurs later.

## Monitoring Plan for Carapicuíba Landfill gas capture and flaring project

| Year | Units | Measurement | 2006 |
|---|---|---|---|
| **Project Year** | | | **1** |
| | | | |
| **Total amount of LFG flared** | **m3** | **Flow Meter** | |
| | | | |
| Methane content of exhaust gas | m3 CH4/m3 ExGas | Gas analyzer | |
| Operation time of flare | hours | Flare | |
| **Flare Combustion Efficiency** | **%** | **Calculated** | |
| | | | |
| **Methane content of landfill gas** | **m3 CH4/m3 LFG** | **Gas analyzer** | |
| | | | |
| Temperature of LFG | Degree Celsius | Manifold | |
| Pressure of LFG | Pa | Manifold | |
| **Density of methane** | **tonnes CH4/m3 CH4** | **Calculated** | |
| | | | |
| **Regulatory requirements relating to LFG projects** | | | |

Annex 5

Electricity Generating Option

**Annex 5: Electricity Generation Potential – Carapicuíba Landfill**

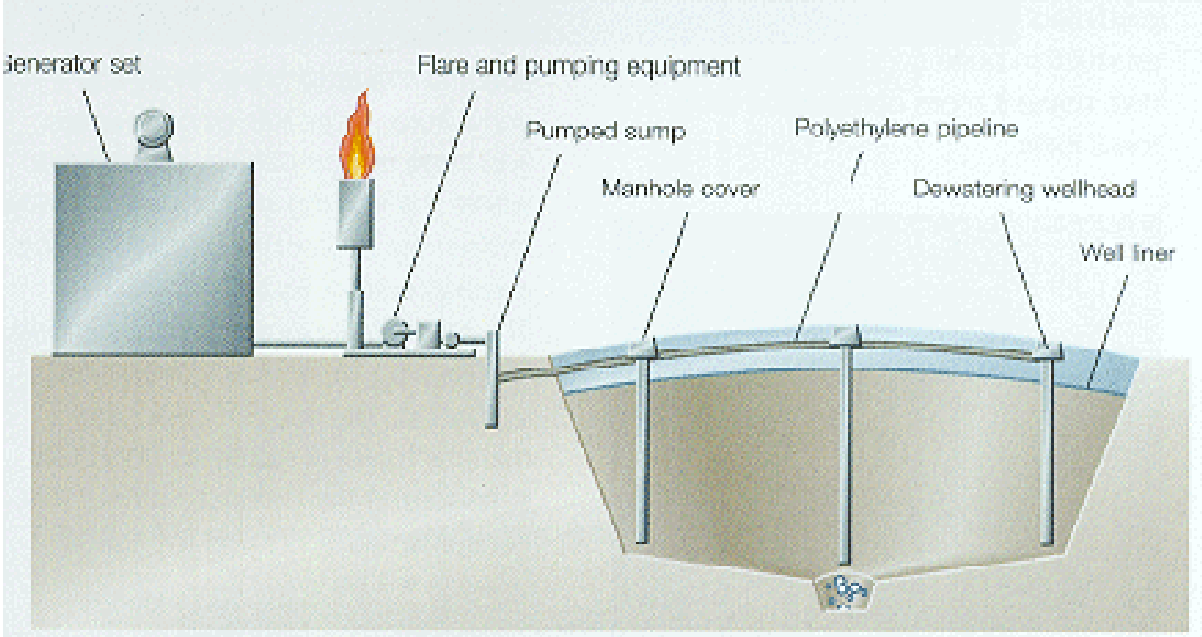
| Electricity Generation | Carapicuíba |
|---|---|

| | Unit | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|---|---|
| | | 1st | 2nd | 3rd | 4th | 5th | 6th | 7th |
| Carbon Cashflow | | | | | | | | |
| Total LFG emitted | m3/h | 408 | 369 | 334 | 302 | 273 | 247 | 224 |
| Carbon CF | | | | | | | | |
| Total Adj. Net Emission Reductions | Tonnes CO2e/yr | 0 | 9,604 | 8,690 | 7,863 | 7,115 | 6,438 | 5,825 |
| Electricity Generation(MWh) | | 0 | 1,594 | 1,594 | 1,594 | 1,594 | 1,594 | 1,594 |
| | | | | | | | | |
| Cost | | | | | | | | |
| Annual Operation Cost | | -12,552 | -12,552 | -12,552 | -12,552 | -12,552 | -12,552 | -12,552 |
| Annual Mentenace Cost | | -9,000 | -9,000 | -9,000 | -9,000 | -9,000 | -9,000 | -9,000 |
| Validation & Verification Cost | | | -5,000 | -5,000 | -5,000 | -5,000 | -5,000 | -5,000 |
| Adaptation Fee/CER | US$0.2 | | -1,921 | -1,738 | -1,573 | -1,423 | -1,288 | -1,165 |
| Electricity Generation Cost | US$70.0 | 0 | -111,602 | -111,602 | -111,602 | -111,602 | -111,602 | -111,602 |
| Depreciation | | -35,246 | -35,246 | -35,246 | -35,246 | -35,246 | -35,246 | -35,246 |
| Interest | | -23,497 | -21,715 | -19,825 | -17,822 | -15,699 | -13,448 | -11,062 |
| Total Cost | | -80,295 | -197,036 | -194,963 | -192,795 | -190,522 | -188,136 | -185,628 |
| | | | | | | | | |
| Income | | | | | | | | |
| | | | | | | | | |
| CER Sales | US$8.0 | 0 | 76,836 | 69,524 | 62,908 | 56,921 | 51,505 | 46,603 |
| | | | | | | | | |
| Electricity Sales | US$50.0 | 0 | 79,716 | 79,716 | 79,716 | 79,716 | 79,716 | 79,716 |
| Total Income | | 0 | 156,552 | 149,240 | 142,624 | 136,637 | 131,221 | 126,319 |
| | | | | | | | | |
| Balance | | -80,295 | -40,484 | -45,723 | -50,171 | -53,885 | -56,915 | -59,308 |
| Income Tax | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Current Income | | -80,295 | -40,484 | -45,723 | -50,171 | -53,885 | -56,915 | -59,308 |
| | | | | | | | | |
| NPV(21years) | -150,146 | | | | | | | |
| IRR(21years) | #DIV/0! | | | | | | | |

## Electricity Market Situation in Brazil

Other than financial return from the carbon market, the only potential revenue to the project derives from the use of gas to produce electricity. The feasibility of this project is, thus, dependent on factors related to energy sector. It is necessary to conduct a financial analysis to determine whether the project is an economically attractive course of action.

Historically, tariff levels in Brazil have been relatively low due to a centralized pricing structure fixed by the government. The government agency ANEEL (Electric Energy National Agency) controls the commercialisation and distribution of through pre-established contracts and prices. While small tariff increases have been observed in the last few years, they are insignificant and not enough to indicate that this scenario is going to change significantly. A free electricity market in Brazil is still in its infancy.




Typical landfill gas extraction and flaring plant arrangement

Source: http://europa.eu.int/comm/energy_transport/atlas/assets/images/Image71.gif

In addition to this electricity generation using landfill gas cannot rely on offsetting carbon income. Due to its enormous hydropower capacity Brazil's energy sector already has low carbon intensity and a correspondingly low carbon emission factor. There is also a lack of governmental pricing policies to support projects that replace fossil energy with new sources of clean energy.

The generation of electricity from landfill gas in Brazil carries several risks. There are clear managerial risks owing to the fact that few landfill operators have the requisite skills and expertise to negotiate long-term power purchase agreements. Moreover, there is considerable uncertainty attached to the production of landfill gas and hence to the reliability of electricity supply. Several external factors such as precipitation levels, waste composition and temperatures can severely impact gas production levels. Most of the required generation technology needs to be imported from international companies, which exposes the project to potential adverse changes in the exchange rate. Given these risks, electricity generation from landfill gas is seen as 'unproven' technology by local investors.

## Carapicuíba Generation Potential and Financial Analysis

A financial analysis was undertaken using assumptions that are highly conservative from the point of view of gas production. It needs to be noted that the landfill gas generation model used, the US EPA First Order Decay Model, has an inherent error up to 50%. A value of 4.95 kWh/m3 was used for the energy content of landfill gas. This number presents an accepted average and was also used in the calculation of the energy potential of the NovaGerar CDM project. According to the estimates used, the Carapicuíba landfill will produce 18,905,635m$^3$ of landfill gas between the start of the project in 2006 and the end of the first Kyoto Commitment Period in 2012. It is important to bear in mind that this number is purely an **estimate** and actual volumes could be considerably lower.

Taking into account a generator efficiency of 38%[70] (industry average for LFGTE generator sets from companies such as Caterpillar and Jenbacher), a methane collection efficiency of 75%, and insurance factor of 20%, a parasitic loss factor of 5% and 91% generator availability, it is estimated that between 2006 and 2012, approximately **18,446 MWh** of electricity will be produced by the Carapicuíba landfill.

Source: www.dti.gov.uk/.../nr47/html/landfill_gas.htm

The US EPA estimates that levelized capital and O&M costs per kWh of landfill gas derived electricity are about 7 cents or US$70/MWh[71]. This is of course only an estimate, but to arrive at more accurate numbers it would be necessary to undertake a more detailed study. For the purpose of this assessment it was deemed to be sufficient to use a generally accepted factor. Given that LFGTE is already an established industry in the US, it is likely that costs in Brazil would be even higher as they would have to factor in importation costs as well as FOREX risk and additional expenses related to lack of experience. At the same time the price currently offered to small producer of electricity by the Brazilian regulatory authority (ANEEL) is only U$58.4/MWh (as of November 2005 the tariff was fixed at R$ 146.00 and assuming a long-term exchange rate of 2.50 R$/US$)[72]. Comparing the costs and revenue per MWh it becomes clear that at the current time it is not financially viable to undertake Landfill gas to Energy projects in Brazil.

In addition to this the CERs that could be earned from the displacement of fossil-derived electricity through the generation of carbon neutral LFG energy are not sufficient to offset the estimated losses. The South-Southeast-Midwest electricity grid has a generally accepted Carbon Emission Factor of 0.249 $tCO_2e/MWh$[73], which is relatively low. Between 2006 and 2012 the Carapicuíba landfill project is hence estimated to generate a net amount of **4,593 $tCO_2e$**. At a price of US$10/CER, the electricity-related carbon component is not sufficient to offset the high generating costs/low electricity tariffs.

---

70 http://www.ge-energy.com/prod_serv/products/recip_engines/en/downloads/type2_en.pdf

71 http://www.forester.net/mw_0401_retail.html
72 http://www.aneel.gov.br/
73 This CEF has been approved by the Brazilian Designated National Authority

Therefore for the Carapicuíba landfill the NPV of the electricity and related carbon components over the first 7 years comes to **negative US$2,053,279**. Thus the generation of electricity is currently not considered to be an option for the Carapicuíba CDM project.

## PDD
## （３）モジグアス市

**CLEAN DEVELOPMENT MECHANISM**
**PROJECT DESIGN DOCUMENT FORM (CDM-PDD)**
**Version 02 - in effect as of: 1 July 2004)**

CONTENTS



Annexes



**ATTENTION PLEASE READ**

**This is a DRAFT version of the PDD. The ownership of the carbon credits has not been satisfactorily proven to the carbon advisors. There is as yet no engineering project. All numbers pertaining to the engineering part of the PDD are based on very rough estimates and CANNOT be submitted to the validators. No stakeholder meeting has yet been planned or held. No environmental licences have been submitted to the carbon advisor to date.**

**This DRAFT CANNOT yet be submitted for validation.**

## SECTION A. General description of project activity

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

Project Name: Landfill Gas Recovery and Flaring Project at Mogi Guaçu Landfill in São Paulo

Version: 2.3

Date: Monday, 14 February 2006

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

The project partners are proposing a CDM project activity, which will result in reduced GHG emissions and contribute to local sustainable development in the Brazilian state of São Paulo. The project activity will involve the capture and flaring of methane, which is a major constituent of landfill gas (LFG). LFG capture and flaring is not mandated by Brazilian law nor is it a common practice to flare a large proportion of the produced gas. Customarily only a small fraction of LFG is flared to reduce risk of explosion. The Mogi Guaçu will therefore provide additional environmental benefits by flaring the majority of the gas produced.

The landfill in Mogi Guaçu was opened in **1985 and is still operating in 2005**. Since 1995 Empreiteira Pajoan Ltda has managed this landfill under a private concession. This is expected to continue operations for another 10 years until 2015. The site covers a total of 105,000 $m^2$ and already contains approximately 476,000[74] tonnes of waste. The landfill receives about 83 tonnes (corresponding to 111.66 $m^3$) per day of municipal solid waste, which is collected by a local association of "catadores" or waste collectors, as well as waste from the commercial and health sectors. It is located in the municipality of Mogi Guaçu in the state of São Paulo. The landfill possesses a leachate management system, but has no impermeable liner. Daily cover is applied in a haphazard manner using clay. Leachate is collected and collected in a storage basin to be recycled at a later date.

The aim of this specific project activity is to install landfill gas collection and flaring equipment to reduce methane emissions to the atmosphere. At the present time electricity generation using captured landfill methane is not foreseen due to the unfavorable pricing regime currently prevailing in Brazil. However, all equipment used can be expanded to include electricity generation at a later stage to accommodate future changes in electricity tariffs. At present the ultimate rationale of the project is the combustion of methane to reduce anthropogenic greenhouse gas (GHG) emissions from the decomposition of organic waste in the landfill. These emissions reductions will be eligible for Certified Emissions Reductions (CERs) under the Kyoto Protocol's Clean Development Mechanism (CDM).

The project activity will have a series of positive social and environmental impacts, especially when compared to traditional Brazilian waste disposal sites. This is important in view of guidelines governing the CDM, which stipulate a contribution to sustainable development and local environmental protection. The Mogi Guaçu project will flare the majority of generated methane and thus eliminate the negative impact of landfill gas emissions. In addition this project provides additional jobs in the municipality and is a step in the right direction towards sustainable management of municipal waste. There will be, for example, proper control over leachate collection, which is necessary to ensure reliable gas collection and avoid the flooding of gas collection pipes with leachate. At a later stage, some electricity may be

---

[74] The total volume used in the LFG estimation is **476,400 tonnes** by the beginning of 2005.

generated with the LFG, although the generated electricity will be used only for onsite usage. This has not been taken into account for the proposed CDM project activity.
Greenhouse gas emission reductions will result from the combustion of the recovered methane contained in the landfill gas. It is estimated that this project will generate **148,760 CERs** within the first 7-year crediting period (2006-2012).

There are several contributions to sustainable development.

*Environmental benefits:*
The local environment benefits from the highest European waste management standards that are applied to this site including:

- The project will contribute to the continued environmental improvements by providing the infrastructure to reduce greenhouse gas emissions.

*Technology transfer:*
The project will be one of the first in Brazil to recover and flare landfill gas from a closed landfill operation. As such it will act as a showcase project for landfill owners and operators as well as other CDM project developers.

**A.3. Project participants:**

| Please list project participants and Party(ies) involved and provide contact information in Annex 1. Information shall be in indicated using the following tabular format. | | |
|---|---|---|
| **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) | Prefecture of Mogi Guaçu; MaxAmbiental; Xenex do Brasil 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. | | |

The Mogi Guaçu landfill is owned by the Prefecture of Mogi Guaçu and is operated by Empreiteira Pajoan Ltda. The gas-flaring project is being developed by between MaxAmbiental, a Brazilian environmental finance company that specializes in greenhouse gas (GHG) mitigation activities, and Xenex do Brasil Ltda. Banco Sumitomo Mitsui Brasileiro SA is financing the baseline study and PDD as well as the project activity (For further details see Annex 1).

MaxAmbiental is an environmental finance company whose specialty lies in the preparation of carbon emissions reductions projects. Its staff has wide ranging experience in this area, including the successful registration of the first landfill gas CDM project, Nova Gerar.

**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.:**

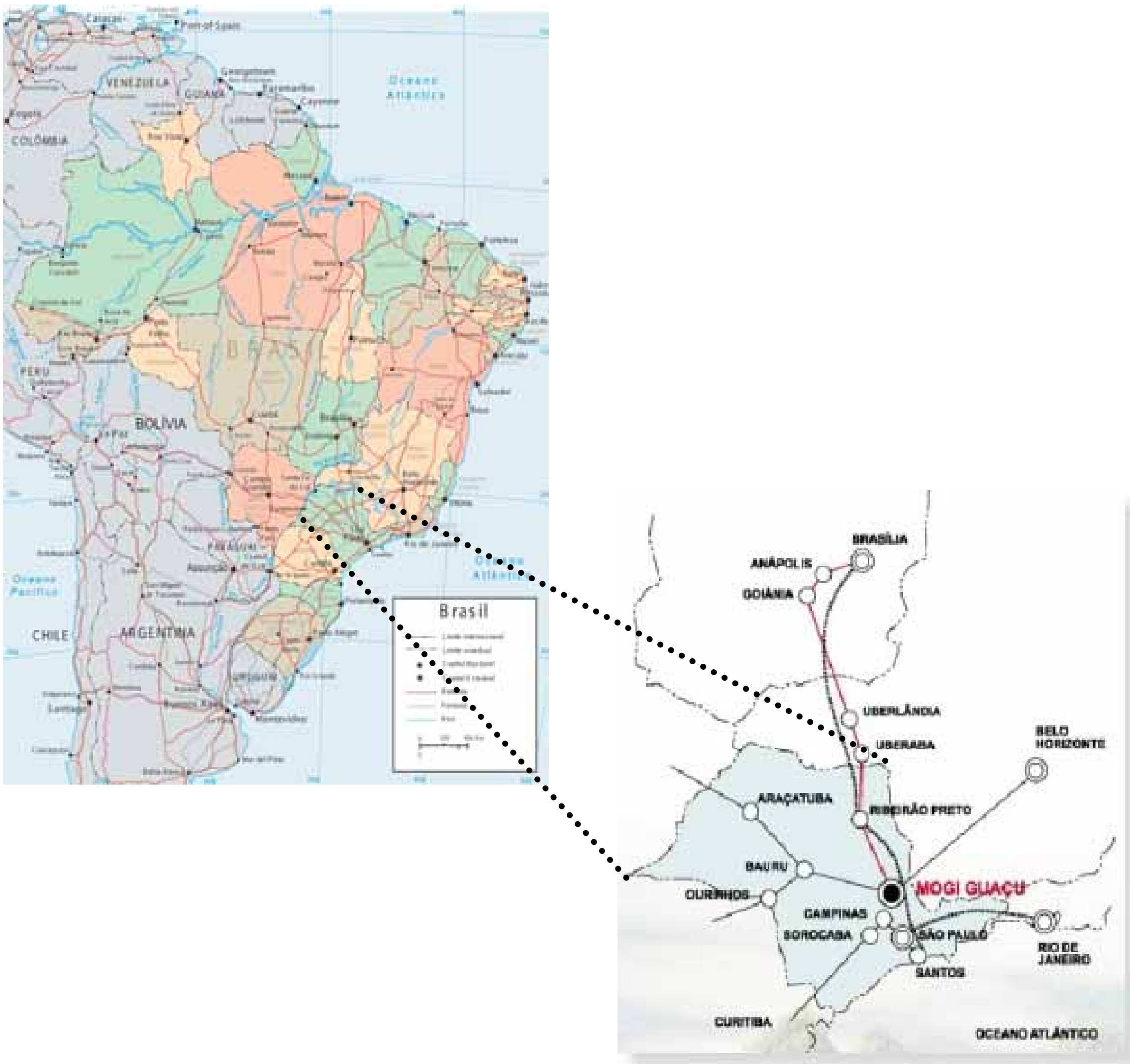
Mogi Guaçu, São Paulo

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

Municipality of Mogi Guaçu

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

The Municipality of Mogi Guaçu is situated on the banks of the river Mogi Guaçu, close to the major cities of the state of São Paulo and the state of Minas Gerais and covers and area of 885 $km^2$ of which 45.15 $km^2$ are urbanized. The population of the Municipality numbered 136.258 in 2004. Annual rainfall is estimated to 1,262.6mm. The Municipality lies at a distance of about 166km from the city of São Paulo.




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

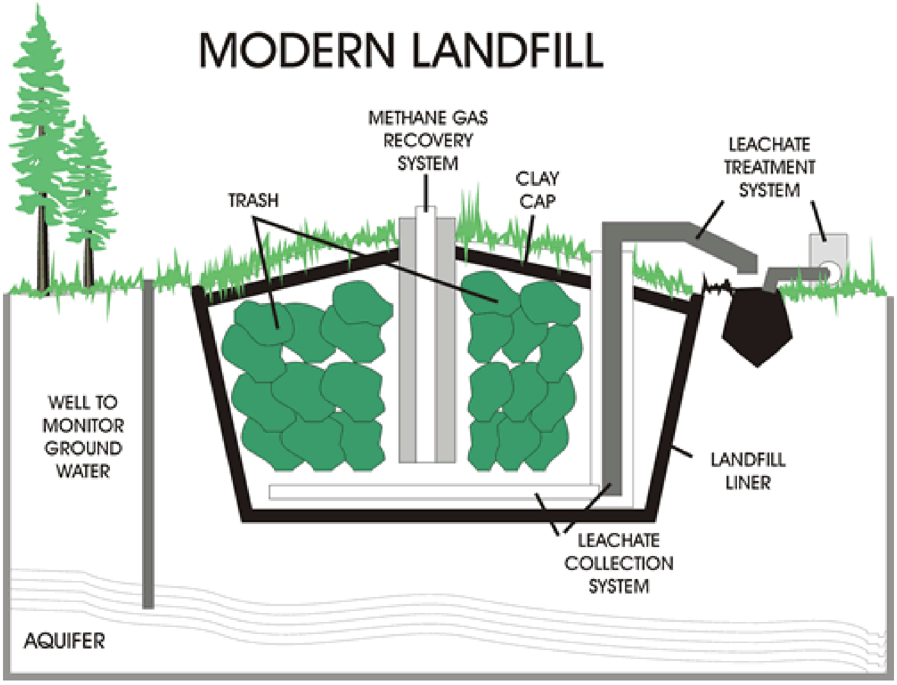
Sectoral scope: 13 - Waste handling and disposal

Project activity: Landfill gas capture and flaring project

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

The project will involve proven technology and hardware for the extraction and treatment of landfill gas.

**Typical Schematic of Modern Landfill**




Below is a brief summary of the equipment and technology proposed for this project:

The landfill gas collection system consists of the following components:

- Landfill cells lined with impermeable high-density polyethylene membrane to ensure minimal leakage of landfill gas from the cells.
- Vertical wells (perforated concrete pipes) to ensure connectivity of all layers. A high-density perforated pipe is installed within the center of the well, which is backfilled with gravel.
- Surface runoffs as well as percolate are collected and then channeled to wastewater treatment plant.
- Landfill gas extraction wells will also be drilled into the landfill once areas reach their final elevation and final cover has been applied. The vertical wells consist of a pipe perforated in its lower part, placed in a drilled borehole in the waste, backfilled with gravel and sealed at the surface. Both well types will be equipped with wellheads that enable monitoring of gas flow and quality. Also valves are provided to allow adjustment of the available vacuum at each well.
- In order to maximize the extraction capacity horizontal drains will also be installed in the waste mass. Preliminarily, the installation of a series of horizontal drains with a horizontal separation distance of 60 meters installed every 5 meters in waste lift height is envisioned. The horizontal drains will consist of perforated pipes surrounded gravel or equivalent drainage material. The drains will be interconnected to the vertical well system.
- The flaring equipment consists of an enclosed flare, 2 compressors to require the vacuum in the collection network, an online gas analyzer, and valves and tubes.
- A condensate extraction and storage system designed at strategic low points throughout the gas system.

**A.4.4. Brief explanation of how the anthropogenic emissions of anthropogenic**

**greenhouse gas (GHGs) by sources are to be reduced by the proposed CDM project activity, including why the emission reductions would not occur in the absence of the proposed project activity, taking into account national and/or sectoral policies and circumstances:**

The project activity intends to collect and flare the methane generated by the anaerobic decomposition of the organic component of the municipal solid waste (MSW) landfilled at the Mogi Guaçu landfill. The combustion of the methane produces carbon dioxide. Taking into account the respective Global Warming Potentials (GWP) of methane and $CO_2$ this combustion signifies a 21-fold reduction of GHG emissions.

The baseline scenario is defined as the most likely future scenario in the absence of the project activity. Based on the analysis of possible alternatives, the baseline scenario is the continued, uncontrolled release of landfill gas into the atmosphere.

The results of the financial analysis demonstrate that the project activity is not the most attractive course of action economically speaking and therefore this kind of project is not part of the baseline scenario. Hence the Mogi Guaçu Project is considered to be additional.

**A.4.4.1. Estimated amount of emission reductions over the chosen crediting period:**

| YEAR | ESTIMATED ANNUAL EMISSION REDUCTIONS IN $TCO_2E$ |
|---|---|
| 2006 | 0 |
| 2007 | 23,540 |
| 2008 | 24,109 |
| 2009 | 24,623 |
| 2010 | 25,088 |
| 2011 | 25,509 |
| 2012 | 25,890 |
| **Total emission reductions 7 years (tCO2e)** | **148,760** |
| Renewable Crediting Period | 3 x 7 years = 21 years |
| Mean annual emission reductions (t CO2e) | 21,251 |

The combustion of the methane generated by the Mogi Guaçu landfill during the chosen crediting period reduces anthropogenic GHG emissions by:

**148,760 tonnes of $CO_2$e between 2006-2012** (first 7 year crediting period)

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

There is no Official Development Assistance used in this project activity.

## SECTION B. Application of a baseline methodology

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

ACM0001: Consolidated Methodology for Landfill Gas Project Activities

**B.1.1. Justification of the choice of the methodology and why it is applicable to the project activity:**

This consolidated methodology was developed specifically for landfill gas capture and flaring. The Mogi Guaçu project is similar to the Nova Gerar project, which served as one of the examples included in the consolidated methodology ACM0001.

**B.2. Description of how the methodology is applied in the context of the project activity:**

The project activity will flare a greater proportion of the landfill gas generated by the decomposition of organic waste in the Mogi Guaçu landfill, than would have occurred in the absence of the project activity. In the baseline scenario (i.e. the absence of the project) only 20% of all gas generated are customarily flared for safety reasons. The project activity leads to higher collection and flaring efficiency through the installation of modern LFG collection and flaring equipment. Therefore the project activity will reduce total GHG emissions below the GHG emissions of the baseline scenario.

Baseline emissions are calculated using a first order decay model proposed by the US Environmental Protection Agency as recommended in the 1996 IPCC Guidelines. Using this model the methane emissions that would have been released to the atmosphere in the absence of the project activity are calculated. A fraction of those emissions need to be discounted to take account of a minimum amount of flaring that does customarily occur for safety reasons. In the case of Brazil this is usually less than 20%. Hence the use of 20% for baseline flaring is considered to be conservative.

For the determination of the baseline scenario a number of financial and market data had to be used. The various sources are listed in the table below.

| **Key data for determining baseline scenario** | **Data Unit** | **Data Source** |
|---|---|---|
| Project activity and plausible alternatives to it | - | Project Participants (PP), Industry data |
| National and local rules and regulations and policies | - | PP, Government |
| Baseline IRR | % | Calculated |
| Project IRR without Carbon | % | Calculated |
| Threshold for investment (IRR/NPV/payback period) | %, etc. | PP, Industry |
| Equipment costs | Brazilian Reais (R$) | Suppliers, PP |
| Operating costs | R$ | PP |
| Revenue from operations | R$ | PP |
| Market data (inflation, interest, tax, discount rate, etc.) | % | Relevant indices |
| Landfill gas generation parameters | 1/yr; $m^3$/tonne | Us EPA, Brazil specific data (SCS Engineers) |
| Methane collection parameters | % | IPCC, PP empirical data |

| | | |
|---|---|---|
| Global Warming Potentials | - | IPCC |
| Proportion of methane flared in baseline | % | Industry Data |

**B.3. 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:**

The project activity will flare a greater proportion of the landfill gas generated by the decomposition of organic waste in the Mogi Guaçu landfill, than would have occurred in the absence of the project activity. In the baseline scenario (i.e. the absence of the project) only 20% of all gas generated are flared for safety reasons. The project activity leads to higher collection and flaring efficiency through the installation of modern LFG collection and flaring equipment. Therefore the project activity will reduce total GHG emissions below the GHG emissions of the baseline scenario.

This description is divided into two parts:

H) The baseline approach and accompanying formulae described in ACM0001 are directly employed to the project activity under discussion.
I) The "Tool for the demonstration and assessment of additionality" is used to establish the additionality of the Mogi Guaçu LFG Capture and Flaring project activity.

**A)**

***Applicability***
*This methodology is applicable to landfill gas capture project activities, where the baseline scenario is the partial or total atmospheric release of the gas and the project activities include situations such as:*

*a) The captured gas is flared; or*
*b) The captured gas is used to produce energy (e.g. electricity/thermal energy), but no emission reductions are claimed for displacing or avoiding energy from other sources1; or*
*c) The captured gas is used to produce energy (e.g. electricity/thermal energy), and emission reductions are claimed for displacing or avoiding energy generation from other sources. In this case a baseline methodology for electricity and/or thermal energy displaced shall be provided or an approved one used, including the ACM0002 "Consolidated Methodology for Grid-Connected Power Generation from Renewable". If capacity of electricity generated is less than 15MW, and/or thermal energy displaced is less than 54 TJ (15GWh), small-scale methodologies can be used.*

*This baseline methodology shall be used in conjunction with the approved monitoring methodology ACM0001 ("Consolidated monitoring methodology for landfill gas project activities").*

**Comments:**
As almost all of the LFG produced in the Mogi Guaçu landfill will be captured and flared, the project activity meets situation "a)" described above; hence this methodology is applicable to the project activity.

***Emission Reduction***

*The greenhouse gas emission reduction achieved by the project activity during a given year "y" ($ER_y$) is the difference between the amount of methane actually destroyed/combusted during the year ($MD_{project,y}$) and the amount of methane that would have been destroyed/combusted during the year in the absence of the project activity ($MD_{reg,y}$) times the approved Global Warming Potential value for methane ($GWP_{CH4}$), plus the net quantity of electricity displaced during the year ($EG_y$) multiplied by the $CO_2$ emissions intensity of the electricity displaced ($CEF_{electricity,y}$) plus the quantity of thermal energy displaced during the year ($ET_y$) multiplied by the $CO_2$ emissions intensity of the thermal energy displaced ($CEF_{thermal,y}$). Electricity and thermal energy emission reductions apply to case (c) only.*

$$ER_y = \left(MD_{project,y} - MD_{reg,y}\right) \times GWP_{CH4} + EG_y \times CEF_{electricity,y} + ET_y \times CEF_{thermal,y} \quad \textbf{(1)}$$

*ERy is measured in tonnes of CO2 equivalents (tCO2e). $MD_{project,y}$ and $MD_{reg,y}$ are measured in tonnes of methane ($tCH_4$). The approved Global Warming Potential value for methane ($GWP_{CH4}$) for the first commitment period is 21 $tCO_2e/tCH_4$. $EG_y$ is measured in megawatt hours (MWh). The CO2 emissions intensity, $CEF_{electricity,y}$, is measured in tonnes of $CO_2$ equivalents per megawatt hour (t $CO_2e$/MWh) and $ET_y$ is measured in TeraJoules (TJ) and $CEF_{thermal,y}$ is measured in terms of tonnes of $CO_2$ equivalents per TJ (t $CO_2e$/TJ).*
*In the case where the $MD_{reg,y}$ is given/defined as a quantity that quantity will be used.*
*In cases where regulatory or contractual requirements do not specify $MD_{reg,y}$ an "Adjustment Factor" (AF) shall be used and justified, taking into account the project context.*

$$MD_{reg,y} = MD_{project,y} \times AF \quad \textbf{(2)}$$

*The following examples provide guidance on how to estimate AF:*
*- In cases where a specific system for collection and destruction of methane is mandated by regulatory or contractual requirements, the ratio of the destruction efficiency of that system to the destruction efficiency of the system used in the project activity shall be used.*
*- In cases where a specific percentage of the "generated" amount of methane to be collected and destroyed is specified in the contract or mandated by regulations, this percentage divided by an assumed efficiency for the collection and destruction system used in the project activity shall be used.*

**Comments:**

In the case of this project activity there are neither regulatory nor contractual requirements for the combustion of the methane produced in the baseline scenario. The "Adjustment Factor" used for $MD_{reg,\, y}$ is 20%, a value that conservatively estimates the amount of gas that would be flared in the absence of the project activity to avoid explosion risks.

Also, this particular project does not intend to generate electricity or thermal energy from the captured LFG. Therefore, greenhouse gas emission reductions related to this source are not to be considered in the calculation of $ER_y$. Therefore Formula (1) can be re-written as:

$$ER_y = \left(MD_{project,y} - MD_{reg,y}\right) \times GWP_{CH4}$$

The approved Global Warming Potential (GWP) of Methane for the first commitment period is 21 t $CO_2e/tCH_4$.

*Project proponents should provide an ex ante estimate of emissions reductions, by projecting the future GHG emissions of the landfill. In doing so, verifiable methods should be used. Ex ante emission estimates may have an influence on $MD_{reg,y}$. $MD_{project,y}$ will be determined ex post by metering the actual quantity of methane captured and destroyed once the project activity is operational.*
*The methane destroyed by the project activity ($MD_{project,y}$) during a year is determined by monitoring the quantity of methane actually flared and gas used to generate electricity and/or produce thermal energy, if applicable.*

$$MD_{project,y} = MD_{flared,y} + MD_{electricity,y} + MD_{thermal,y} \quad \textbf{(3)}$$

$$MD_{flared,y} = LFG_{flared,y} \times w_{ch4} \times D_{ch4} \times FE \quad \textbf{(4)}$$

*Where $MD_{flared,y}$ is the quantity of methane destroyed by flaring, $LFG_{flared,y}$ is the quantity of landfill gas flared during the year measured in cubic meters ($m^3$), wCH4,y is the average methane fraction of the landfill gas as measured during the year and expressed as a fraction (in $m^3$ $CH_4$ / $m^3$ LFG), FE is the flare efficiency (the fraction of the methane destroyed) and $D_{CH4}$ is the methane density expressed in tonnes of methane per cubic meter of methane ($tCH_4/m^3CH_4$).*

$$MD_{electricity,y} = LFG_{electricity,y} \times w_{ch4} \times D_{ch4} \quad \textbf{(5)}$$

*Where $MD_{electricity,y}$ is the quantity of methane destroyed by generation of electricity and $LFG_{electricity,y}$ is the quantity of landfill gas fed into electricity generator.*

$$MD_{thermal,y} = LFG_{thermal,y} \times w_{ch4} \times D_{ch4} \quad \textbf{(6)}$$

*Where $MD_{thermal,y}$ is the quantity of methane destroyed for the generation of thermal energy and $LFG_{thermal,y}$ is the quantity of landfill gas fed into the boiler.*

**Comments:**
Again, since no electricity or thermal energy will be generated, the emission reductions will be equivalent to the amount of methane flared only, thus:

$$MD_{project,y} = MD_{flared,y}$$

Consequently equations (5) and (6) will not be used for this specific project activity.

For the purpose of estimating baseline emissions and overall emission reductions of the project activity the USEPA's First Order Decay Model has been used. A detailed description and formulae used are provided in Section D.2.1.4.

According to ACM0001 at standard temperature and pressure (0 degree Celsius and 1,013 bar) the density of methane is 0.000656 $tCH_4/m^3CH_4$.

***Project Boundary***
*The project boundary is the site of the project activity where the gas is captured and destroyed/used.*

*Possible $CO_2$ emissions resulting from combustion of fuels other than the methane recovered should be accounted as project emissions. Such emissions may include fuel combustion due to pumping and collection of landfill gas or fuel combustion for transport of generated heat to the consumer locations.*
*In addition, electricity required for the operation of the project activity, including transport of heat, should be accounted and monitored. Where the project activity involves electricity generation, only the net quantity of electricity fed into the grid should be used in equation (1) above to account for emission reductions due to displacement of electricity in other power plants. Where the project activity does not involve electricity generation, project participants should account for $CO_2$ emissions by multiplying the quantity of electricity required with the $CO_2$ emissions intensity of the electricity displaced ($CEF_{electricity,y}$).*

Comments:
For more detailed information concerning the project boundary, please refer to Section B.4.

***Baseline***
*The baseline is the atmospheric release of the gas and the baseline methodology considers that some of the methane generated by the landfill may be captured and destroyed to comply with regulations or contractual requirements, or to address safety and odor concerns.*

Comments:
As mentioned above, flaring of landfill gas is not a common or required practice in Brazil. However, it is common to flare a small fraction (usually around 20%) of the produced gas to reduce the risk of explosion. Hence this fraction is deducted from the estimated total emissions of LFG from the landfill.

***Leakage***
*No leakage effects need to be accounted under this methodology.*

**B)**

***Additionality***
*The additionality of the project activity shall be demonstrated and assessed using the latest version of the "Tool for the demonstration and assessment of additionality" agreed by the CDM Executive Board, which is available on the UNFCCC CDM web site.*

Using the "Tool for demonstration and assessment of additionality":

Step 0: Preliminary screening based on the starting date of the project activity
Step 1: Identification of alternatives to the project activity consistent with the current laws and regulations
Step 2: Investment analysis
Step 4: Common practice analysis
Step 5: Impact of CDM registration

Step 1:

Sub-step 1a. Define alternatives to the project activity:
There are 3 possible baseline scenarios for the MOGI GUAÇU landfill:

1) The landfill operator adheres to the business as usual practice of not collecting and flaring landfill gas from its waste operations or flaring just a small fraction of the gas, for safety reasons. This is in fact the approach taken by most waste management operations in Brazil. In this case, no power is generated at the site and the Brazilian power system remains unaffected.

2) The landfill operator invests in LFG collection and flaring but not in power generation (the proposed project activity). The Brazilian power system remains unaffected.

3) The landfill operator invests in power generation from LFG. The operation marginally reduces the generation of power from other grid-connected sources and hence avoids carbon emissions.

Sub-step 1b. Enforcement of applicable laws and regulations:
Current Brazilian legislation does not require that landfills collect and dispose of landfill gases, and there are very few landfills in operation in Brazil that have been designed to collect, flare or utilize the full amount of gas generated. Most of these, like the NovaGerar landfills, were designed and built in the last two years specifically as CDM projects. When LFG collection and flaring does happen, this occurs mainly on a voluntary basis to diminish explosion risk. Usually only a low proportion of methane is collected due to the utilization of unsophisticated collection systems and the occasional flooding of pipes with leachate.

The implementation of environmental protection legislation in Brazil has a relatively long lead-time, and the Ministry of the Environment has no immediate plans to introduce legislation requiring the collection and flaring of landfill gas from landfill sites. Historically in Brazil there also tends to be a gulf between stated regulations and practice with regards to the implementation of environmental protection legislation.

Step 2:

Sub-step 2a. Determine appropriate analysis method:
This project activity will not generate any financial or economic benefits other than CDM related income. Other than financial return from the carbon market, the only potential revenue to the project could come from the use of gas to produce electricity (Alternative 3 above). It is necessary to conduct a financial analysis to determine whether the project activity is an economically attractive course of action.

Historically, tariff levels have been relatively low due to a centralised pricing structure fixed by the government. The commercialisation and distribution of electricity is controlled by the government, through ANEEL (Electric Energy National Agency), by pre-establishing the contracts and the price range. While small tariff increases can be observed in the last few years, they are insignificant and not sufficient to indicate that this scenario is going to change now. The free electricity market is still very incipient in Brazil. These low tariffs make electricity generation from LFG economically unattractive at present.

Brazil's energy sector is already relatively clean and there is lack of governmental pricing policies to support and favour projects for the replacement of some non-renewable energy with new sources of clean electricity.

In parallel to the risks related to the sale of electricity, the exact amounts of landfill gas and the performance of the plants also concerns landfill operators. Given that the production of methane in the landfills can vary greatly and currently there isn't a single landfill site in Brazil generating electricity, this is seen as 'unproven' technology by local investors.

A sensitivity analysis was undertaken using assumptions that are highly conservative from the point of view of analysing environmental additionality, i.e. the best-case scenario IRR was calculated. It was assumed that the average daily waste placement rate at the Mogi Guaçu Landfill would peak around 83 tonnes. The volumes of landfill gas to be generated from the site were estimated using the US EPA First Order Decay Model. It was further assumed that the project has unlimited access to capital to invest in all the equipment necessary to use the increased amount of gas produced. The IRR (without carbon) is negative and still exposed to a series of risks (project, country, currency, etc.). These results show that even with the best possible conditions, which are obviously quite unrealistic, the project is still not an economically attractive course of action.

Sub-step 2b. Apply simple cost analysis
N/a

Step 4:

According to the National GHG Emissions Inventory conducted by CETESB in 1994, 84% of Brazil's methane emissions came from the deposition of waste in uncontrolled rubbish dumps. This source is still responsible for a large part of the methane emitted since not much has changed in the business as usual scenario in the country. Besides, the amount of waste produced in Brazil has been increasing and, as estimated in 2000, Brazilians were already producing an average of 0.52 kg of waste per person everyday.[75]

Nowadays 59% of the municipalities in Brazil still dispose of their waste in 'rubbish dumps' ("lixões") with no management, gas collection, water treatment, or regulation by environmental authorities whatsoever. Among the other 30% that use landfills, only 13% invest in sanitary landfills with sophisticated leachate collection and treatment systems.

Although, until the present moment there are no regulatory requirements for flaring landfill gas, a number of landfills are collecting a small amount of LFG for safety reasons. To maintain the calculations' conservatism and to assure the environmental integrity of the project, all emission reductions arising from the Mogi Guaçu site will be discounted by 20% in the project. This amount, as argued before, more than sufficiently covers the volume of gas that would be flared to follow the business-as usual scenario found in the landfills considered in this analysis.

Since there are no legislation requiring gas flaring in Brazilian landfills, besides the flaring of a small fraction for security (less than 20%), there is no reason to believe that an LFG system for the collection and flaring of all gas produced would be installed now, when the landfill is being built. The installation of even a rudimentary LFG collection system with passive venting or flaring would go beyond what is required by law and involve considerable expenses for the landfill operator without any offsetting

[75] CETESB and IGBE Census

revenues.

Given the regulatory situation in Brazil and the location and conditions of the landfill, the realization of alternative 2 is not required and would also not be an economically attractive course of action for the landfill owner and/or operator. It is therefore not considered a plausible alternative to the baseline scenario. Alternative 3 was also proven not to be financially feasible at Brazil's present electricity tariff levels. Consequently the only remaining plausible option is Alternative 1 (i.e. Business- as-usual: the construction of a landfill without any LFG treatment).

Step 5: Impact of CDM Registration
As can be seen form the attached financial analysis, successful CDM registration adds an additional revenue stream (in fact the only revenue stream) to the project activity. At a price of **US$8 per CER** and a discount rate of 6%, the project has a net present value of **US$579,544 and an IRR of 10.1% for the first 7 years**. When compared to the financial analysis without carbon financing, it becomes clear that the project activity would not be undertaken in the absence of CDM registration.

Baseline development in time and description of baseline scenario:

It has been shown that the BAU baseline holds at the time of preparing the project. The main determinants of this baseline are:

- Landfill regulations applicable to the site
- The economics of landfill gas utilization

It is possible that future regulatory requirements for landfills in Brazil will necessitate a higher level of LFG collection in the baseline scenario. If this occurs, the future baseline scenario will include compliance with such regulations.

It is also possible that the economics of LFG utilization for power generation may change at some time in the future. If such changes lead to a sufficient increase in the profitability of LFG utilization the proposed project could well be implemented without the help of carbon finance. If this occurs, the future baseline scenario will include an LFG to power project.

The baseline scenario for the proposed project can thus be described as follows:

No collection and treatment of LFG occurs at the Mogi Guaçu landfill site and this allows the uncontrolled release of most of the LFG to the atmosphere until some future time when the collection and treatment of LFG will either be required by law or becomes an economically attractive course of action. The monitoring plan for the project will re-evaluate the baseline scenario, report any changes during the crediting period and determine the new baseline scenario.

This baseline scenario is the basis for the determination of the project's ERs as per the monitoring plans instructions.

The Mogi Guaçu project baseline assumptions will be revisited every 7 years to ensure that the assumptions made in the baseline scenario still hold true, or they will be revised accordingly. In addition, the introduction of Brazilian legislation regarding the collection and flaring of landfill gas will be monitored **annually** as a part of the Monitoring Plan.

**B.4. Description of how the definition of the project boundary related to the baseline methodology selected is applied to the project activity:**

The following flow diagram describes the project boundary and includes those GHG emissions, which are "under the control of" the project participants, "significant" and "reasonably attributable".

In the light of these attributes, the following emissions have not been taken into account:

- Emissions from the transport of the waste to the landfill site, as these would occur even in the absence of the proposed project activity.
- Emissions from the vehicles used to compact and cover the waste, as these would also occur in the absence of the project activity.

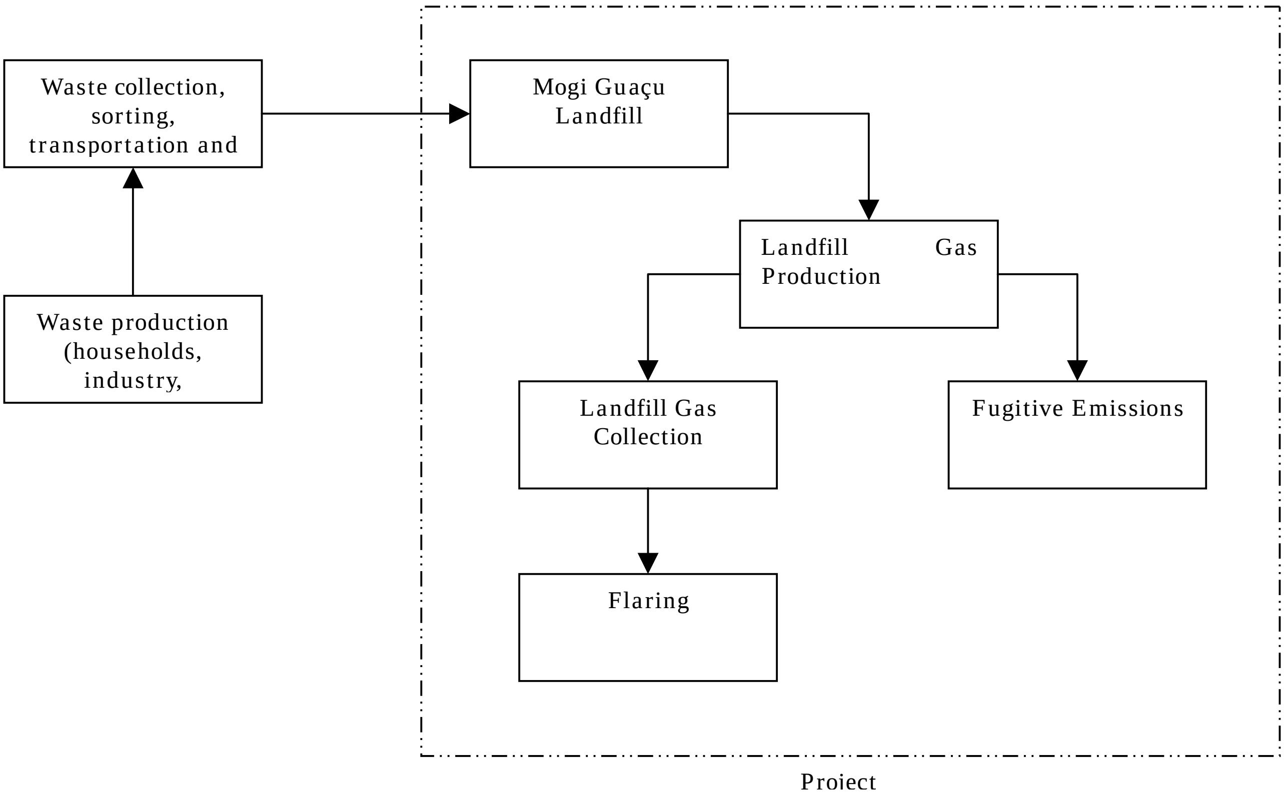



Figure B.4.1: Project Boundary

| Emissions | Project Scenario | Baseline Scenario |
|---|---|---|
| Direct On-site | Emissions associated with the inefficiency of the LFG capture and flaring process. MaxAmbiental estimates that only about 75% of total LFG produced will be collected and then combusted to $CO_2$. Hence 25% of the total gas production will be released as fugitive emissions. | Uncontrolled release of practically all LFG generated by the landfill. |
| Direct Off-site | Transportation of equipment to project site – | None identified |

| | | |
|---|---|---|
| | excluded because deemed to be insignificant | |
| Indirect On-site | NA | NA |
| Indirect Off-site | Transportation of waste to landfill site – excluded because would happen even in absence of project | Transportation of waste to landfill site – excluded because would happen even in absence of project |

Table B.4.2: System emissions

**B.5. Details of baseline information, including the date of completion of the baseline study and the name of person (s)/entity (ies) determining the baseline:**

The project is using **ACM0001**: Consolidated Methodology for Landfill Gas Project Activities

The baseline study was concluded in November 2005.

The entity determining the baseline and participating in the project, as the technical consultants are **MaxAmbiental** and **Xenex do Brasil Ltda** Brazil, listed in Annex 1 of this document.

## 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:

The project start date has been set for the second quarter of 2006.

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

The landfill is scheduled to close in 2015. The actual project activity will have a renewable crediting period of 7 years. This period can be renewed twice.

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

The project activity will use a renewable crediting period as described below in the following section (C.2.1).

#### C.2.1. Renewable crediting period

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

The starting date is 1st January 2006

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

7 years duration per renewable period

**C.2.2. Fixed crediting period:**

**C.2.2.1. Starting date:**

NA

**C.2.2.2. Length:**

NA

## SECTION D. Application of a monitoring methodology and plan

**D.1. Name and reference of approved monitoring methodology applied to the project activity:**

ACM0001: “Consolidated monitoring methodology for landfill gas project activities”

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

This monitoring methodology was specifically developed for landfill gas capture projects using baseline methodology ACM0001.

**D.2. 1. Option 1: Monitoring of the emissions in the project scenario and the baseline scenario**

**D.2.1.1. Data to be collected in order to monitor emissions from the project activity, and how this data will be archived:**

| ID number *(Please use numbers to ease cross-referencing to table D.3)* | Data variable | Source of data | Data unit | Measured (m), calculated (c), estimated (e), | Recording frequency | Proportion of data to be monitored | How will the data be archived? (electronic/ paper) | Comment |
|---|---|---|---|---|---|---|---|---|

Not applicable. Total project emissions are actually zero; there are neither project emissions nor leakage. The only discernable and significant difference between baseline and project emissions comes from the collection and destruction of methane contained in LFG, which is monitored and calculated directly. The only discernable yet insignificant (indirect) modification of emissions is associated with the physical construction of the project (see discussion under D.4 below). The monitoring methodology is based on direct measurement of the amount of landfill gas captured and destroyed at the flare platform.

**D.2.1.2. Description of formulae used to estimate project emissions (for each gas, source, formulae/algorithm, emissions units of $CO_2$ equ.)**

Not applicable, see D.2.1.1.

**D.2.1.3. Relevant data necessary for determining the baseline of anthropogenic emissions by sources of GHGs within the project boundary and how such data will be collected and archived:**

| ID number *(Please use numbers to ease cross-referencing to table D.3)* | Data variable | Source of data | Data unit | Measured (m), calculated (c), estimated (e), | Recording frequency | Proportion of data to be monitored | How will the data be archived? (electronic/ paper) | Comment |
|---|---|---|---|---|---|---|---|---|

The monitoring methodology is based on direct measurement of the amount of landfill gas captured and destroyed at the flare platform.

**D.2.1.4. Description of formulae used to estimate baseline emissions (for each gas, source, formulae/algorithm, emissions units of $CO_2$ equ.)**

Not applicable. The monitoring methodology is based on direct measurement of the amount of landfill gas captured and destroyed at the flare platform.

**D. 2.2. Option 2: Direct monitoring of emission reductions from the project activity (values should be consistent with those in section E).**

This is the Option chosen for the monitoring methodology of the Mogi Guaçu landfill gas capture and flaring project. As stated in ACM0001: "*The monitoring methodology is based on direct measurement of the amount of landfill gas captured and destroyed at the flare platform.*"

**D.2.2.1. Data to be collected in order to monitor emissions from the project activity, and how this data will be archived:**

| ID number *(Please use numbers to ease cross-referencing to table D.3)* | Data variable | Source of data | Data unit | Measured (m), calculated (c), estimated (e), | Recording frequency | Proportion of data to be monitored | How will the data be archived? (electronic/ paper) | Comment |
|---|---|---|---|---|---|---|---|---|
| *D2-1* | *Annual Waste landfilled* | *Truck balance* | *Tonnes* | *M* | *Arrival of truck* | *100%* | *Electronic (spreadsheet)* | *Measured on site* |
| *D2-2* | *Flow of landfill gas to flares* | *Continuous Flow Meter* | $m^3$ | *M* | *Continuous* | *100%* | *Electronic (spreadsheet)* | *Data will be aggregated monthly and yearly* |
| *D2-3* | *Flare efficiency determined by 1) operating hours And 2) Methane content in exhaust gas* | *Continuous methane analyser* | *%* | *M &C* | *1) Continuously 2) Quarterly* | *N/a* | *Electronic (spreadsheet)* | *Data will be used to test and, if necessary, correct the flare's efficiency rating* |
| *D2-4* | *Methane fraction in LFG* | *Continuous methane analyser* | *%* | *M &C* | *Continuous* | *100%* | *Electronic (spreadsheet)* | *Data will be aggregated monthly and yearly* |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| *D2-5* | *Gas pressure* | *Pressure gauge* | *Pa* | *M* | *Continuous* | *100%* | *Electronic (spreadsheet)* | *Data will be used to calculate methane density* |
| *D2-6* | *Gas temperature* | *Thermometer* | *Deg. Celsius* | *M* | *Continuous* | *100%* | *Electronic (spreadsheet)* | *Data will be used to calculate methane density* |
| *D2-7* | *Amount of methane flared* | *N/a* | *Tonnes of $CH_4$* | *M & C* | *Daily* | *100%* | *Electronic (spreadsheet)* | *It can be measured or calculated with the following data: LFG flow to flare, methane fraction in LFG, LFG temperature and pressure, flare temperature, and flare working hours* |
| *D2-8* | *Amount of methane flaring required in baseline* | *N/a* | *Tonnes of $CH_4$* | *C* | *Daily* | *100%* | *Electronic (spreadsheet)* | *20% of the amount of methane flared* |
| *D2-9* | *Regulatory requirements relating to landfill gas projects* | *Legislation* | *N/a* | *N/a* | *Annually* | *100%* | *Electronic (spreadsheet)* | *Required for any changes to the adjustment factor (ID 8)* |

**D.2.2.2. Description of formulae used to calculate project emissions (for each gas, source, formulae/algorithm, emissions units of $CO_2$ equ.):**

Not applicable. Total project emissions are actually zero; there are neither project emissions nor leakage. The only discernable and significant difference between baseline and project emissions comes from the collection and destruction of methane contained in LFG, which is monitored and calculated directly. The only discernable yet insignificant (indirect) modification of emissions is associated with the physical construction of the project (see discussion under D.4 below). The monitoring methodology is based on direct measurement of the amount of landfill gas captured and destroyed at the flare platform.

The following formulae are used to calculate project emissions using the direct monitoring data measured and collected during the lifetime of the project:

$$MD_{project,y} = LFG_{flared,y} \times w_{ch4} \times D_{ch4} \times FE$$

Where:

$LFG_{flared,y}$ = Flow of landfill gas ($m^3$)

$w_{ch4}$ = Methane fraction in LFG (%)

$D_{ch4}$ = Temperature/(Pressure * R) ($kg/m^3$)

$FE$ = Flare efficiency (%)

### D.2.3. Treatment of leakage in the monitoring plan

#### D.2.3.1. If applicable, please describe the data and information that will be collected in order to monitor leakage effects of the project activity

| ID number *(Please use numbers to ease cross-referencing to table D.3)* | Data variable | Source of data | Data unit | Measured (m), calculated (c) or estimated (e) | Recording frequency | Proportion of data to be monitored | How will the data be archived? (electronic/ paper) | Comment |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | |
| | | | | | | | | |

Not applicable, there is no significant leakage in the project. See comment under D.2.3.2. below.

#### D.2.3.2. Description of formulae used to estimate leakage (for each gas, source, formulae/algorithm, emissions units of $CO_2$ equ.)

Only the construction of the LFG collection and utilization system will lead to some GHG emissions that would not have occurred in the absence of the project. These emissions are, however, insignificant. No increased in emissions are discernable other than those targeted and directly monitored by the project. Moreover, because the project employs direct monitoring of emission reductions, indirect emissions will not distort their calculation.

**D.2.4. Description of formulae used to estimate emission reductions for the project activity (for each gas, source, formulae/algorithm, emissions units of $CO_2$ equ.)**

The following formulae are used to calculate emission reductions for the project activity using the direct monitoring data measured and collected during the lifetime of the project:

$$ER_y = \left(MD_{project,y} - MD_{reg,y}\right) \times GWP_{CH4}$$

Where:

$GWP_{CH4}$ = Global Warming Potential of methane (IPCC, 1996)

$$MD_{project,y} = LFG_{flared,y} \times w_{ch4} \times D_{ch4} \times FE$$

Where:

$MD_{project,y}$ = Amount of methane actually **flared/destroyed** during year y

$LFG_{flared,y}$ = Flow of landfill gas ($m^3$)

$w_{ch4}$ = Methane fraction in LFG (%)

$D_{ch4}$ = Temperature/(Pressure * R) ($kg/m^3$)

$FE$ = Flare efficiency (%)

$MD_{reg,y}$ = Amount of methane flaring required in baseline (or **customarily** carried out for safety reasons)

Where:

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

$AF$ = Adjustment factor based on the project context, i.e. what fraction of methane is customarily flared for safety considerations.

| **D.3. Quality control (QC) and quality assurance (QA) procedures are being undertaken for data monitored** | | |
|---|---|---|
| Data *(Indicate table and ID number e.g. 3.-1.; 3.2.)* | Uncertainty level of data (High/Medium/Low) | Explain QA/QC procedures planned for these data, or why such procedures are not necessary. |
| *D-1* | Low | All the arriving waste at the landfill will be immediately weighed using a truck balance, with regular maintenance, and all the values recorded for future calculations |
| *D2-2* | Low | Flow meters will be subject to a regular maintenance and testing regime to ensure accuracy |
| *D2-3* | Low | Regular maintenance will ensure optimal operation of flares. Flare efficiency will be calibrated annually or more often, if significant deviation from previous efficiency rating is observed. |
| *D2-4* | Low | Gas analyzer will be subject to a regular maintenance and testing regime to ensure accuracy |
| *D2-5* | Low | Meters will be subject to a regular maintenance and testing regime to ensure accuracy. |
| *D2-6* | Low | Meters will be subject to a regular maintenance and testing regime to ensure accuracy. |
| *D2-7* | Low | This value is going to be calculated and recorded using the data that is directly collected and monitored at the site |
| *D2-8* | Low | This data will be determined from current industry practice. |
| *D2-9* | Low | This data will be determined from current legislation. |

**D.4 Please describe the operational and management structure that the project operator will implement in order to monitor emission reductions and any leakage effects, generated by the project activity**

As described before, the flaring station, where the emission reductions will actually happen, will be equipped with a measurement chain, which will allow direct daily measurement of the real amount of methane flared.

The management structures implemented in the Mogi Guaçu project are as follows:

**Daily Monitoring Records**: On the larger more active sites site staff takes daily gas field and engine readings. These readings are then checked for any anomalies before being filed for future reference. The readings can be taken at weekly or other set periods depending on the activity and consistency of the gas field and engine operation. All engines have telemetry links back to a central computer, which continually monitors the performance of the engine detecting problems and highlighting them for attention.

**Gas Field Monitoring Records**: Taken on a weekly basis or at periods to be determined. The Site Technician walks the gas field taking readings at each gas well and recording these on a form. These readings are then checked for any anomalies before being filed for future reference. A gas analyser will be installed in order to enable continuous accurate measurement of the methane content on the landfill gas. These gas field inspections will also observe occurrence of any unintended releases of landfill gas. In case unintended releases are observed, appropriate corrective action will be taken immediately.

**Routine Reminders for Site Technicians**: All Site Technicians are issued with a reminder list to guide them through their daily, weekly and monthly routine. The Engineering Manager, Operations Manager and Training and Health & Safety Co-ordinator go through this routine during site visits to ensure all aspects of the role are being performed. In addition monitoring records, oil sample reports and meter readings that are due, are checked to ensure they have arrived. Again, the telemetry link records a lot of the data automatically.

**Site Audits**: The Engineering Manager, Operations Manager and Training and Health & Safety Co-ordinator make regular site visits. In addition to ensuring the site routines are being performed any additional training needs are assessed and an audit is taken of any outstanding task on site.

**Outstanding Work Notice**: Following the Site Audit a ‘Plant Outstanding Works Notice’ is issued to the Site Technician listing all the jobs that the management team consider necessary to be undertaken. This is checked on subsequent site audits to ensure these jobs have been carried out.

**Calibration of measurement equipment:** Calibration of measurement equipment will be done monthly in accordance with the requirements of the National Measurement Regulation Agency, INMETRO (Instituto Nacional de Metrologia).

**Corrective Actions:** Management structure measures include procedures to handle and correct non-conformities in the implementation of the Project or this Monitoring Plan. In case such non-conformities are observed:

- An analysis of the nonconformity and its causes will be carried out immediately by landfill staff
- Landfill management will make a decision, in consultation with MaxAmbiental when needed, on appropriate corrective actions to eliminate the non-conformity and its causes.
- Corrective actions are implemented and reported back to Landfill management.

It will be assured that the landfill gas management team will receive support and appropriate training on the implementation of this Monitoring Plan and of the project

**D.5 Name of person/entity determining the monitoring methodology:**

**Paulo Braga, MaxAmbiental and**
**Xenex do Brasil, Ltda (see Annex 1)**

## SECTION E. Estimation of GHG emissions by sources

| | Emission Source | Greenhouse Gas | Validity | Quantity of Emissions (2006-2012) |
|---|---|---|---|---|
| Project Scenario | Landfill & LFG Flare | Methane | Yes. Due to collection and flaring inefficiencies some gas will not be destroyed. Hence there will still be emissions of LFG even after the project activity has been implemented. | **86,248 tonnes of $CO_2$e** |
| | LFG Flare | $CO_2$ | No. $CH_4$ emissions from the decay of biomass are not counted as anthropogenic GHG emissions | NA |
| | Equipment construction | Various | No. These are not considered to be “significant” in relation to overall emissions | NA |
| | On-site transportation | Various | No. On-site transportation of MSW would occur even in the absence of the project activity. | NA |
| Baseline Scenario | Landfill | Methane | Yes. Methane emissions from the anaerobic decomposition of MSW are considered to be additional. In the baseline scenario only 20% of LFG is captured and flared. | **318,501 tonnes of $CO_2$e** |

Figure E.1: Emission Sources

### E.1. Estimate of GHG emissions by sources:

Not applicable. Total project emissions are actually zero; there are neither project emissions nor leakage. The only discernable and significant difference between baseline and project emissions comes from the collection and destruction of methane contained in LFG, which is monitored and calculated directly. The only discernable yet insignificant (indirect) modification of emissions is associated with the physical construction of the project. To calculate emission reduction estimates baseline emissions only are estimated and then multiplied by the flaring inefficiencies and collection rates of the installed equipment.

### E.2. Estimated leakage:

Only the construction of the LFG collection and utilization system will lead to some GHG emissions that would not have occurred in the absence of the project. These emissions are, however, insignificant. No increased in emissions are discernable other than those targeted and directly monitored by the project. Moreover, because the project employs direct monitoring of emission reductions, indirect emissions will not distort their calculation.

### E.3. The sum of E.1 and E.2 representing the project activity emissions:

Project activity emissions are actually zero, as the project activity does not cause any GHG emissions by itself. Due to equipment inefficiencies it is estimated that there will still be a fraction of LFG released to the atmosphere. However, this is reflected in lower emissions reductions rather than in project activity emissions.

As the project aims to flare a large proportion of LFG produced, this percentage can be applied to the baseline emissions. In the case of the Mogi Guaçu landfill and as explained above, a collection and flaring efficiency of 75% has been estimated. This plus further adjustments are then applied to the baseline emissions calculated in Section E.4 to arrive at total emission reductions.

**E.4. Estimated anthropogenic emissions by sources of greenhouse gases of the baseline:**

**General Assumptions**

| Parameter | Value | Source |
|---|---|---|
| Global Warming Potential (GWP) of $CH_4$ | 21 | IPCC, 2001 |
| Amount of methane flared in baseline (AF) | 20% for safety reasons | Industry common practice |
| MCF – Methane Correction Factor for landfill | **1** for managed landfill | IPCC, 1996 |
| Density of methane | 0.000656 $tCH_4/m^3CH_4$ | Literature |
| Methane generation rate (k) | 0.1 $year^{-1}$ | US EPA/SCS Engineers |
| Potential methane generation capacity ($L_o$) | 164 $m^3$/tonne | US EPA/SCS Engineers |
| Methane content of LFG | 50% | IPCC, 1996 |
| Methane collection efficiency | 75% | Supplier |
| Insurance Adjustment Factor | 20% | MaxAmbiental |

**Waste Projections**

| Year | Daily Waste Disposal Rate (tonnes/day) | Waste added in Year (tonnes/yr) | Cumulative Waste-in-Place (tonnes) |
|---|---|---|---|
| 1985 | 44 | 16,200 | 0 |
| 1986 | 44 | 16,200 | 16,200 |
| 1987 | 44 | 16,200 | 32,400 |
| 1988 | 44 | 16,200 | 48,600 |
| 1989 | 44 | 16,200 | 64,800 |
| 1990 | 61 | 22,320 | 81,000 |
| 1991 | 61 | 22,320 | 103,320 |
| 1992 | 61 | 22,320 | 125,640 |
| 1993 | 61 | 22,320 | 147,960 |
| 1994 | 61 | 22,320 | 170,280 |
| 1995 | 74 | 27,000 | 192,601 |
| 1996 | 74 | 27,000 | 219,601 |
| 1997 | 74 | 27,000 | 246,601 |
| 1998 | 74 | 27,000 | 273,601 |
| 1999 | 74 | 27,000 | 300,601 |
| 2000 | 82 | 29,760 | 327,601 |
| 2001 | 82 | 29,760 | 357,360 |
| 2002 | 82 | 29,760 | 387,120 |
| 2003 | 82 | 29,760 | 416,880 |
| 2004 | 82 | 29,760 | 446,640 |
| 2005 | 83 | 30,295 | 476,400 |

**USEPA First Order Decay Model**

The estimation of baseline emissions is principally carried out to determine approximate gas volumes and by deduction emissions reductions. The following model is NOT part of the monitoring methodology per se, but rather suited for the **ex ante calculation** of potential emission reductions.

An assessment of the landfill gas generation of the Mogi Guaçu Landfill was carried out using the **USEPA's Landfill Air Emissions Estimation Model**, which is consistent with the more complex methodology recommended by the Intergovernmental Panel on Climate Change (IPCC) for calculating methane emissions from landfills. The assumptions applied were those successfully used by the Brazilian NovaGerar project, whose two landfills operate under similar conditions as the Mogi Guaçu landfill.

Model Inputs

The US EPA first order exponential decay model equation from the US EPA manual 'Turning a Liability into an Asset: **A Landfill Gas to Energy Handbook for Landfill Owners and Operators' (December 1994)** is as follows:

$$LFG = 2 \times L_o \times R \times \left(e^{-kc} - e^{-kt}\right)$$

Where:

LFG = total landfill gas generated in current year (m3)
$L_o$ = theoretical potential amount of landfill gas generated (m3/tonne)
R = waste disposal rate (tonnes/year)
t = time since landfill opened (years)
c = time since landfill closed (years)
k = rate of landfill gas generation (1/year)
MCF – Methane Correction Factor of 1 is used because Mogi Guaçu is a managed waste facility (1996 IPCC guidelines).

The site-specific inputs used were:

Waste disposal rate (R):
The Mogi Guaçu landfill received a total of approximately 476,000[76] tonnes of MSW between **1985 and 2005**. These data forms the foundation of the gas volume projection. This implies that the gas volume projection will vary accordingly. Therefore, even though gas volumes may fluctuate over a period of time because of varying disposal rates, the ultimate total volume of gas projected for the site will remain constant. The values used for R are shown in the waste projections table above.

Gas Generation Rate (k):
The gas generation rate for this site was determined based on specific ranges given for Brazilian landfills. The gas generation rate is influenced by the temperature, humidity and composition of the waste. A figure of **0.1** was used as recommended by SCS Engineers in a presentation on behalf of the US EPA in Sao Paulo, Brazil (Part 5: Evaluating Landfill Gas Potential, June 26 2001, Training Workshop for the US EPA Landfill Methane Outreach Program, Sao Paulo Brazil).

Theoretical Yield (Lo):
Another input into the computer model is theoretical maximum yield i.e. the total amount of landfill gas

[76] The total volume used in the LFG estimation is **476,400 tonnes** by the beginning of 2005.

that one metric tonne of waste is expected to generate over its lifetime (cubic meters per tonne of MSW). Lo is a variable dependent on the type of waste deposited and its organic content. Again estimates recommended by SCS Engineers in a presentation on behalf of the US EPA in Sao Paulo, Brazil (Part 5: Evaluating Landfill Gas Potential, June 26 2001, Training Workshop for the US EPA Landfill Methane Outreach Program, Sao Paulo Brazil) were used, and the value chosen was **164 m3/tonne**.

Time since landfill opened (t): These values varied depending on which site was being investigated. In the case of the Mogi Guaçu landfill the opening year was **1985**. Therefore the value used for t changed depending on which year landfill gas generation figures were being developed for.

Time since landfill closed (c): The landfill is scheduled to close in 2015.

The USEPA model was then applied to the specific case of the CTRPE landfill and using the parameters detailed above gas volumes were estimated. The results are in the following table.

| Project Emissions for 1st Crediting Period | | | | |
|---|---|---|---|---|
| **Year** | **Methane Production ($tCH_4$/yr)** | **Baseline CO2e Emissions ($tCO_2$e/yr)** | **$CO_2$e Emissions after project activity ($tCO_2$e/yr)** | **Net emissions reductions (tCO2e/yr)** |
| 2006 | 2,530 | 42,508 | 42,508 | 0 |
| 2007 | 2,600 | 43,674 | 13,648 | 23,540 |
| 2008 | 2,662 | 44,728 | 13,978 | 24,109 |
| 2009 | 2,719 | 45,683 | 14,276 | 24,623 |
| 2010 | 2,771 | 46,546 | 14,546 | 25,088 |
| 2011 | 2,817 | 47,327 | 14,790 | 25,509 |
| 2012 | 2,859 | 48,034 | 15,011 | 25,890 |
| **Total** | **18,958** | **318,501** | **128,756** | **148,760** |

**E.5. Difference between E.4 and E.3 representing the emission reductions of the project activity:**

After to accounting for registration fees and a 20% insurance factor, total emission reductions amount to **148,760 $tCO_2$e over the first 7-year crediting period**. For a summary of estimated results please see the table in E.6 below.

**E.6. Table providing values obtained when applying formulae above:**

| **Year** | **Estimation of baseline emissions (tonnes of $CO_2$e)** | **Estimation of project activity emissions (tonnes of $CO_2$e)** | **Estimation of gross emission reductions (tonnes of $CO_2$e)** | **Estimation of net emission reductions (tonnes of $CO_2$e)** |
|---|---|---|---|---|
| 2006 | 42,508 | 42,508 | 0 | 0 |
| 2007 | 43,674 | 13,648 | 30,026 | 23,540 |
| 2008 | 44,728 | 13,978 | 30,751 | 24,109 |
| 2009 | 45,683 | 14,276 | 31,407 | 24,623 |
| 2010 | 46,546 | 14,546 | 32,000 | 25,088 |
| 2011 | 47,327 | 14,790 | 32,537 | 25,509 |
| 2012 | 48,034 | 15,011 | 33,023 | 25,890 |
| **Total (tonnes of $CO_2$e)** | **318,501** | **128,756** | **189,745** | **148,760** |

## SECTION F. Environmental impacts

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

**This section needs to be completed with section that the project sponsor has yet to provide.**

**F.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:**

>>

## SECTION G. Stakeholders' comments

As with any CDM project activity PDD, this section will only be completed during the validation phase of the project cycle by the chosen Designated operational entity (DOE) and in cooperation with the relevant project participants. This section will reflect comments submitted pertaining to the **ACTUAL** project engineering plans.

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

>>

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

>>

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

>>

## Annex 1

**CONTACT INFORMATION ON PARTICIPANTS IN THE PROJECT ACTIVITY**

| | |
|---|---|
| Organization: | MaxAmbiental |
| Street/P.O.Box: | Avenida Brigadeiro Faria Lima, 2894 cj. 44 |
| Building: | |
| City: | São Paulo |
| State/Region: | SP |
| Postfix/ZIP: | 01452 938 |
| Country: | Brazil |
| Telephone: | +55 11 3709 3440 |
| FAX: | +55 11 3709 3446 |
| E-Mail: | |
| URL: | www.maxambiental.com.br |
| Represented by: | Paulo Braga |
| Title: | Director |
| Salutation: | |
| Last Name: | Braga |
| Middle Name: | |
| First Name: | Paulo |
| Department: | |
| Mobile: | +55 11 8271 3626 |
| Direct FAX: | +55 11 3709 3446 |
| Direct tel: | +55 11 3709 3440 |
| Personal E-Mail: | Paulo@maxambiental.com.br |

| | |
|---|---|
| Organization: | Xenex do Brasil, Ltda. – Project Developer |
| Street/P.O.Box: | Rua Manuel da Nobrega 354, cj. 82 |
| Building: | |
| City: | São Paulo, Paraiso |
| State/Region: | SP |
| Postfix/ZIP: | 04001 001 |
| Country: | Brazil |
| Telephone: | +55 11 3262 0854 |
| FAX: | |
| E-Mail: | xenexbr@nethall.com.br |
| URL: | |
| Represented by: | Junichi Ishihara |
| Title: | Director President |
| Salutation: | |
| Last Name: | Ishihara |
| Middle Name: | |
| First Name: | Junichi |
| Department: | |
| Mobile: | |
| Direct FAX: | |
| Direct tel: | |
| Personal E-Mail: | |

| | |
|---|---|
| Organization: | Banco Sumitomo Mitsui Brasileiro S.A.- Project Sponsor |
| Street/P.O.Box: | Avenida Paulista, 37 – 11th Floor |
| Building: | |
| City: | São Paulo |
| State/Region: | SP |
| Postfix/ZIP: | 01311 902 |
| Country: | Brazil |
| Telephone: | +55 11 3178 8129 |
| FAX: | +55 11 3178 8190 |
| E-Mail: | |
| URL: | www.smbcgroup.com.br |
| Represented by: | Hajime Uchida |
| Title: | Marketing Group – Japanese Corporate General Manager |
| Salutation: | |
| Last Name: | Uchida |
| Middle Name: | |
| First Name: | Hajime |
| Department: | |
| Mobile: | |
| Direct FAX: | |
| Direct tel: | |
| Personal E-Mail: | Hajime_uchida@smbcgroup.com.br |

## Annex 2

**INFORMATION REGARDING PUBLIC FUNDING**

The project will not receive any public funding from Parties listed in Annex I of the UNFCCC.

# ANNEX 3

## BASELINE INFORMATION

**Project Cashflow 1**

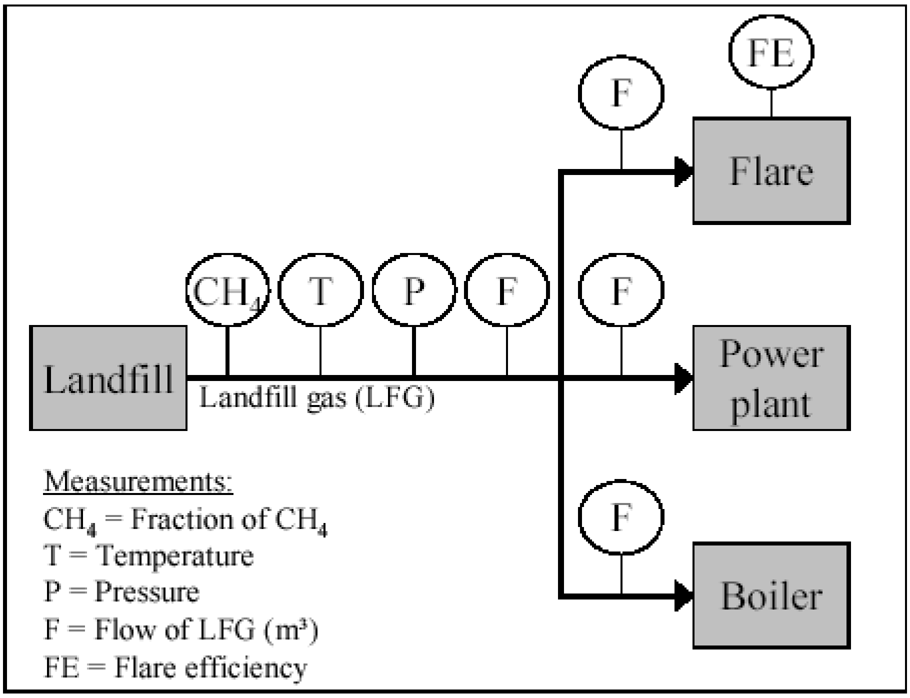
**Landfill/Project Name:** **Mogi Guacu**

| | Unit | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|---|---|
| | | 1st | 2nd | 3rd | 4th | 5th | 6th | 7th |
| Carbon Cashflow | | | | | | | | |
| Total LFG emitted | m3/h | 881 | 905 | 927 | 946 | 964 | 980 | 995 |
| Carbon CF | | | | | | | | |
| Total Adj. Net Emission Reductions | Tonnes CO2e/yr | 0 | 23,540 | 24,109 | 24,623 | 25,088 | 25,509 | 25,890 |
| Cost | | | | | | | | |
| Annual Operation Cost | | -12,552 | -12,552 | -12,552 | -12,552 | -12,552 | -12,552 | -12,552 |
| Annual Mentenance Cost | | -12,000 | -12,000 | -12,000 | -12,000 | -12,000 | -12,000 | -12,000 |
| Validation & Verification Cost | | | -5,000 | -5,000 | -5,000 | -5,000 | -5,000 | -5,000 |
| Adaptation Fee/CER | US$0.2 | | -4,708 | -4,822 | -4,925 | -5,018 | -5,102 | -5,178 |
| Electricity Generation Cost | US$70.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Depreciation | | -44,088 | -44,088 | -44,088 | -44,088 | -44,088 | -44,088 | -44,088 |
| Interest | | -29,392 | -27,162 | -24,799 | -22,293 | -19,637 | -16,822 | -13,838 |
| Total Cost | | -98,033 | -105,511 | -103,261 | -100,858 | -98,295 | -95,564 | -92,656 |
| | | | | | | | | |
| Income | | | | | | | | |
| Price of CER | US$/tCO2 | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 |
| CER Sales | | 0 | 188,322 | 192,869 | 196,983 | 200,706 | 204,075 | 207,123 |
| Electricity Tariff | US$/MWh | 50.0 | 50.0 | 50.0 | 50.0 | 50.0 | 50.0 | 50.0 |
| Electricity Sales | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Income | | 0 | 188,322 | 192,869 | 196,983 | 200,706 | 204,075 | 207,123 |
| | | | | | | | | |
| Balance | | -98,033 | 82,811 | 89,608 | 96,126 | 102,411 | 108,511 | 114,467 |
| Income Tax | | 0 | -28,156 | -30,467 | -32,683 | -34,820 | -36,894 | -38,919 |
| Current Income | | -98,033 | 54,655 | 59,142 | 63,443 | 67,592 | 71,617 | 75,548 |
| | | | | | | | | |
| NPV(21years) | 1,146,637 | | | | | | | |
| IRR(21years) | 19.5% | | | | | | | |

**Annex 4**

**MONITORING PLAN**

The monitoring plan for the Carapicuíba LFG Flaring project activity is based on the monitoring methodology of ACM0001. The following diagram is provided.




Please note that for this project activity there is no boiler or power plant but only a flare.

The principal variables that need to be calculated for monitoring purposes are as follows:

1. $MD_{project, y}$ for every project year
2. $MD_{reg, y}$ for every project year

The input data required for this will be stored in the following spreadsheet and archived for at least two years after the end of the crediting period or the last issuance of CERs for this project activity whatever occurs later.

# Monitoring Plan for Mogi Guaçu Landfill gas capture and flaring project

| **Year** | **Units** | **Measurement** | **2006** |
|---|---|---|---|
| **Project Year** | | | **1** |
| | | | |
| **Total amount of LFG flared** | **m3** | **Flow Meter** | |
| | | | |
| Methane content of exhaust gas | m3 CH4/m3 ExGas | Gas analyzer | |
| Operation time of flare | hours | Flare | |
| **Flare Combustion Efficiency** | **%** | **Calculated** | |
| | | | |
| **Methane content of landfill gas** | **m3 CH4/m3 LFG** | **Gas analyzer** | |
| | | | |
| Temperature of LFG | Degree Celsius | Manifold | |
| Pressure of LFG | Pa | Manifold | |
| **Density of methane** | **tonnes CH4/m3 CH4** | **Calculated** | |
| | | | |
| **Regulatory requirements relating to LFG projects** | | | |

## Annex 5

### ELECTRICITY GENERATING OPTION

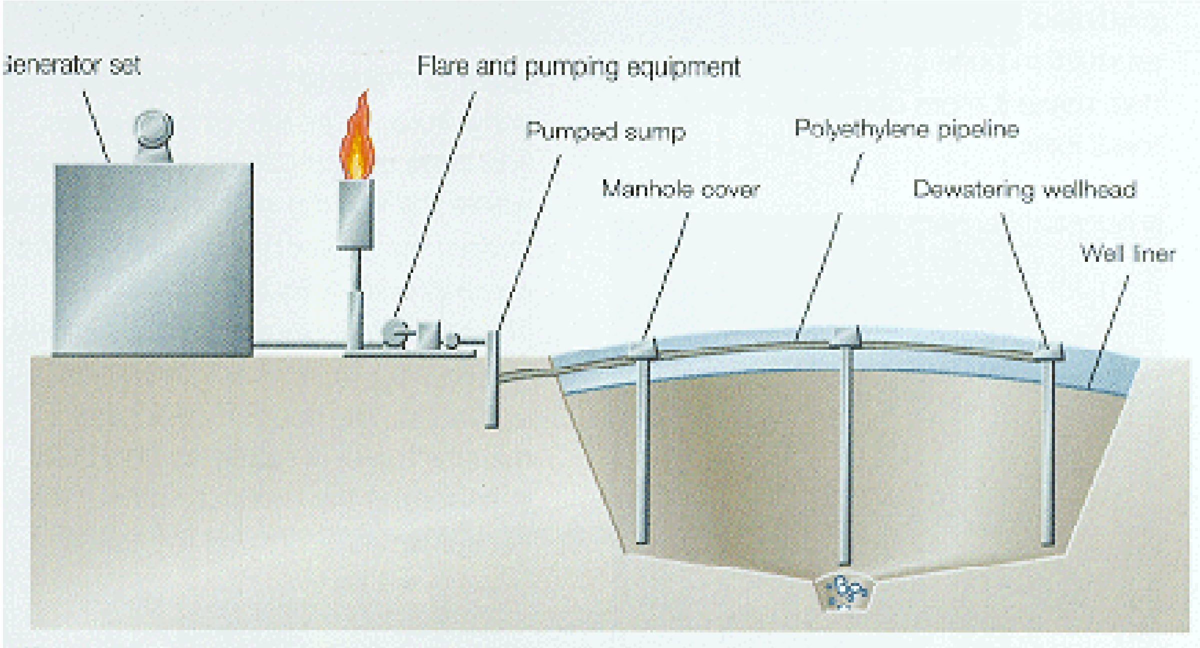
Annex 5: Electricity Generation Potential – Mogi Guaçu Landfill

| **Electricity Generation** | | **Mogi Guacu** | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Unit | **2006** | **2007** | **2008** | **2009** | **2010** | **2011** | **2012** |
| | | 1st | 2nd | 3rd | 4th | 5th | 6th | 7th |
| Carbon Cashflow | | | | | | | | |
| Total LFG emitted | m3/h | 881 | 905 | 927 | 946 | 964 | 980 | 995 |
| Carbon CF | | | | | | | | |
| Total Adj. Net Emission Reductions | Tonnes CO2e/yr | 0 | 23,540 | 24,109 | 24,623 | 25,088 | 25,509 | 25,890 |
| Electricity Generation(MWh) | | 0 | 7,733 | 7,920 | 7,972 | 7,972 | 7,972 | 7,972 |
| Cost | | | | | | | | |
| Annual Operation Cost | | -12,552 | -12,552 | -12,552 | -12,552 | -12,552 | -12,552 | -12,552 |
| Annual Mentenace Cost | | -12,000 | -12,000 | -12,000 | -12,000 | -12,000 | -12,000 | -12,000 |
| Validation & Verification Cost | | | -5,000 | -5,000 | -5,000 | -5,000 | -5,000 | -5,000 |
| Adaptation Fee/CER | US$0.2 | | -4,708 | -4,822 | -4,925 | -5,018 | -5,102 | -5,178 |
| Electricity Generation Cost | US$70.0 | 0 | -541,304 | -554,375 | -558,012 | -558,012 | -558,012 | -558,012 |
| Depreciation | | -44,088 | -44,088 | -44,088 | -44,088 | -44,088 | -44,088 | -44,088 |
| Interest | | -29,392 | -27,162 | -24,799 | -22,293 | -19,637 | -16,822 | -13,838 |
| Total Cost | | -98,033 | -646,815 | -657,635 | -658,870 | -656,307 | -653,576 | -650,668 |
| | | | | | | | | |
| Income | | | | | | | | |
| Price of CER | US$/tCO2 | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 |
| CER Sales | US$8.0 | 0 | 188,322 | 192,869 | 196,983 | 200,706 | 204,075 | 207,123 |
| Electricity Tariff | US$/MWh | 50.0 | 50.0 | 50.0 | 50.0 | 50.0 | 50.0 | 50.0 |
| Electricity Sales | US$50.0 | 0 | 386,646 | 395,982 | 398,580 | 398,580 | 398,580 | 398,580 |
| Total Income | | 0 | 574,968 | 588,851 | 595,563 | 599,286 | 602,655 | 605,703 |
| | | | | | | | | |
| Balance | | -98,033 | -71,847 | -68,784 | -63,306 | -57,021 | -50,921 | -44,965 |
| Income Tax | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Current Income | | -98,033 | -71,847 | -68,784 | -63,306 | -57,021 | -50,921 | -44,965 |
| | | | | | | | | |
| NPV(21years) | 6,363 | | | | | | | |
| IRR(21years) | #DIV/0! | | | | | | | |

**Electricity Market Situation in Brazil**

Other than financial return from the carbon market, the only potential revenue to the project derives from the use of gas to produce electricity. The feasibility of this project is, thus, dependent on factors related to energy sector. It is necessary to conduct a financial analysis to determine whether the project is an economically attractive course of action.

Historically, tariff levels in Brazil have been relatively low due to a centralized pricing structure fixed by the government. The government agency ANEEL (Electric Energy National Agency) controls the commercialisation and distribution of through pre-established contracts and prices. While small tariff increases have been observed in the last few years, they are insignificant and not enough to indicate that this scenario is going to change significantly. A free electricity market in Brazil is still in its infancy.




Typical landfill gas extraction and flaring plant arrangement

Source: http://europa.eu.int/comm/energy_transport/atlas/assets/images/Image71.gif

In addition to this electricity generation using landfill gas cannot rely on offsetting carbon income. Due to its enormous hydropower capacity Brazil's energy sector already has low carbon intensity and a correspondingly low carbon emission factor. There is also a lack of governmental pricing policies to support projects that replace fossil energy with new sources of clean energy.

The generation of electricity from landfill gas in Brazil carries several risks. There are clear managerial risks owing to the fact that few landfill operators have the requisite skills and expertise to negotiate long-term power purchase agreements. Moreover, there is considerable uncertainty attached to the production of landfill gas and hence to the reliability of electricity supply. Several external factors such as precipitation levels, waste composition and temperatures can severely impact gas production levels. Most of the required generation technology needs to be imported from international companies, which exposes the project to potential adverse changes in the exchange rate. Given these risks, electricity generation from landfill gas is seen as 'unproven' technology by local investors.

**Mogi Guaçu Generation Potential and Financial Analysis**

A financial analysis was undertaken using assumptions that are highly conservative from the point of view of gas production. It needs to be noted that the landfill gas generation model used, the US EPA First Order Decay Model, has an inherent error up to 50%. A value of 4.95 kWh/m3 was used for the energy content of landfill gas. This number presents an accepted average and was also used in the calculation of the energy potential of the NovaGerar CDM project. According to the estimates used, the Mogi Guaçu landfill will produce 57,799,929 $m^3$ of landfill gas between the start of the project in 2006 and the end of the first Kyoto Commitment Period in 2012. It is important to bear in mind that this number is purely an **estimate** and actual volumes could be considerably lower.

Taking into account a generator efficiency of 38%[77] (industry average for LFGTE generator sets from companies such as Caterpillar and Jenbacher), a methane collection efficiency of 75%, and insurance factor of 20%, a parasitic loss factor of 5% and 91% generator availability, it is estimated that between 2006 and 2012, approximately 56,394 MWh of electricity will be produced by the Mogi Guaçu landfill.

Source: **www.dti.gov.uk/.../nr47/html/landfill_gas.htm**

The US EPA estimates that levelized capital and O&M costs per kWh of landfill gas derived electricity are about 7 cents or US$70/MWh[78]. This is of course only an estimate, but to arrive at more accurate numbers it would be necessary to undertake a more detailed study. For the purpose of this assessment it was deemed to be sufficient to use a generally accepted factor. Given that LFGTE is already an established industry in the US, it is likely that costs in Brazil would be even higher as they would have to factor in importation costs as well as FOREX risk and additional expenses related to lack of experience. At the same time the price currently offered to small producer of electricity by the Brazilian regulatory authority (ANEEL) is only U$58.4/MWh (as of November 2005 the tariff was fixed at R$146.00 and assuming a long-term exchange rate of 2.50 R$/US$). Comparing the costs and revenue per MWh it becomes clear that at the current time it is not financially viable to undertake Landfill gas to Energy projects in Brazil.

In addition to this the CERs that could be earned from the displacement of fossil-derived electricity

77 http://www.ge-energy.com/prod_serv/products/recip_engines/en/downloads/type2_en.pdf

78 http://www.forester.net/mw_0401_retail.html

through the generation of carbon neutral LFG energy are not sufficient to offset the estimated losses. The South-Southeast-Midwest electricity grid has a generally accepted Carbon Emission Factor of 0.249 tCO2e/MWh[79], which is relatively low. Between 2006 and 2012 the Mogi Guaçu landfill project is hence estimated to generate a net amount of 14,042 tCO2e. At a price of US$10/CER, the electricity-related carbon component is not sufficient to offset the high generating costs/low electricity tariffs.

Therefore for the Mogi Guaçu landfill the NPV of the electricity and related carbon components over 7 years comes to **negative US$1,401,647**. Thus the generation of electricity is currently not considered to be an option for the Mogi Guaçu CDM project.

[79] This CEF has been approved by the Brazilian Designated National Authority