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

## CONTENTS

## SECTION A. General description of project activity

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

*Alto-Tietê* landfill gas capture project

Version 06. PDD completed on 13/12/2007.

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

The Project activity aims to extract the landfill gas (LFG) produced at the *Itaquaquecetuba* landfill by means of using a gas collection and gas flaring system. In contrast to the project activity, the baseline scenario shows a landfill operating only with a passive ventilation system.

The implementation of the project activity foresees the interconnection of the current and future vertical drains ended up by a gas pumping equipment through aerial horizontal tubing. At this point two torches will be installed in order to burn the extracted gases. Through this process, the oxidation of the methane generates $H_2O$ and $CO_2$ gases that will be monitored, measured and controlled directly on site. Finally, the income generated from the CER sales will make possible to eliminate the barriers preventing the implementation of this project.

The landfill is currently operated by the *Empreiteira Pajoan Ltd*, (hereafter referred to as *Pajoan Ltd*) a private landfill operator company. The landfill was the second private site licensed in the State of *Sao Paulo*, attending around 1,670,000 inhabitants and providing high quality waste management services. Moreover, the proposed project activity is conducted by *Alto Tietê Biogás Redução de Emissões e Geração de Energia LTDA.* (listed as Project Participant), which is a private company created exclusively to manage and assess the CDM project activity.

The *Alto-Tietê* landfill was opened on March 2000 and was designed to manage waste type class 2, 3 (non-hazardous waste). The waste disposition area is of 500,000 $m^2$ from a total surface of 884,000 $m^2$, being 2,319 $m^2$ of constructed areas, were now is central office and the area for equipments storage. Currently, the landfill receives around 600,000 tones of waste per year (1,500 tonnes/day) from the metropolitan area of *São Paulo*. The release of landfill gas at the baseline scenario brings negative impacts to the quality of the environment and to the health of the local inhabitants, also increasing risks of explosions. Furthermore the *Alto-Tietê* project can be seen in association with a large program of rationalization and management of urban waste collection, initiated by the *Itaquaquecetuba* municipality and its influence area, to manage the growing development of the local economy. The project activity will improve the waste handling and waste management of many small municipalities, industries and commercial establishments within the *São Paulo* State.

In addition to its efforts in reducing the levels of GHG emissions, the project activity promotes local sustainable development as it foresees the creation of jobs in different fields associated with the project activity operation (i.e., garbage selection, flare operations and waste management) and the further possibility of energy generation from a renewable source.

Moreover, the project activity will strength the already in place social responsibility programs, such as environmental education, construction of sport facilities, afforestation activities (tropical forest conservation) and reforestation with native species. The already ongoing reforestation plan covers an area of 55,400 $m^2$ and makes use of native species coming from a sampling nursery built at the landfill premises. The native species produced are also distributed for use at local schools and green public areas.

## A.3. Project participants:

| Name of the Party involved | Private and/or public entity (ies) project participants | Kindly indicate if the Party involved whishes to be considered as project participant |
|---|---|---|
| UK | *Carbon Capital Markets Ltd.* | No |
| Brazil (Host Country) | *Alto Tietê Biogás, Redução de Emissões e Geração de Energia Ltda.* | No |

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

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

The landfill is located at the Municipality of *Itaquaquecetuba*, northeast of *Sao Paulo* State, in the *Alto Tietê* Region.

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

Brazil.

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

*Sao Paulo* State. Southeast Brazil.

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

*Itaquaquecetuba.*

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

*Nossa Senhora das Graças* Avenue, *599*, *Jardim Pinheirinho*, *Itaquaquecetuba/SP*, Brazil, ZIP: 08589-140. The geographical coordinates are Latitude South: 23°26'00'' and 23°26'20'', Longitude West: 46°17'30" and 46°17'45".

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

The sectoral scope for the project activity is waste handling and disposal (Sectoral number 13).

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

The LFG is composed primarily of carbon dioxide and methane and, in minor degree of additional trace constituents such as hydrogen sulphide, mercaptans, vinyl chloride, and numerous other non methanic volatile organic compounds (NVOCs). The production of LFG is a consequence of a methanogenesis reaction influenced by the composition and moisture of the waste present at the landfill, the absence of oxygen and toxics, a relatively neutral waste moisture pH, 6.7 - 7.2, and an appropriate internal temperature.

At the first phase, the project activity begins with the installation of a gas collection and flaring system (enclosed flares) through a network of pipes connected to the wellheads at the already ongoing cells. The second phase foresees the infrastructure of the gas extraction and flaring system at the new cells in parallel to the waste disposal.

The gas collection system will mainly be composed by the following elements:

- Vertical progressive drains to extract gas made on PVC perforated material. The drains are equipped with gas sensors (sampling points) to monitor the LFG flux and quality in order to analyse the trace gases.

- Horizontal drains (HDPE type) are installed each 4 meters high to maximize the extraction efficiency; the project activity forecasts an intensive use of these horizontal wells on the shallow areas to increase gas yields and to reduce the number of wells required for proper gas pumping.

The pipes used for the gas network system (HDPE) are placed down on slope downwards to the water-collection points. By doing so, the condensate can be drained away by gravity. Attached to the vertical progressive drain, a sampling point will regulate and monitor the LFG passing through.

The LFG must be condensed and stored on the lowest collecting points for further decantation and pumping. At the flare point, the combustion temperature is controlled to achieve a value range from 700°C to 1,000°C during 0.3 seconds of retention time for 50% methane content on the landfill gas. Eventually the enclosed flare must allow a homogeneous temperature distribution across the combustion chamber at the flare.

The monitoring and control equipment will optimize the LFG pressure, volume and temperature at the flare inlet for the best burning efficiency. According to the Brazilian environmental regulations on flaring gas emissions, the flare operation must ensure that emissions on carbon monoxide (CO), oxides of nitrogen ($NO_x$) and unburned hydrocarbons are kept under standard values.

Since the landfill gas extraction and management is not compulsory in Brazil, many landfill components are not present at the Brazilian market, such as control and monitoring equipment, LFG treatment and high efficient flare. However, local technology for the project activity will be used, where possible. The latter applies for the components used on the vertical/horizontal drains, gas network and pumps which are made in Brazil.

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

| Year | Annual estimation of emission reductions in tonnes of $CO_2$equ |
|---|---|
| March 2008- Feb 2009 | 354,776 |
| March 2009- Feb 2010 | 396,399 |
| March 2010- Feb 2011 | 438,048 |
| March 2011- Feb 2012 | 479,900 |
| March 2012- Feb 2013 | 522,128 |
| March 2013- Feb 2014 | 564,779 |
| March 2014- Feb 2015 | 608,138 |
| **Total estimated reductions ($tCO_2$ equ.)** | 3,364,168 |

| | |
|---|---|
| Total number of crediting years | 7 |
| **Annual average over the crediting period of estimated reductions (tonnes of $CO_2$ equ.)** | 480,595 |

Table 1: Estimated emission reductions during the crediting period.

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

No public financing for the project activity.

## SECTION B. Application of a baseline and monitoring methodology

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

The approved baseline methodology ACM0001 Version 05: "Consolidated baseline methodology for landfill gas project activities". The project activity relates to the sectoral scope "Waste handling and disposal".

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

This methodology is applicable to landfill gas capture project activities, where the baseline scenario is the partial or total atmospheric release of the gas. The proposed project activity does not consider the energy (electricity and/or thermal) generation, therefore no emission reductions are claimed from this source. The only source claimed in this project will be the flaring of the capture gas from the landfill.

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

For the *Alto-Tietê* landfill there is only one primary source of $CO_2$ emissions within the boundary of the project activity. The emissions are due to the use of electricity in extracting and pumping the landfill gas.

In the baseline ex-ante emissions calculations, 30% is considered as LFG not captured and 2% not flared by the technology (efficiency 98%). This emissions sum 3,364,168 tCO2equ for the period of March 2008- February 2015. The emissions of $CO_2$ in the flaring equipment of extracting and pumping of the landfill gas, is based on an electricity based pump system with 30kW resulting a total of 27.40 tCO2e/year.

| | Gas | Source | Included? | Justification |
|---|---|---|---|---|
| **Baseline** | $CO_2$ | Waste | No | Emissions from biomass that can be defined as zero |
| | $CH_4$ | Waste | Yes | Anaerobic decay of the biomass |
| | $N_20$ | Waste | No | Emissions from biomass that can be defined as zero |
| **Project Activity** | $CO_2$ | Flaring equipment | Yes | Emissions from the use of electricity in extracting and pumping the landfill gas |
| | $CH_4$ | Flaring equipment | Yes | Methane capture and flaring with efficiency of 98% |
| | $N_20$ | Flaring equipment | No | Emissions from biomass combustion that can be defined as zero |

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

According to the National Inventory of Greenhouse Effect Gas Emission conducted by CETESB[1] in 1994, Brazil has more than 6,000 garbage dumping sites that receive more than 60,000 tons of garbage per day.

Related to the same study, the 76% of the total waste amount produced currently in Brazil is disposed in unmanaged "dumping sites", 12% on basic landfills, 10% on controlled landfills (sanitary landfills) and 2% on other disposal ways (see table 2). Moreover, the ABETRE (Brazilian Association for Waste Treatment) estimates nearly 3 millions tonnes of industrial waste are disposed on uncontrolled dump sites and only the 20% are disposed under some technical regulations. Overall figures show that 84% of methane emissions in Brazil are from unmanaged waste dumpsites.

| Final waste destination | Percentage | Source |
|---|---|---|
| Open Dump | 76 % | *CETESB*[2] |
| Controlled landfill | 12 % | *CETESB* |
| Sanitary landfill | 10 % | *CETESB* |

*Table 2: Final waste deposition in Brazil.*

The current Brazilian legislation does not require an efficient treatment of the LFG generated besides gas venting (passive ventilation). In spite of the guidelines provided by the Brazilian Association of Technical Norms (ABNT), there are no binding regulations for the technical conditions of LFG recovery systems in Brazil.

The baseline scenario shows the atmospheric release of the LFG gas with no regulations and/or contractual requirements governing the landfill gas emissions. For the *Alto-Tietê* landfill, the baseline scenario represents a basic LFG ventilation system currently ongoing under no basic flaring at the wellhead. In opposite, the project activity foresees, as defined on section B.6.4, a total GHGs (green house gases) emissions reduction of 3,364,168 tonnes of $CO_2$equ.

The baseline scenario relates to the waste management activities currently ongoing on the *Alto-Tietê* landfill operated by the project developer, *Pajoan Ltd*. The sanitary landfill currently serves a total population of 1,500,000 inhabitants, gathering the cities of *Arujá, Carapicuíba, Ferraz de Vasconcelos, Itaquaquecetuba, Mairiporã, Mogi das Cruzes, Poá, Suzano* and *São Paulo* (only commercial waste).

The core business of *Pajoan* is the control and management of the waste disposition of municipal and commercial waste in an environmental sustainable way. No hazardous waste material is on place, in compliance with the Brazilian technical standard 10-0004 for such landfill type.

Under this scenario the company operates a landfill based on a simple landfill gas venting system that releases the LFG generated as a consequence of the anaerobic decomposition of the waste. The *Alto-Tietê* landfill covers an approximate surface of 500,000 m² and sanitary cells of 5 meters depth with a bottom covered by a PVC coating to avoid leachate leakage into the freatic layers.

The leachate is being treated by a sanitary service provider, *SABESP*[3]. Furthermore, a processing plant (aerobic lagoon) was implemented with the following characteristics:

[1] *CETESB (Environmental and Sanitation Company of the São Paulo State)*

[2] *Methane emissions from waste treatment and waste disposal in Brazil, MCT.*

1. Sludge sedimentation and blending.
2. Physic-Chemical treatment stage.
3. Biological (bacterial) treatment stage, aerobic treatment (lagoon).
4. Water free sludge decantation.
5. Decanted water goes to treatment plant for recycling.
6. Recycled water is returned to the natural watercourse (local stream course, *Taboãozinho*).

Moreover, a waste recycling facility was build, the equipments covers about 10% of the daily waste in (1,500 tonnes/day).

In opposition to the business as usual scenario (BAU), the project activity will capture and flare the landfill gas through forced gas exhaustion. The proposed project activity is covered and defined under the applicability of the ACM0001 methodology.

On Table 3, project data relating to the baseline scenario.

| Variable | Units | Definition | Value | Data Source |
|---|---|---|---|---|
| k | (1/yr) | Methane generation rate | 0.09 | *Pajoan Ltd (see Annex 3)* |
| $L_o$ | $m^3$/ Mg | Methane generation potential | 132.5 | *Pajoan Ltd (see Annex 3)* |
| MCF | -- | Methane correction factor | 1 | IPCC Guidelines, 1996 |
| $R_{x,y}$ | Mg | Daily waste in at the landfill | 1,500 | *Pajoan Ltd* |
| $O_d$ | Year | Opening date of the landfill | 2000 | *Pajoan Ltd* |
| $C_d$ | Year | Closing date of the landfill | 2020 | *Pajoan Ltd* |
| FE | % | Flaring efficiency | 98 | *Pajoan Ltd* |
| EE | % | Extraction efficiency | 70 | *Pajoan Ltd* |
| $W_{CH4,y}$ | $m^3$ $CH_4$ / $m^3$ LFG | Average methane fraction of the landfill gas | 0.5 | IPCC Guidelines, 1996 |

*Table 3. Key project variables and data used to determine the baseline scenario.*

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

This chapter is constructed based on the document: "Tool for the demonstration and assessment of additionality" version 03, as defined from the 29th Meeting of the Executive Board.

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

The Brazilian Association for Waste treatment, Recycling and Management (*ABETRE*) states that no legislation will/may be prescribed in the future obliging LFG flaring within the next 10 years in Brazil[4]. Therefore there are no current specific regulations governing LFG flaring and it is not expected to have any regulation within the near future.

[3] *São Paulo state sanitation company www.sabesp.com.br*

[4] *The letter was sent by ARBETRE to ONYX relating the CDM project "Projeto Onyx de Recuperação de Gás de Aterro" approved the 9th September of 2005 by the Brazilian DNA.(http://www.mct.gov.br/clima/cigmc/projaprov.htm)*

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

Definition of possible/potential alternatives to the project activity:

| ALTERNATIVE 1 |
|---|
| **Continuation of the current situation**<br>**Business as usual in Brazil**<br><br>This scenario defines the business as usual in Brazil. The current regulations oblige passive venting in order to avoid potential risk of explosion. Under this scenario, the project developer would continue to use a venting system for safety reasons as conformed by the regulations. |

| ALTERNATIVE 2 |
|---|
| **The proposed project activity not undertaken as a CDM project activity**<br>**Landfill gas is extracted and flared, with no use or energy generation.**<br><br>Under this alternative, *Pajoan Ltd* will invest on the implementation of a gas collection, flaring and monitoring system. The technology to be employed presents the following characteristics:<br>▪ Use of a collection piping system, installed to convey the landfill gas from the well network to the blower/flare/evaporator station.<br>▪ Use of a leachate evaporator (EVAP), which uses landfill gas as a fuel/heat source to evaporate leachate collected from the lined disposal areas.<br>▪ Use of an enclosed flare that serves as an after burner to assure the thermal destruction of NVOC's (Non volatile organic compounds) and to control odours.<br>▪ Use of a control system to outfit flare and evaporator with an automatic safety and monitoring controls of the waste disposal and of the GHGs, such as $CO_2$, $CH_4$, $N_2O$, $NO_x$ and CO gases.<br><br>The total investment for the project activity is estimated on USD 2,311,983. The investment would not have any financial return. Under the current Brazilian legislation for landfill gas management this scenario has no advantages for the landfill operator and is not economically feasible. |

| ALTERNATIVE 3 |
|---|
| **Credible alternatives to the project activity that deliver outputs and on services**<br>**LFG commercial use off-site**<br><br>Upgrading the landfill from the current scenario (passive venting) into a natural gas producer scenario will face high investment cost for the gas capture and treatment phase. Therefore, the project is economically and technically not interesting for the project developer. |

| ALTERNATIVE 4 |
|---|
| **Credible alternatives to the project activity that deliver outputs and on services**<br>**Landfill gas is extracted for energy generation**<br><br>The landfill gas will be captured and flared for commercial purposes (energy generation). This option foresees the installation of an electric generation system based on LFG. Moreover an electrical transformer of 12.5kVA will be necessary to step up the energy generated for the local transmission lines, specially built for the project.<br><br>However the high investment cost surrounding the landfill gas treatment stage (gas quantity and quality) brings the generation cost into uncompetitive market prices. Moreover, the fact that the energy generation is not on the core business of the landfill operator and the uncertainty to secure a fare selling price for the energy results on a high risk and unprofitable activity. It would represent a non attractive option for the landfill operator. |

***Sub-step 1b. Consistency of applicable laws and regulations:***

There is no landfill gas extraction and/or flaring system on site, only a passive ventilation system attending all applicable legal requirements and therefore all its necessary licenses in date. Potential alterations in the possible future of the baseline will be followed by the monitoring plan elaborated for the project.

There are no specific laws governing LFG mitigation in Brazil. Nevertheless local environmental agencies at state level are acting towards closing rubbish dumps and forcing municipalities and industries to give proper destination to the waste generated through concessions to private entities. In all cases, however, active collection and flaring of the landfill gas has never been enforced by law. In addition, all of the identified scenarios are in consistency with the applicable laws and regulations.

**Step 2. Investment analysis.**

This step is to determine whether the proposed project activity is economically or financially less attractive than at least one other alternative, identified in step 1, without the revenue from the sale of certified emission reductions (CERs). To conduct the investment analysis, the following sub-steps is applied:

***Sub-step 2a. Determine appropriate analysis method***

The proposed project activity does not generates financial or economic benefits other than CDM related income, therefore the Option I – Simple cost analysis shall be applied.

***Sub-step 2b – Option I. Apply simple cost analysis.***

The *Alto-Tietê* landfill has currently no LFG flaring system installed. The installation of a LFG capture and flaring system, even an undeveloped one, would require costs for the landfill operator with no sort of financial compensation. On table 4 below, the costs associated with the CDM project activity are specified.

The investment costs for the LFG collection system are proportional to the landfill surface, cell dimensions, waste volume and the landfill topography.

| BIOGAS CAPTURE AND FLARING IMPLEMENTATION COST | | | | | |
|---|---|---|---|---|---|
| **Item #** | | **Description** | **Amount** | **Unit** | **Total (US$)** |
| **1** | **Invoice for projects and environmental license** | | | | |
| | 1.1 | Civil works and Environmental license | 1.00 | -- | 103,841.73 |
| | | | | **Sub-total** | **103,841.73** |
| **2** | **Gas drain and gas capture** | | | | |
| | 2.1 | Auxiliary vertical drains | 2,000.00 | Meters | 186,915.11 |
| | 2.2 | Primary network | 3,000.00 | Meters | 349,039.04 |
| | 2.3 | Secondary network | 8,000.00 | Meters | 690,339.81 |
| | | | | **Sub-total** | **1,226,293.97** |
| **3** | **Gas management** | | | | |
| | 3.1 | Gas collection point | 1.00 | Unit | 186,981.56 |

| | | | | | |
|---|---|---|---|---|---|
| | 3.2 | Gas filter | 3.00 | Unit | 462,388.109 |
| | 3.3 | Civil works | 1.00 | -- | 80,921.78 |
| | | | | **Sub-total** | **730,291.45** |
| **4** | **Gas flaring** | | | | |
| | 4.1 | Decantation network | 500.00 | Meters | 50,659.19 |
| | 4.2 | Burners | 1.00 | Un | 200,896.98 |
| | | | | **Sub-total** | **251,556** |
| **Total (US$): 2,311,983** | | | | | |

*Table 4. Cost related to the CDM project activity.*

Under this scenario (investment with no financial returns) the project activity produces no economic benefits and therefore is not financially attractive without the CDM revenue stream (as defined on *Sub-step 2b*).

**Step 4. Common practice analysis**

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

There is not a similar project activity implemented previously or currently underway (other than CDM project activities) in Brazil.

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

No similar activities as the project activity are carried out in Brazil out of the CDM.

## B.6. Emission reductions:

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

The greenhouse gas emission reductions achieved by the project activity during a given year "y" (ERy) are estimated as follows (Equation 1):

$$ER_y = (MD_{project,y} - MD_{reg,y}) * GWP_{CH4} + EL_y \cdot CEF_{electricity,y} - ET_y * CEF_{thermal,y}$$

(Equation 1)

Where:

| | |
|---|---|
| $ER_y$ | Is emissions reduction, in tonnes of $CO_2$ equivalents ($tCO_2e$). |
| $MD_{project,y}$ | Amount of methane that would have been destroyed/combusted during the year, in,tonnes of methane ($tCH_4$) |
| $MD_{reg,y}$ [3] | Amount of methane that would have been destroyed/combusted during the year in the absence of the project, in, tonnes of methane ($tCH_4$) |
| $GWP_{CH4}$ | Global Warming Potential value for methane for the first commitment period is 21 $tCO_2e/tCH_4$ |
| $EL_y$ | Net quantity of electricity exported during year y, in megawatt hours (MWh). |

| | |
|---|---|
| $CEF_{electricity}$ | $CO_2$ emissions intensity of the electricity displaced, in $tCO_2e/MWh$[5]. This can be estimated using either ACM0002 or AMSI.D, if the capacity is within the small scale threshold values, when grid electricity is used or displaced, or AMS-I.A if captive electricity is used or displaced. |
| $ET_y$ | Incremental quantity of fossil fuel, defined as difference of fossil fuel used in the baseline and fossil use during project, for energy requirement on site under project activity during the year y, in TJ. |
| $CEF_{thermal,y}$ | $CO_2$ emissions intensity of the fuel used to generate thermal/mechanical energy, in $tCO_2e/TJ$ |

**1. Baseline emissions.**

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 odour concerns.

Estimating baseline emissions from the *Alto-Tietê* landfill requires a kinetic approach[6]. The IPCC advices a first order decay model to determine the rate of $CH_4$ generation over time. Further derivation of the mathematical model allows also waste variances in annual acceptance rates.

$$Q_{T,x} = k\ R_x\ L_O\ e^{-k(T-x)} \qquad \textit{Equation 2}$$

Where:

$Q_{T,x}$ = the amount of methane generated in the current year (T) by the waste $R_x$

x = the year of waste input.

$R_x$ = the amount of waste disposed in year x (Mg).

T = current year.

k = methane generation rate

Lo = methane generation potential

The yearly waste input ($R_x$) at the landfill is as follows:

| Year | Waste input (Tonnes) | Waste on place (Tonnes) | Data Source |
|---|---|---|---|
| 2000 | 200,000 | 200,000 | *Pajoan Ltd* |
| 2001 | 350,000 | 550,000 | *Pajoan Ltd* |
| 2002 | 480,000 | 1,030,000 | *Pajoan Ltd* |

[5] An ex-post calculation for the national grid electricity emissions factors are available at: http://www.mct.gov.br/index.php/content/view/50862.html

[6] Chapter 5, *IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories, May 2000*: http://www.ipcc-nggip.iges.or.jp/public/gp/english/ in chapter 5, named as WASTE. or directly on http://www.ipcc-nggip.iges.or.jp/public/gp/english/5_Waste.pdf

| | | | |
|---|---|---|---|
| 2003 | 540,000 | 1,570,000 | *Pajoan Ltd* |
| 2004 | 573,937 | 2,143,937 | *Pajoan Ltd* |
| 2005 | 602,633 | 2,746,570 | *Pajoan Ltd* |
| 2006 | 632,764 | 3,379,334 | *Pajoan Ltd* |
| 2007 | 664,402 | 4,043,736 | *Pajoan Ltd* |
| 2008 | 697,622 | 4,741,358 | *Pajoan Ltd* |
| 2009 | 732,503 | 5,473,861 | *Pajoan Ltd* |
| 2010 | 769,128 | 6,242,989 | *Pajoan Ltd* |
| 2011 | 807,584 | 7,050,573 | *Pajoan Ltd* |
| 2012 | 847,963 | 7,898,536 | *Pajoan Ltd* |
| 2013 | 889,150 | 8,787,686 | *Pajoan Ltd* |
| 2014 | 933,610 | 9,721,296 | *Pajoan Ltd* |

*Table 5: Waste input and on place disposal*

In order to estimate the current emissions from waste placed in all years, Equation 2 can be solved for all values of $R_x$ and the results summed.

Values for the Equation 2 above are sourced from the table 6 and 7.

| Variable | Units | Definition | Value | Data Source |
|---|---|---|---|---|
| k | (L/yr) | Methane generation rate | 0.09 | Pajoan Ltd |
| Lo | m3/ Mg | Methane generation potential | 132.5 | Pajoan Ltd |

*Table 6: Values of k and Lo for equation 2.*

**2. Methane destroyed/flared at the project activity** *($MD_{project,y}$)*

The methane destroyed by the project activity (MDproject,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, and the total quantity of methane captured. The *Alto-Tietê* landfill project do not consider any electricity and/or thermal generation, thus the quantity of methane for these applications is assumed to be zero.
The MDflared,y (quantity of methane destroyed by flaring) is calculated as follows (Equation 3):

$$MD_{flared,y} = \{LFG_{flare,y} * w_{CH4,y} * D_{CH4}) - (PE_{flare,y} / \mathrm{GWP}_{CH4})$$

(Equation 3)

Where LFGflare,y is the quantity of landfill gas fed to the flare during the year measured in cubic meters ($m^3$), $wCH_4$,y is the average methane fraction of the landfill gas as measured during the year and expressed as a fraction (in m³ $CH_4$ / m³ LFG), $DCH_4$ is the methane density expressed in tonnes of methane per cubic meter of methane ($tCH_4/m^3CH_4$) and the PEflare,y are the project emissions from flaring of the residual gas stream in year y ($tCO_2e$) determined following the procedure described in the "Tool to determine project emissions from flaring gases containing Methane". The tool offers two options for enclosed flares. Option 2 will be used: continuous monitoring of the methane destruction efficiency of the flare as per the tool methodology.

This tool involves the following seven steps:

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

STEP 2: Determination of the mass fraction of carbon, hydrogen, oxygen and nitrogen in the

residual gas

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

STEP 4: Determination of methane mass flow rate of the exhaust gas on a dry basis

STEP 5: Determination of methane mass flow rate of the residual gas on a dry basis

STEP 6: Determination of the hourly flare efficiency

STEP 7: Calculation of annual project emissions from flaring based on measured hourly values.

These steps will be applied to calculate project emissions from flaring (*PEflare,y*) based on the measured hourly flare efficiency (*PEflare,h*). Steps 3 and 4 will be applied only in case of enclosed flares and continuous monitoring of the flare efficiency.

The calculation procedure in this tool determines the flow rate of methane before and after the destruction in the flare, taking into account the amount of air supplied to the combustion reaction and the exhaust gas composition (oxygen and methane). The flare efficiency is calculated for each hour of a year based either on measurements plus operational parameters. Project emissions are determined by multiplying the methane flow rate in the residual gas with the flare efficiency for each hour of the year.

According to ACM0001 methodology, the increase in emissions outside the project boundary (leakage) does not need to be accounted.

According to ACM0001 methodology, the emissions resulting from the use of electricity in extracting and pumping the LFG should be accounted as project emissions. The considered pump has a nominal potency of 30kW and is supplied by the local grid electricity (Southeast Electrical Subsystem).

The ex-post electricity emission factor ($CEF_{electricity, y}$) is 0.10425 tonnes of CO2e per MWh which has been calculated (averaged) based on the 2006 monthly emission factors provided by the Brazilian Designated National Authority[8], therefore the total emissions related to the extraction and pumping system is 27.40 tCO2e/year. The ($CEF_{electricity, y}$) will be calculated on an annual

[8] National grid electricity emissions factors are available at:
http://www.mct.gov.br/index.php/content/view/50862.html

basis, on an ex-post vintage, and specifically as data becomes available (if data is not made available on an annual basis). The table 8 below summarizes the presented data.

| Extraction and Pumping System | | | |
|---|---|---|---|
| Nominal Potency | Operational time | Southeast Emission Factor | Resulting Emissions |
| 30 kW | 8,760 hours/year | 0.10425 tCO2/MWh | 27.40 tCO2e/year |

*Table 8. Extraction and pumping related emissions.*

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

| **Data / Parameter:** | **Adjustment Factor** |
|---|---|
| Data unit: | Percent |
| Description: | In cases where regulatory or contractual requirements do not specify $MD_{reg,y}$ an adjustment factor shall be used and justified taking into account the project context. |
| Source of data used: | Brazilian DNA letter (Number MDL 0152/2006/CIMGC) dated 22 Sept 2006. |
| Value applied: | 20% |
| Justification of the choice of data or description of measurement methods and procedures actually applied : | Suggested by the Brazilian DNA |
| Any comment: | |

| **Data / Parameter:** | **Extraction efficiency** |
|---|---|
| Data unit: | % |
| Description: | Rate of efficiency in the extraction of methane from the LFG |
| Source of data used: | Based on the project's landfill designers and contractors |
| Value applied: | 70% |
| Justification of the choice of data or description of measurement methods and procedures actually applied : | Based on the project's landfill designers and contractors |
| Any comment: | |

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

The ex-ante calculation for Equation1 was carried out accordingly:

In cases where regulatory or contractual requirements do not specify $MD_{reg,y}$ an "Adjustment Factor" (AF), suggested by Brazilian DNA[9], shall be used and justified, taking into account the

[9] Source: Brazilian DNA letter (Number MDL 0152/2006/CIMGC) dated 22 Sept 2006.

project context. For the *Alto Tietê* project the adjustment factor has been estimated to be 20% of the gas captured by the passive venting system, it represents the amount of LFG flared that would have been destroyed/combusted in the absence of the proposed project. Thus, the first half of the equation could be simplified to:

$MD_{project,y} – [(MD_{project,y}) * 0.20]$; ( Equation 4a)

and, further simplified to:

$MD_{project,y}$ (0.8) (Equation 4b)

As for the second half of the equation, the proposed project activity do not foresees electricity generation to be exported to the grid or for captive utilization nor will there be generation of thermal/mechanical energy, thus the "$EL_y$" and "$ET_y$" are assumed to be zero.

However, as an electrical pump will be used to operate the flare, additional parameters "$CEF_{elec,y}$" (in $tCO_2e/MwH$ ) and $EL_{IMP}$ (in MWh)has been included in the equation which considers project emissions from electricity also be expressed in. These emissions will be deducted from the equation.

In summary, the equation used, which was derived from ACM0001 is the following:

$ER_y = MD_{project,y}$ (0.8) * $GWP_{CH4} – EL_{IMP} * CEF_{elec,y}$ (Equation 4c)

For the Project Design Document (PDD), *ex ante* emission reductions estimative are made by projecting the future greenhouse gas emissions of the landfill using a first order kinetic model. These estimates are for reference purposes only, since emission reductions will be determined (*ex post*) by metering of the quantity of captured and flared methane once the project activity is operational.

For the ex-ante calculation, $MD_{flared, y}$ was calculated based on Equation 3 and simplified accordingly:

**$MD_{flared}$**

| **$MD_{flared} = CH4_{extracted,y} - PE_{flared,y}$ (Equation 5)** | | | |
|---|---|---|---|
| Variable | Description | Unit of Measurement | Data Source |
| $MD_{flared}$ = | $CH_4$ destroyed in project | $tCH_4$ | calculation |
| $CH4_{extracted,y}$ = | $CH_4$ fed to flaring in project | $tCH_4$ | Calculation |
| $PE_{flared,y}$ = | emissions in project from flaring | $tCH_4$ | calculation |

For the ex-ante calculation of PEflare,y the following equation was used, consistent with Equation 3 and Equation 5:

| **$PE_{flared,y} = CH4_{extracted,y}$ * (1-EFF_flared) (Equation 6)** | | | |
|---|---|---|---|
| Variable | Description | Unit of Measurement | Data Source |
| $PE_{flared,y}$ = | emissions in project from flaring | $tCH_4$ | calculation |
| $CH4_{extracted,y}$ = | $CH_4$ fed to flaring in project | $tCH_4$ | Calculation |

| | | | |
|---|---|---|---|
| Eff_flare = | efficiency of $CH_4$ destruction by flaring | % | According to manufacturer (98%) |

| Variable | Units | Definition | Value | Data Source |
|---|---|---|---|---|
| $W_{CH4,y}$ | m³ $CH_4$ / m³ LFG | Average methane fraction of the landfill gas | 0.5 | IPCC Guidelines, 1996 |
| $D_{CH4}$ | $tCH_4/m^3CH_4$ | Density of methane | 0.0007168[10] | IPCC Guidelines, 1996 |

*Table 7: Values for the variables of equation 3.*

For ex ante calculation, the $LFG_{flare,y}$ is calculated as result of the methane generated when extracted, treated and finally available at the flaring point . The quantity of $CH_4$ *extracted,y* is a result of the following equation:

$$CH_4 \text{ extracted,y} = EE * Q_{T,x} * D_{CH4} \qquad \textbf{Equation 7}$$

Where the value $Q_{T,x}$ represents the amount of methane generated in the current year (T) and *EE* is the extraction efficiency of LFG at the landfill for the project activity.

The ex post emission reduction calculation is described in detail in Annex 4.

Landfill designers and landfill operators consulted by *Ecologica Assessoria* recommends a conservative approach for the flaring efficiency of 98% and a 70% on the extraction efficiency of the LFG for ex-ante calculations.

[10] *At standard temperature and pressure (0 degree Celsius and 1,013 bar) the density of methane is 0.0007168 $tCH4/m^3CH4$.*

The estimated emission reductions for each gas, source and formulae/algorithm due to the Project activity are presented at the table 9.

| Variable | CH4 Baseline ($m^3$/year) | CH4 extracted (tonnes/yr) | Project´s Emissions (electricity) (tCO2e/year) | PEflare,y (tCH4/yr) | MDflared (tCH4/yr) | Project emissions reduction[11] (tCO2e/yr) |
|---|---|---|---|---|---|---|
| **Notes** | **Based on the FOD model (Equation 2)** | **Equation 7** | **Based on Table 8** | **Equation 6** | **Equation 5** | **Equation 4c** |
| **March 2008-Feb 2009** | 42,949,372 | 21,550 | 27.40 | 431 | 21,119 | 354,776 |
| **March 2009-Feb 2010** | 47,987,869 | 24,078 | 27.40 | 482 | 23,597 | 396,399 |
| **March 2010-Feb 2011** | 53,029,461 | 26,608 | 27.40 | 532 | 26,076 | 438,048 |
| **March 2011-Feb 2012** | 58,095,718 | 29,150 | 27.40 | 583 | 28,567 | 479,900 |
| **March 2012-Feb 2013** | 63,207,447 | 31,715 | 27.40 | 634 | 31,081 | 522,128 |
| **March 2013-Feb 2014** | 68,370,371 | 34,306 | 27.40 | 686 | 33,619 | 564,779 |
| **March 2014-Feb 2015** | 73,619,113 | 36,939 | 27.40 | 739 | 36,200 | 608,138 |
| **TOTAL** | 407,259,351 | 204,346 | 191.8 | 4,087 | 200,260 | 3,364,168 |

*Table 9: Estimated emissions reductions for the gases due to the Project activity.*

[11] The emission reduction calculation reflects 7 years ; that is from 1 March 2008 until 28 February 2015.

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

| Year | Estimation of project activity emissions (tonnes of CO2e) | Estimation of baseline emissions (tonnes of CO2e) | Estimation of leakage (tonnes of CO2e) | Estimation of overall emission reductions (tonnes of CO2e) |
|---|---|---|---|---|
| March 2008-Feb 2009 | 27.40 | 646,508 | 0 | 354,776 |
| March 2009-Feb 2010 | 27.40 | 722,352 | 0 | 396,399 |
| March 2010-Feb 2011 | 27.40 | 798,242 | 0 | 438,048 |
| March 2011-Feb 2012 | 27.40 | 874,503 | 0 | 479,900 |
| March 2012-Feb 2013 | 27.40 | 951,449 | 0 | 522,128 |
| March 2013-Feb 2014 | 27.40 | 1,029,166 | 0 | 564,779 |
| March 2014-Feb 2015 | 27.40 | 1,108,174 | 0 | 608,138 |
| Total (tonnes of CO2e) | 191.80 | 6,130,394 | 0 | 3,364,168 |

*Table 10. Values obtained when applying formulae above.*

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

### B.7.1 Data and parameters monitored:

| **Data / Parameter:** | **$LFG_{total,y}$** |
|---|---|
| Data unit: | $m^3$ |
| Description: | Total amount of landfill gas captured from project wells |
| Source of data to be used: | Measured |
| Value of data applied for the purpose of calculating expected emission reductions in section B.5 | N/a |
| Description of measurement methods and procedures to be applied: | Measured continuously by a flow meter. Data to be aggregated monthly and yearly. Data will be archived in electronic format during the crediting period and two years after. |
| QA/QC procedures to be applied: | Flow meters should be subject to a regular maintenance and testing regime to ensure accuracy |
| Any comment: | - |

| **Data / Parameter:** | **$LFG_{flared,y}$** |
|---|---|

| | |
|---|---|
| Data unit: | $m^3$ |
| Description: | Total amount of landfill gas flared |
| Source of data to be used: | Measured by PLC-Electronic device. |
| Value of data applied for the purpose of calculating expected emission reductions in section B.5 | CH4extracted,y in Table 9. |
| Description of measurement methods and procedures to be applied: | Measured continuously by a flow meter. Data to be aggregated monthly and yearly. Data will be archived in electronic format during the crediting period and two years after. |
| QA/QC procedures to be applied: | Flow meters should be subject to a regular maintenance and testing regime to ensure accuracy |
| Any comment: | - |

| **Data / Parameter:** | **$PE_{flare,y}$** |
|---|---|
| Data unit: | $tCO_{2e}$ |
| Description: | Project emissions from flaring of the residual gas stream in year y |
| Source of data to be used: | Calculated |
| Value of data applied for the purpose of calculating expected emission reductions in section B.5 | Please observe table 9. |
| Description of measurement methods and procedures to be applied: | Determined according to Annex 13 "Tool to determine project emissions from flaring gases containing methane"Continuous monitoring of the methane destruction efficiency of the flare measured hourly. Data will be archived in electronic format during the crediting period and two years after. |
| QA/QC procedures to be applied: | Calibration of equipment as per manufacturer's specifications to ensure validity of data measured. |
| Any comment: | If the temperature of the exhaust gas of the flare ($T_{flare}$) is below 500°C during the hour h, the flare efficiency value will be $\eta_{flare,h} = 0\%$. |

| **Data / Parameter:** | **$WCH_{4,y}$** |
|---|---|
| Data unit: | $m^3CH_4$/ $m^3$LFG |
| Description: | Methane fraction in the landfill gas |
| Source of data to be used: | Measured by analyzer |
| Value of data applied for the purpose of calculating expected emission reductions in section B.5 | 0.5 |
| Description of measurement methods and procedures to be applied: | Measured by continuous gas quality analyzer. Data will be archived in electronic format during the crediting period and two years after. |
| QA/QC procedures to | The gas analyser should be subject to a regular maintenance and testing regime |

| | |
|---|---|
| be applied: | to ensure accuracy. |
| Any comment: | Methane fraction of the landfill gas should be measured on wet basis. |

| **Data / Parameter:** | **T** |
|---|---|
| Data unit: | *°C* |
| Description: | Temperature of the landfill gas |
| Source of data to be used: | Measured by a temperature sensor |
| Value of data applied for the purpose of calculating expected emission reductions in section B.5 | 60°C |
| Description of measurement methods and procedures to be applied: | Temperature will be continuously measured and data will be kept in electronic format. Data will be archived in electronic format during the crediting period and two years after. |
| QA/QC procedures to be applied: | The temperature sensor will be checked and tested to ensure accuracy. |
| Any comment: | This measurement is used to determine the density of methane. |

| **Data / Parameter:** | **P** |
|---|---|
| Data unit: | Mbar |
| Description: | Pressure of the landfill gas |
| Source of data to be used: | Measured by pressure sensor |
| Value of data applied for the purpose of calculating expected emission reductions in section B.5 | 200 |
| Description of measurement methods and procedures to be applied: | Pressure will be continuously measured and data will be kept in electronic format. Data will be archived in electronic format during the crediting period and two years after. |
| QA/QC procedures to be applied: | The gas sensor will be checked and tested to ensure accuracy. |
| Any comment: | This measurement is made to determine the density of methane. |

| **Data / Parameter:** | $EL_{IMP}$ |
|---|---|
| Data unit: | MWh/year |
| Description: | Total amount of electricity imported to meet project requirement |
| Source of data to be used: | Measured |
| Value of data applied for the purpose of calculating expected emission reductions in section B.5 | 262.8 MWh/year |
| Description of measurement methods and procedures to be | Measured continuously by an energy meter. Data to be aggregated monthly and yearly. Data will be archived in electronic format during the crediting period and two years after. |

| | |
|---|---|
| applied: | |
| QA/QC procedures to be applied: | Energy meters should be subject to a regular maintenance and testing regime to ensure accuracy. |
| Any comment: | Required to determine CO2 emissions from use of electricity or other energy carriers to operate the project activity. The records of any electricity imported in the baseline too should be recorded at the start of project. |

| **Data / Parameter:** | $CEF_{elec, BL,y(GRID)}$ |
|---|---|
| Data unit: | Tonnes of $CO_2e$/MWh |
| Description: | $CO_2e$ emissions conversion factor for electricity |
| Source of data used: | Brazilian DNA |
| Value applied: | 0.10425 tCO2/MWh |
| Justification of the choice of data or description of measurement methods and procedures actually applied : | The emission factor was developed based on official emission and generation data of the Southeast region, the region where the project is located, in 2006.<br><br>An Excel spreadsheet has been provided to the DOE separately detailing the calculation that has derived the value. |
| Any comment: | This value will be reviewed annually on an ex-post vintage basis (and specifically, when data becomes available) |

| **Data / Parameter:** | **Landfill Waste** |
|---|---|
| Data unit: | Metric tonnes |
| Description: | Waste disposal during a year in *Alto-Tietê* Landfill |
| Source of data used: | Data will be measured |
| Value applied: | Variable. Values available at table 5. |
| Justification of the choice of data or description of measurement methods and procedures actually applied : | Waste will be measured at weight bridge at landfill entrance. Data will be archived daily in paper and monthly in electronic format. |
| Any comment: | |

| **Data / Parameter:** | **Regulatory requirements relating to landfill gas projects** |
|---|---|
| Data unit: | Test |
| Description: | Regulatory requirements relating to landfill gas projects |
| Source of data to be used: | |
| Value of data applied for the purpose of calculating expected emission reductions in section B.5 | N/a |
| Description of measurement methods and procedures to be applied: | The information though recorded annually, is used for changes to the adjustment factor suggested by the DNA (AF) or directly $MD_{reg,y}$ at renewal of the credit period. Data to be aggregated yearly and archived in electronic format during the crediting period and two years after. |
| QA/QC procedures to be applied: | All documentation will be available for revision for a verifier. |
| Any comment: | - |

| Data / Parameter: | **FE** |
|---|---|
| Data unit: | % |
| Description: | Combustion efficiency |
| Source of data to be used: | Measured and calculated |
| Value of data applied for the purpose of calculating expected emission reductions in section B.5 | 98% as per advise from manufacturer |
| Description of measurement methods and procedures to be applied: | It will be perfomed by<br>(1) Continuous measurement of methane content of flare exhaust gas.<br>(2) Continuous measurement of operation time of flare (e.g. with temperature), as flare is considered an enclosed flare.<br>Data will be measured weekly or monthly, if unstable.<br>Data will be archived in electronic format during the crediting period and two years after. |
| QA/QC procedures to be applied: | The flare is monthly checked and the flare efficiency is measured continuously to ensure optimal operation. |
| Any comment: | - |

| Data / Parameter: | $T_{Flaring}$ |
|---|---|
| Data unit: | °C |
| Description: | Flaring temperature/ temperature used for flaring |
| Source of data to be used: | Measured by temperature sensor |
| Value of data applied for the purpose of calculating expected emission reductions in section B.5 | N/a |
| Description of measurement methods and procedures to be applied: | Temperature will be metered continuously and data will be kept in electronic format. Data will be archived in electronic format during the crediting period and two years after. |
| QA/QC procedures to be applied: | The flaring temperature sensor will be checked to ensure a proper activity, as suggested in the manufacturer's specification guidance. |
| Any comment: | - |

| Data / Parameter: | $Flare_h$ |
|---|---|
| Data unit: | Hours |
| Description: | Flare working hours |
| Source of data to be used: | Measured |
| Value of data applied for the purpose of calculating expected emission reductions in section B.5 | 8760 |

| | |
|---|---|
| Description of measurement methods and procedures to be applied: | The period will be metered continuously and data will be recorded in electronic format during the crediting period and two years after. |
| QA/QC procedures to be applied: | Regular maintenance will ensure optimal operation of flares. Flare activity will be checked continuously, with daily checks if the efficiency shows significant deviations from previous values. |
| Any comment: | - |

| **Data / Parameter:** | **$fv_{,h}$** |
|---|---|
| Data unit: | - |
| Description: | Volumetric fraction of component i in the residual gas in the hour h where i = $CH_4$, CO, $CO_2$, $O_2$,$H_2$, $N_2$ |
| Source of data to be used: | Measurements by project participants using a continuous gas analyzer. |
| Value of data applied for the purpose of calculating expected emission reductions in section B.5 | n/a |
| Description of measurement methods and procedures to be applied: | For $fv_{CH4,h}$ ensure that the same basis (dry or wet) is considered for this measurement and the measurement of the volumetric flow rate of the residual gas (FVRG,h) when the residual gas temperature exceeds 60 ºC. It must be measured continuously. Values to be averaged hourly or at a shorter time interval. Thus, only methane content of the residual gas will be measured.<br>As for the remaining parts (where i = CO, $CO_2$, $O_2$,$H_2$, $N_2$), it will be considered as $N_2$. |
| QA/QC procedures to be applied: | Analyzers must be periodically calibrated according to the manufacturer's recommendation. A zero check and a typical value check should be performed by comparison with a standard certified gas. |
| Any comment: | |

| **Data / Parameter:** | **$Fv_{RG,h}$** |
|---|---|
| Data unit: | $m^3/h$ |
| Description: | Volumetric flow rate of the residual gas in dry basis at normal conditions in the hour h. |
| Source of data to be used: | Measurements by project participants using a flow meter. |
| Value of data applied for the purpose of calculating expected emission reductions in section B.5 | n/a |
| Description of measurement methods and procedures to be applied: | Ensure that the same basis (dry or wet) is considered for this measurement and the measurement of volumetric fraction of all components in the residual gas (fvi,h) when the residual gas temperature exceeds 60 ºC. It must be measured continuously. Values to be averaged hourly or at a shorter time interval |
| QA/QC procedures to be applied: | Flow meters are to be periodically calibrated according to the manufacturer's recommendation. |

| | |
|---|---|
| Any comment: | |

| **Data / Parameter:** | $t_{o2,h}$ |
|---|---|
| Data unit: | - |
| Description: | Volumetric fraction of O2 in the exhaust gas of the flare in the hour h |
| Source of data to be used: | Measurements by project participants using a continuous gas analyser |
| Value of data applied for the purpose of calculating expected emission reductions in section B.5 | n/a |
| Description of measurement methods and procedures to be applied: | Extractive sampling analysers with water and particulates removal devices or in situ analysers for wet basis determination. The point of measurement (sampling point) shall be in the upper section of the flare (80% of total flare height). Sampling shall be conducted with appropriate sampling probes adequate to high temperatures level (e.g. inconel probes). An excessively high temperature at the sampling point (above 700 ºC) may be an indication that the flare is not being adequately operated or that its capacity is not adequate to the actual flow. Values to be averaged hourly or at a shorter time interval. Data will be archived in electronic format. |
| QA/QC procedures to be applied: | Analysers must be properly calibrated according to the manufacturer's recommendation. A zero check and a typical value check should be performed by comparison with a standard gas. |
| Any comment: | Monitoring of this parameter is only applicable in case of enclosed flares and continuous monitoring of the flare efficiency. |

| **Data / Parameter:** | $fv_{CH4,FG,h}$ |
|---|---|
| Data unit: | $mg/m^3$ |
| Description: | Concentration of methane in the exhaust gas of the flare in dry basis at normal conditions in the hour h |
| Source of data to be used: | Measurements by project participants using a continuous gas analyzer |
| Value of data applied for the purpose of calculating expected emission reductions in section B.5 | n/a |
| Description of measurement methods and procedures to be applied: | Extractive sampling analysers with water and particulates removal devices or in situ analyser for wet basis determination. The point of measurement (sampling point) shall be in the upper section of the flare (80% of total flare height). Sampling shall be conducted with appropriate sampling probes adequate to high temperatures level (e.g. inconel probes). An excessively high temperature at the sampling point (above 700 ºC) may be an indication that the flare is not being adequately operated or that its capacity is not adequate to the actual flow. It must be measured continuously. Values to be averaged hourly or at a shorter time interval |
| QA/QC procedures to be applied: | Analysers must be periodically calibrated according to manufacturer's recommendation. A zero check and a typical value check should be performed |

| | |
|---|---|
| | by comparison with a standard gas. |
| Any comment: | Monitoring of this parameter is only applicable in case of enclosed flares and continuous monitoring of the flare efficiency. Measurement instruments may read ppmv or % values. To convert from ppmv to mg/m3 simply multiply by 0.716. 1% equals 10 000 ppmv. |

| **Data / Parameter:** | $T_{flare}$ |
|---|---|
| Data unit: | ºC |
| Description: | Temperature in the exhaust gas of the flare (not the temperature used to flare) |
| Source of data to be used: | Measurements by project participants. |
| Value of data applied for the purpose of calculating expected emission reductions in section B.5 | n/a |
| Description of measurement methods and procedures to be applied: | Measure the temperature of the exhaust gas stream in the flare by a Type N thermocouple. A temperature above 500 ºC indicates that a significant amount of gases are still being burnt and that the flare is operating. It must be measured continuously. |
| QA/QC procedures to be applied: | Thermocouples should be replaced or calibrated every year. |
| Any comment: | An excessively high temperature at the sampling point (above 700 ºC) may be an indication that the flare is not being adequately operated or that its capacity is not adequate to the actual flow. |

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

The monitoring plan at the *Alto-Tietê* landfill, based on the approved monitoring methodology ACM-0001 - "Consolidated baseline methodology for landfill gas project activities", foresees the direct measurement of the amount of landfill gas captured ($MD_{project,y}$) and destroyed (flared). The monitoring plan provides for continuous measurement of the quantity and quality of LFG flared. The main variables to account are the quantity of methane actually captured ($MD_{project,y}$), quantity of methane flared ($MD_{flared,y}$), and the quantity of methane generated ($MD_{total,y}$) .Where the landfill gas flows through the gas network up to the flaring point where the monitoring equipment is placed, composed of several sensors placed on-line to the gas pipeline to measure continually the gas flow, which will be calibrated by an officially accredited entity.

The party responsible for implementing the monitoring plan shall be the landfill operation company *Pajoan Ltd*. The landfill operator through the technical team, will be also responsible for the day-to-day operation of the landfill gas monitoring, flaring and the party responsible for developing the data and registration forms for further classification. And also an automatic system controlling flare adjustments, blowers speed and alarm system in failure case is under the proponent responsibility.

1. **Operational structure.**

It will be based on daily monitoring of the LFG flow from the gas extraction stage to the landfill gas flaring. Continuous measurers of gas flow and flared gas meter will be installed along the landfill gas extraction network. The main purpose is the direct monitoring of any fugitive emissions and the empirical calculation of the landfill gas generated.

**2. Monitoring follow-up process.**

All data collected following the B.7.1 will be registered and transferred to electronic spreadsheets and/or other suitable electronic files.

The calibration certificates should be stored as paper copies and calibration data would be subject to quality control procedures as described in each description of data to be monitored (Quality control and Quality assurance) The management structure will also ensure that the monitoring equipment is perfectly equilibrated based on the INMETRO standards (Brazilian institute for metrology and calibration).

Following an internal audit of the collected data carried out by the Project developer, the electronic data would be verified by an independent Designated Operational Entity (DOE), on an annual basis. The DOE would issue a verification report based on the data sheets to calculate emissions reductions.

**3. The management structure.**

The landfill operator will be responsible for training of the monitoring and operation staff with the help of the equipment manufactures. Then, the technical team will manage the monitoring, quality control and the quality assessment procedures carried out at the landfill premises. Further detailed procedures for monitoring shall be developed during the final design of the facilities.

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

The baseline study for the project activity and monitoring methodology were completed on 12/12/2007 by *Ecologica Assessoria*, which is not a project participant. Below, the name of person and entity determining the baseline:

| Name of person/Organization | Project Participant |
|---|---|
| Paulo Zanardi<br>Ecologica Assessoria Ltda.<br>São Paulo, Brazil.<br>Tel: +55 11 5083 3252<br>Fax: +55 11 5083 8442<br>e-mail: zanardi@ecologica.ws<br>WWW: www.ecologica.ws | NO |

## SECTION C. Duration of the project activity / crediting period

### C.1 Duration of the project activity:

#### C.1.1. Starting date of the project activity:

01/03/2008

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

21 years – 0m.

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

The CDM project activity will use a renewable crediting period.

#### C.2.1. Renewable crediting period

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

01/03/2008

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

7 years – 0 m.

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

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

Not applicable.

##### C.2.2.2. Length:

Not applicable.

## SECTION D. Environmental impacts

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

The project will extract and flare landfill gas, therefore improving the landfill management by reducing adverse global and local environmental effects of uncontrolled releases of landfill gas. The project activity shall start operation with all operation and the environmental licenses in compliance with local and national regulations.

*Baseline scenario*: LFG contains over 150 trace components that may cause: odour nuisances, stratospheric ozone layer depletion and in concentrated amounts leads to asphyxia and/or toxic effects in humans.

*Project activity*: The installation of a set of wells designated for gas collection and further flaring will lead into a daily monitoring (as stated at the monitoring plan) and proper landfill operation. The operation will remove safety risks from the surrounding communities by reducing the risks of toxic effects on the local community, freatic layers, watercourse pollution and odour nuisances.The combustion of the LFG at the flare point will lead on the release of organic compounds and trace amounts of toxic materials, including mercury and dioxins.

*Operation mitigation measures*: A set of mitigation measures are defined during the operation of the project activity, i.e. concerning the noise of the flare and the mitigation of the NVOCs compounds present at the flare point, the project operator will follow local and national regulations and technical specifications defined by the ABNT (Brazilian technical standard association) for the project activity. The mitigation measures will be defined at the operation plan implemented by the project operator. Once the project activity is implemented, further studies and mitigation measures may be undertaken.

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

No significant negative impacts applicable.

## SECTION E. Stakeholders' comments

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

According to the Resolution number 1 of the Brazilian Inter-Ministerial commission on Climate Change[12], invitations for comments by local stakeholders are required by the Brazilian Designated National Authority (DNA) as part of the procedures for analyzing CDM projects and issuing letters of approval.

The DNA required project participants to communicate with the public through letters, to be sent inviting for comments to:

- The Brazilian national NGO's forum.
- The local attorneys' and prosecutors' agency.
- The municipality's chamber (mayor and assembly men).
- State's and municipal's environmental authorities.
- Local communities' associations.

As defined by the Designated National Authority (DNA), the project developer sent information letters to the key institutions, describing the major aspects of the implementation and operation of the proposed project. The project participant should leave 30 days opened for comments. The letters were distributed by *Pajoan Ltd* via mail to the key institutions (see table 11, below).

[12] *Issued on December 2nd of the 2003, decree from July 7th 1999.*

| Name of the Institution | Type of Entity | Address | Phone / Fax | Contact Point | E-mail |
|---|---|---|---|---|---|
| Brazilian Forum of NGOs | Association of NGOs | SCLN 210 Block C Room 102 CEP 70856-530 Brasília DF | (61) 3340-0741 | -- | forumbr@tba.com.br |
| Public Ministry of the State of São Paulo | Ministry | 115 Riachuelo Street, Center São Paulo | (11) 3119-9015 | -- | web-master@mp.sp.gov.br |
| Itaquaquecetuba City Hall | City Hall | 283, Ver. João Fernandes da Silva Avenue | (11) 4640-1000 | Armando Tavares | -- |
| CETESB | Environmental Agency | 345, Prof. Frederico Hermann Jr Avenue, Alto de Pinheiros, São Paulo, ZIP Code: 05459-900 | (11) 3030-6000 | -- | -- |
| Foundation for the Conservation and Forestry Production of São Paulo | Governmental Organization | 931, Horto Street, São Paulo, ZIP Code: 02377-000 | (11) 6997-5000 | | fflorestal@fflorestal.sp.gov.br |
| Botany Institute | Governmental Organization | 3687, Miguel Estéfano Avenue, Água Funda, São Paulo, ZIP Code: 04301-902 | (11) 5073-6300 | -- | -- |
| Geological Institute | Governmental Organization | 3900, Miguel Estéfano Avenue, Água Funda, São Paulo, ZIP Code: 04301-903 | (11) 5077-1155 | -- | igeologico@igeologico.sp.gov.br |
| State Secretariat of Health | Public Secretariat | 188, Dr Enéas de Carvalho Aguiar Avenue, ZIP Code: 05403-000, São Paulo, SP | (11) 3066-8000 | Danilo Vicente | -- |
| Environment Secretariat of the State of São Paulo | Public Secretariat | 345, Prof Frederico Hermann Jr Avenue, ZIP Code: 05489-900 | (11) 3030-6477 | José Goldemberg | ouvidoria@ambiente.sp.gov.br |
| Environmental Policing Command | Governmental Organization | 345, Prof Frederico Hermann Jr Avenue, ZIP Code: 05489-900, 4th floor, Alto de Pinheiros | (11) 3030-6625 | Deputy Marcelo Robis | cpambp5@polmil.sp.gov.br |
| Name of the Institution | Type of Entity | Address | Phone / Fax | Contact Point | E-mail |
| Waters and Electric Energy Department | Public Department | 170, Boa Vista Street, 8th floor, Block 5 ZIP Code: 01014-000, São Paulo | (11) 3293-8571 | Ubirajara Félix | ufelix@sp.gov.br |
| Ferraz de Vasconcellos City Hall | City Hall | 1841, Brasil Avenue, Center, ZIP Code: 08529-310 | (11) 4674-1000 | Jorge Abissamra | ferrazadm@superig.com.br |

| | | | | | |
|---|---|---|---|---|---|
| Mogi das Cruzes City Hall | City Hall | 277, Vereador Narciso Yague Guimaraes Avenue, ZIP Code: 08780-000 | (11) 4798-5000 | Jungi Abe | gabinete@pmmc.com.br |
| Health Secretariat of Mogi das Cruzes | Public Secretariat | 277, Vereador Narciso Yague Guimaraes Avenue, ZIP Code: 08780-000 | (11) 4795-4500 | Cláudio Miyake | saude@pmmc.com.br |
| Poá City Hall | City Hall | 198, Brasil Avenue, Center, ZIP Code: 08550-000 | (11) 4634-8800 | Carlos Roberto da Silva | -- |
| Suzano City Hall | City Hall | 501, Baruel Street, Center, ZIP Code: 08675-000 | -- | Marcelo Souza Candido | suzano.gabinete@uol.com.br |
| Health Secretariat of Suzano | Public Secretariat | 179, Baruel Street, Vila Costa, ZIP Code: 08675-902 | -- | Célia Bortoletto | saude@suzano.sp.gov.br |
| Arujá City Hall | City Hall | 90, José Basilio Alvarenga Street, Vila Flora Regina | (11) 4652-7600 | Genésio da Silva | -- |
| Carapicuíba City Hall | City Hall | 205, Joaquim das Neves Street, Center, ZIP Code: 06310-030 | (11) 6886-5200 | -- | carapic@pmcarapicuiba.com.br |
| Health Secretariat of Arujá | Public Secretariat | 231, Pedro Severino Martins Street | (11) 4655-2871 | Messias Covre | -- |
| Health Secretariat of Carapicuíba | Public Secretariat | 1304, President Tancredo Neves Street | (11) 4167-9116 | -- | -- |

*Table 11.Participant entities.*

| E.2. Summary of the comments received: |
|---|

No comments have been received.

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

Not applicable, as no comments were received.

## Annex 1

## CONTACT INFORMATION ON PARTICIPANTS IN THE PROJECT ACTIVITY

| | |
|---|---|
| Organization: | *Alto Tietê Biogás, Redução de Emissões e Geração de Energia Ltda.* |
| Street/P.O.Box: | Sandovalina nº 53, Bairro Morro Branco |
| Building: | --- |
| City: | Itaquaquecetuba |
| State/Region: | São Paulo |
| Postfix/ZIP: | CEP 08572-580 |
| Country: | Brazil |
| Telephone: | +55 (11) 81 72 01 22 |
| FAX: | --- |
| E-Mail: | --- |
| URL: | --- |
| Title: | Director |
| Salutation: | Mr. |
| Last Name: | Pais de Arruda |
| Middle Name: | Roberto |
| First Name: | Iule |
| Department: | --- |
| Mobile: | --- |
| Direct FAX: | --- |
| Direct tel: | +55 (11) 81 72 01 22 |
| Personal E-Mail: | prat_iulearruda@hotmail.com |

| | |
|---|---|
| Organization: | *Carbon Capital Markets Ltd* |
| Street/P.O.Box: | Level 3, 15 Berkeley Street |
| Building: | --- |
| City: | London |
| State/Region: | --- |
| Postfix/ZIP: | W1J 8DY |
| Country: | United Kingdom |
| Telephone: | +44 (0)20 7317 6200 |
| FAX: | +44 (0)20 7317 6201 |
| E-Mail: | carbon.logistics@carboncapitalmarkets.com |
| URL: | www.carboncapitalmarkets.com |
| Title: | CEO |
| Salutation: | Mr. |
| Last Name: | Fretz |
| Middle Name: | --- |
| First Name: | Lionel |
| Department: | --- |
| Mobile: | --- |
| Direct FAX: | +44 (0)20 7317 6201 |
| Direct tel: | +44 (0)20 7317 6203 |
| Personal E-Mail: | Lionel.fretz@carboncapitalmarkets.com |

## Annex 2

## INFORMATION REGARDING PUBLIC FUNDING

There are no public financing for the project.

## Annex 3

## BASELINE INFORMATION

The fraction of the organic compounds presented in the waste for the project activity is defined as 64.4 %. Based on the Brazilian study about methane emissions from waste treatment and waste disposal, the estimative is that for the mayor part of the waste disposal, the 80% comes from domestical waste where almost 60% is composed of organic waste.

| Landfill | Location | % Total of commercial and waste Disposal | % Organic Waste |
|---|---|---|---|
| Bandeirantes | São Paulo | 75 | 55 |
| Biguaçu | Florianópolis | 95 | 60 |
| Caximba | Curitiba | 80 | 65 |
| Goiânia | Goiânia | 90 | High |
| Joinville | Joinville | 70 | 50 - 60 |
| Lara | Mauá | 72 | 65 |
| Zona Norte | Porto Alegre | 66 | 60 |

*Table 12: Percentage of organic waste presented at the waste. Data Source: USAID, 1997.*

Below, the parameters and data sources used to determine the baseline for the project activity. The key elements such as variables and parameters are provided below. The tables 13 and 14 show the values for the parameters used for the LFG emissions estimation.

| **PROJECT ACTIVITY MAIN INFORMATION** | |
|---|---|
| **Alto-Tietê landfill project specifications** | |
| Year when operations started | 2000 |
| Year when flaring starts | 2008 |
| R=daily average deposition (t/day) | 1,500 |
| Lo ($m^3$/ Mg) | 132.5 |
| k (1/year) | 0.09 |
| Methane Global Warming Potential | 21 |
| % of Methane in landfill gas | 50 % |

*Table 13: Alto-Tietê landfill project specifications*

| **Fraction of Degradable Organic Carbon (DOC)** | | |
|---|---|---|
| **Waste type** | **Value** | **Data Source** |
| Paper & Cardboard | 14.40 % | *Pajoan Ltd* |
| Plastics | 12 % | *Pajoan Ltd* |
| Aluminum, other metallic compounds | 3.2 % | *Pajoan Ltd* |
| Organic waste | 64.4 % | *Pajoan Ltd* |
| Glass | 1.1 % | *Pajoan Ltd* |
| Others | 4.9 % | *Pajoan Ltd* |

*Table 14: Fraction of degradable organic carbon*

For the *Alto-Tietê* landfill to gas project the type of weather is humid and the waste decomposition occurs under rapid degradation conditions. However, for the LFG estimation purposes the k value was defined, conservatively speaking, as of 0.09 (L/year), which is 87.5% less than the default value of 0.4 for tropical, moist and wet climate with rapidly degrading waste[13]. In selecting the k value, the premises below were adopted[14]:

[13] Source: See Table 3.3, Chapter 3 of the IPCC Guidelines, 2006.

[14] Information/data source: *Itaquaquecetuba* City Hall – Environment Secretary Office. Available at: http://www.itaquaquecetuba.sp.gov.br/v1/a_cidade/a_cidade_dados_gerais.asp?Codigo=13)

- Mean Annual Temperature: 22º C (maximum: 35 ºC and minimum: 9 ºC)
- Climate Zone: Tropical
- Mean Annual Precipitation: 1200 mm/year

Apart from the value obtained from the IPCC (0.4), the Project Developer adopted a more conservative value (0.09) due to the fact that precipitation and temperature conditions could suffer a lot of variations during the crediting period. The value of 0.09 is widely applied by several CDM projects in Brazil and it is in accordance with the CETESB[15] (Environmental and Sanitation Company of the São Paulo State) recommendations.

Moreover, the waste composition (See Table 14) was considered to determine the total disposed residues as "rapidly degrading waste". Almost 80% of the total waste is composed from organic waste (64.40% of food waste and 14.40% of paper).

The Lo factor depends directly to the waste composition (see Table 14) as well as the site physical conditions. The values here adopted for Lo are defined as 132.5 m3/Mg of waste for the year 2006. The old landfill site close to the new one is not considered in the project activity. It was estimated using the national and sectoral average. According to the IPCC Guidelines, 1996, Lo values can range from less than 100 to 200 $m^3$/Mg. For this project, 80% is the estimated organic waste content, which would be expected to be in the range of 200 $m^3$/Mg. Thus, the 132.5 Lo value is quite conservative for its 80% organic waste content.


*Photo 1: Alto-Tietê landfill entrance.*

[15] *Source: National Inventory of Greenhouse Effect Gas Emission – CETESB, 2004.*


*Photo 2: Alto-Tietê landfill top view.*

## Annex 4

### MONITORING INFORMATION

The Monitoring plan is based on the approved monitoring methodology ACM-0001, "Consolidated baseline methodology for landfill gas project activities". The monitoring methodology is based on direct measurement of the amount of landfill gas captured and destroyed at the flare platform to determine the quantities as shown in Figure 2.

The monitoring plan provides for continuous measurement of the quantity and quality of LFG flared. The main variables that need to be determined are the quantity of methane actually captured (MDproject,y, which represents the amount of methane that *would* have been destroyed/combusted during the year), quantity of methane flared (MDflared,y, which represents the real quantity of methane destroyed by the flaring system), which are the same in the project activity and the quantity of methane generated (MDtotal,y).

The monitoring plan for the project activity and the Quality control (QC) and quality assurance (QA) procedures are based on the ACM-0001. The monitoring plan provides for continuous measurement of the quantity and quality of LFG flared and the quality control and quality assurance procedures are needed to ensure consistency on monitoring equipment and the data collected.

***1. Monitoring Process***

Below, the monitoring plan defines a set of parameters in order to calculate the main project activity variables.

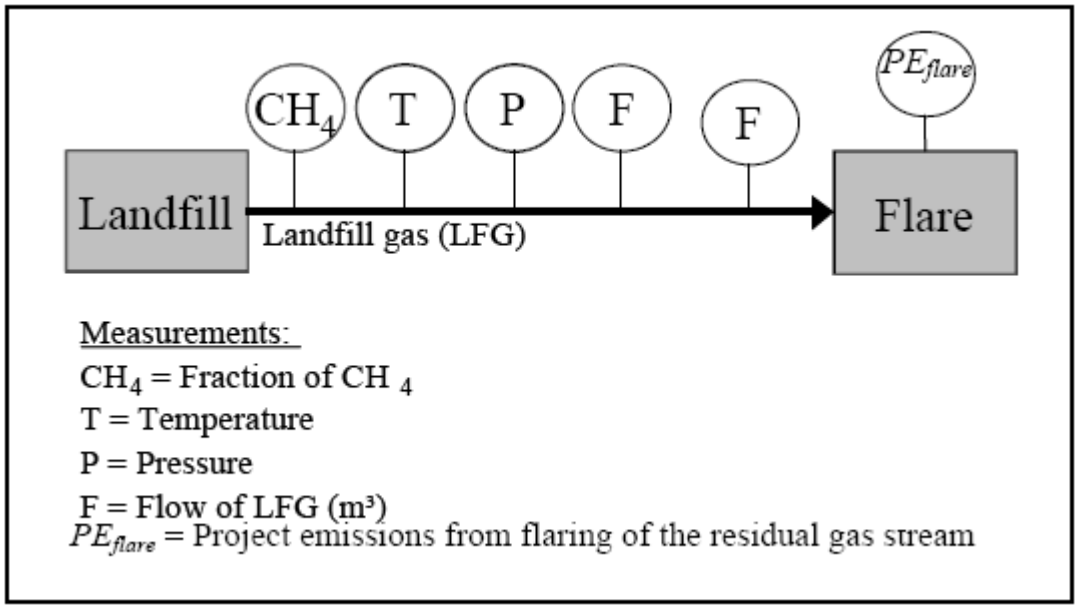


*Figure 2. Monitoring plan scheme for the Alto-Tietê landfill to gas project.*

At the figure 2, the landfill gas flows through the gas network up to the flaring point where the monitoring equipment is placed. Several sensors are placed on-line to the gas pipeline in order to measure continuous gas flows and this gas flow meter must be calibrated by an officially accredited entity.

The party responsible for implementing the monitoring plan shall be the landfill operation company *Pajoan Ltda*. The landfill operator will also be responsible for developing the forms and registration formats for data collection and further classification.

***2. Emissions reduction calculation process***

The monitoring process will establish the effective emissions reduction occurred at the landfill. The LFG generated at the cells will flow through the gas network to the gas treatment system under pressure conditions. The monitoring operation will result on $tCO_2equ.$ as the LFG is being flared.

For this purpose, the quantity LFG ($m^3$) and the methane content (%) of the LFG is monitored. The equation below outputs the amount of $CO_2e$ (in tonnes):

$$ER_y = (MD_{project,y} - MD_{reg,y}) * GWP_{CH4} + EL_y \cdot CEF_{electricity,y} - ET_y * CEF_{thermal,y}$$

(Equation 1)

| Parameter | Definition | Unit |
|---|---|---|
| $ER_y$ | Emissions reduction. | $tCO_2e$ |
| $MD_{project,y}$ | Amount of methane that would have been destroyed/combusted during the year y. | $tCH_4$ |
| $MD_{reg,y}$ [3] | Amount of methane that would have been destroyed/combusted during the year in the absence of the project. | $tCH_4$ |
| $GWP_{CH4}$ | Global Warming Potential value for methane for the first commitment period. | $tCO_2e/tCH_4$ |
| $EL_y$ | Net quantity of electricity exported during year y. | MWh |
| $CEF_{electricity}$ | $CO_2$ emissions intensity of the electricity displaced. This can be estimated using either ACM0002 or AMSI.D, if the capacity is within the small scale threshold values, when grid electricity is used or displaced, or AMS-I.A if captive electricity is used or displaced. For this project, the value used for CEFelectricity was calculated (ex-post) by the Brazilian DNA. | $tCO_2e/MWh$ |
| $ET_y$ | Incremental quantity of fossil fuel, defined as difference of fossil fuel used in the baseline and fossil use during project, for energy requirement on site under project activity during the year y. | TJ |
| $CEF_{thermal,y}$ | $CO_2$ emissions intensity of the fuel used to generate thermal/mechanical energy. | $tCO_2e/TJ$ |

*Table 15. Parameter used at the equation cited above..*

| Parameter | Definition | Unit |
|---|---|---|
| $Q_{T,x}$ | Amount of methane generated in the current year by the waste $R_x$ | tonnes |
| x | year of waste input | - |
| $R_x$ | Amount of waste disposed in year x | Mg |
| T | Current year | - |
| k | Methane generation rate | (L/yr) |
| Lo | Methane generation potential | m3/ Mg |

*Table 16. Parameter used at the equation cited above.*

The tables 15 and 16 show the parameters used at the equations above. The parameter $CEF_{electricity}$ is an ex-post calculated value[16] related to the region where the project activity is inserted. The amount of waste displaced on site is defined by the technical equipment.

The monitoring methodology schedules a continuous screening of the defined values and the further storage on a data-logger (set on place). Finally the data will be daily download and archived on electronic format. Please refer to the B.7.1 for more information.

***3. QA/QC procedures (Data consistency)***

The planning procedures are set to ensure consistency on the monitoring equipment and sensors (Quality control) and the data collected (Quality assurance). In cases of failure of measurement, failure will be reported to equipment supplier and repairs carried out. If repair is not possible, equipment will be replaced by equivalent item within one month. Failure events will be recorded in the site events log book. In addition, an alarm system in failure case will be adopted

The procedures are defined and based throughout the following points: process scheduling, operation and maintenance plan, data collecting and data registration, equipment calibration, quality auditing and quality prevention plan. The procedures also include measures to resolve non-conformities due to the implementation, operation and maintenance of the project activity.

The data to be included within the QA/QC procedures corresponds to B.7.1 on this PDD. The uncertainty level for the data was set in low. In order to ensure the reliability of the sensors, the following operation steps will be undertaken:

1. On-field sensors.

- LFG flow meter

  The meter will provide two values, the daily amount of LFG ($m^3$) stored by the data-logger and the total value to date passed through that will be shown at the flow meter. The validator will check both for consistency.

- Sampling points.

  The sensors will be placed at the gas network directly connected to the data logger that will register the pressure of the flowing gas. The meter will be checked by the technical team for consistency.

[16] National grid electricity emissions factors are available at: http://www.mct.gov.br/index.php/content/view/50862.html

- Methane analyzer.

  The most important parameter at the gas analyzer is the normal deviation from the marginal error presented at the electronic device. In order to ensure consistency, the project developer will follow the operation guidelines set up by the fabricant and technical standards provide by the Brazilian technical standard association (ABNT) for the sensor operation.

- Temperature and pressure sensor.

  The temperature and pressure will also suffer time to time deviation outside boundaries of the normal deviation set up by the fabricant. In order to ensure consistency, the project developer will follow recommendations on the operation guidelines defined either by the fabricant and the Brazilian technical standard association (ABNT) for the sensor operation.

2. Data logger

Several models for data logger are available at the market. The data logger will be connected directly to the electronic devices (PLC, flow meter, analyzer, temperature sensor). The performance of the data logger will allow hourly registration of the B.7.1 data being daily checked for consistency.

3. Energy meter

The electrical power consumption is measured by means of a kWh-meter.

***4. Operation and validation***

Nowadays, the project owner develops its own operation and environmental monitoring at the landfill and landfill premises. The current operation plan monitors the flux of the percolated liquid from landfill to the final treatment, the water quality at the freatic layers, cleaning and pest control activities and finally the administration of the existing re-forestation activities. The operation routine scheduled for the project activity will be added to the existing operation plan.

Moreover, the project developer will prepare an operation handbook for the monitoring plan. The manual will define the necessary technical and safety procedures for normal operation and the emergency measures for the project operation.

The project developer is the only responsible for the operation of the guidelines described at the handbook. Also the project developer will ensure enough human and material resources for the accomplishment of the activities within the monitoring plan.

***5. Regulatory requirements governing landfills in Brazil.***

The project developer will be responsible for the analysis and direct monitoring on the governmental rules regarding the landfill gas capture and destruction.

***6. Corrective, Preventive and Improvement actions.***

Actions and procedures are here defined for treating and correcting non-conformities, deviations from the Monitoring Plan and Operational Manual, observed by the landfill operator or during the periodic monitoring. In case of non-conformities regarding the maintenance and operation, further actions are implemented:

1. Problem analysis: Definition of the origin, causes and further actions to be undertaken.

2. Corrective actions: Administration staff will implement and reported to the technical staff the necessary measures.