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

CONTENTS

Annexes

SECTION A. General description of project activity

A.1 Title of the project activity:

>>

SANTECH – Saneamento & Tecnologia Ambiental Ltda. – SANTEC Resíduos landfill gas emission reduction Project Activity.

Version: 23

Date: 23/05/2008.

A.2. Description of the project activity:

>>

The primary objective of the SANTEC Resíduos landfill gas emission reduction Project Activity is to avoid greenhouse gases emission by the SANTEC Resíduos landfill through landfill gas capture and flaring, while contributing to the environmental, social and economic sustainability by minimizing global climate changes and local air pollution.

This project is owned by SANTECH – Saneamento & Tecnologia Ambiental Ltda., a waste management company originally founded in 2005, created to develop new technologies in the complete process of waste management, from pick-up to final disposal at sites strategically designed for waste treatment.

Today, SANTEC Residuos landfill has approximately 80 industrial customers, comprising the states of Santa Catarina and the north region of Rio Grande do Sul, and collects the residues of 19 cities. It was established in this region because of its deficiency in collecting and correctly disposing the industrial and commercial residues.

SANTEC Resíduos landfill (Figure 1) is located in Içara, state of Santa Catarina, south region of Brazil. It is operational since September, 2005, when the waste started to be deposited, and has 240 tonnes of deposit waste each day (80% of domestic and 20% industrial waste) and prediction date for closing is 2025 with 2 million tones of waste approximately. There is a passive venting system for biogas installed since the day it started to operate. A wake tractor is used to compact the waste.

Figure 1 - Overview from SANTEC Resíduos landfill

The project activity involves the installation of methane collection and destruction equipment consisting of pipes connected to the drainage wells leading to an enclosed flare capable of performing almost a complete destruction of the methane.

The organic content of the waste land filled, through its decomposition, produce large quantities of biogas whose major contents are methane (CH_4) and carbon dioxide (CO_2). The emission of these gases to the atmosphere, in the absence of the project activity, contributes to raise the greenhouse effect, climate global changes, besides its emissions can do harm to the surroundings by increasing potential explosions and fire risks. Additionally, the biogas causes bad odors and significant health impacts. The Project will have several positive social impacts as well as providing for both short and long-term employment opportunities for local people. Local contractors and laborers will be required for construction, and long-term staff will be used to operate and maintain the system, in addition, by paying the local authority a royalty fee from the sale of the carbon credits, the project will be injecting capital into the local economy, and its use will be entirely decided upon by the local authority.

Total emissions reductions are 276,343 tCO_2e over first 7 years crediting period. The revenues obtained from the sale of the CER's will also help SANTECH to continue supporting the community. SANTECH has a strong social responsibility evidenced in numerous initiatives, including: the complete recovery of Içara Waste Disposal; recovery of the area of preservation that leads to the landfill; Environment Educational Center, which promotes activities with the local neighbors and visitors of the landfill; Social Program, promotes incentives and qualification to the collectors of waste from Içara; and, incentives of researches with local schools. This revenue distribution and social efforts must be added to the environmental benefits when evaluating the contribution to sustainable development of this project activity.

Additionally, SANTECH received in October 2006 the prize Fritz Muller, granted by FATMA (State of Santa Catarina Environmental Agency) to the companies located in that state which had outstanding results in controlling the pollution generated in their productive process.

Figure 2 - Director of the SANTECH, William Wagner de Lima, receiving Trophy FRITZ MÜLLER 2006. (Picture: Felipe Christ)

A.3. Project participants:

>>

Name of Party involved	Private and/ or public entity(ies) project participants	Kindly indicate if the Party involved wishes to be considered as project participant (Yes/No)
Brazil (host)	SANTECH – Saneamento & Tecnologia Ambiental Ltda. (Private entity)	No
	Ecoinvest Carbon Brasil Ltda. (Private entity)	
(*) In accordance with the CDM modalities and procedures, at the time of making the CDM-PDD public at the stage of validation, a Party (country) involved may or may not have provided its approval. At the time requesting registration, the approval by the Party(ies) involved is required. Further contact information of project participants is provided in 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.:

>>

State of Santa Catarina, south of Brazil.

A.4.1.3. City/Town/Community etc:

Içara.

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

SANTEC Resíduos landfill is located on federal road BR-101, Km 389, city of Içara, state of Santa Catarina (Figure 3). Içara is a town of approximately 48,000 inhabitants. It is 182Km away from the state capital - Florianópolis - and it is the largest producer of plastics of all Latin America.

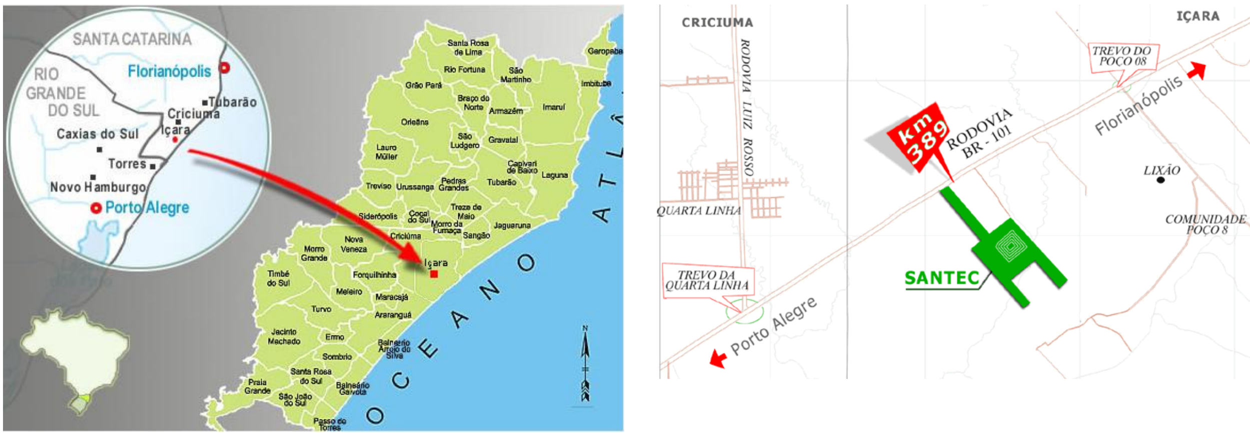

Figure 3 - Location of the project activity in the city of Içara

Point	GPS	
A	49d19'40.6"W	28d47'21.4"S
B	49d19'54.5"W	28d47'29.7"S
C	49d19'47.6"W	28d47'41.0"S
D	49d19'35.9"W	28d47'29.5"S

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

>>

According to Annex A of the Kyoto Protocol, this project fits in Sectoral Category 13, Waste Handling and Disposal.

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

>>

The project activity consists in substitute the passive venting system that operates at the present time in SANTEC Resíduos landfill, by a forced exhaustion one. The collection efficiency of the actual method of LFG emission avoidance is not enough to mitigate the impacts of these emissions, and will decrease due to this alteration. The landfill has the following structure (Figure 4 -).

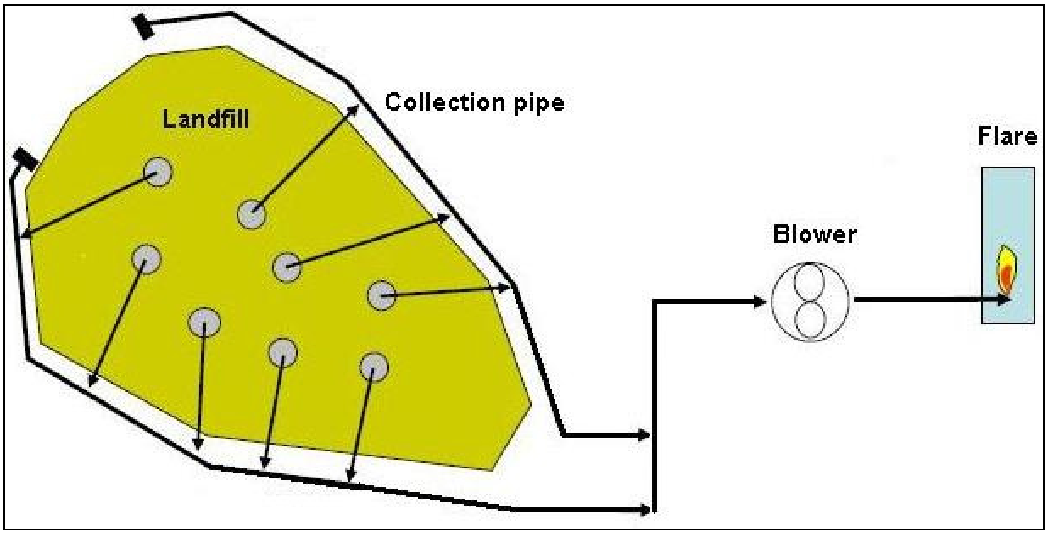

Figure 4 - Technical structure of the project activity

In the passive venting system the biogas is burned directly in the top of the well (well head), with probably less than 50% of combustion efficiency. The biogas that reaches these wells is located around the structure, and is drained naturally. Consequently, the LFG destruction efficiency is 9.25% of total LFG production (for details please refer to section B.6.1.). This scenario is typically what is practiced in Brazil. In the other hand, in the forced exhaustion system the biogas is collected through forced exhaustion promoted by blowers. The landfill is covered by clay to prevent the biogas to come out through the landfill surface. Consequently, the collection efficiency could reach 64 % in relation to the total LFG produced, depending on the area type and conditions (in operation or not). This efficiency is not monitored, but estimated for evaluating the amount of the landfill gas capturing for blowers. Also, the project activity will use an enclosed flare and continuous monitoring of compliance with the manufacturer's specifications of the flare in order to ensure a 90% of methane destruction.

The project activity involves the installation of state of the art LFG collection technology. This includes:

- Vertical gas wells drilled into waste to extract the LFG. The gas wells cover the area of the landfill available for gas extraction and are spaced on a site-specific grid to maximize LFG collection.
- The gas collection pipe work consists of pipes connecting groups of gas wells to the manifolds. Manifolds connect into a main pipe and then into the main header pipe delivering the gas to the extraction plant and the flare. The system is modular, so it is relatively easy to extend it on parts of the landfill available for gas extraction in the future.
- The gas collection pipe work allows for effective condensate management by employing dewatering points at strategic low points and returning the condensate back to landfill.
- The system operates at pressure slightly lower than atmospheric. A blower(s) draws the gas from the wells through the collection system and delivers it to the flare. The system is optimized to address issues related to pressure losses.
- For efficient operation of the gas collection system, each landfill cell, where the gas is collected from, is covered by an impermeable material (high density polyethylene membrane or mineral

material) to provide sufficient containment and prevent air ingress into landfill body.

The tentative schedule for the implementation of the project is as described below.
- Finalization of the engineering project on September 28th, 2007;
- Beginning of the environmental licensing process on October 5th, 2007;
- Beginning of the implementation of the project and elaboration of the operational instructions manual on April 1st, 2008;
- Beginning of the staff's training on July 1st, 2008;
- Works' finalization and beginning of the tests of biomass burning on September 20th, 2008;
- Practical training and final technical evaluation from August 20th to October 1st, 2008;
- Beginning of the forced gas collection and destruction on October 2nd, 2008.

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

>>

The total emission reductions of the project over the first crediting period of seven years are expected to be 276,343 tCO2e.

Table 1 - Estimated emission reductions from the project.

Year	Annual estimation of emission reductions in tones of CO2e
2008 (from October 1st)	2,286
2009	15,668
2010	25,294
2011	34,121
2012	42,434
2013	50,281
2014	57,703
2015 (until September 30th)	48,556
Total estimated reductions (tonnes of CO2e)	276,343
Total number of crediting years	7
Annual average over the crediting period of estimated reductions tonnes of CO2e)	**39,478**

A.4.5. Public funding of the project activity:

>>

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

SECTION B. Application of a baseline methodology

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

>>

- ACM0001 "Consolidated baseline methodology for landfill gas project activities" (version 6, 06 July 2007). ACM0001 refers to the following tools:
  - "Tool for the demonstration and assessment of additionality" – version 04, adopted at EB36.
  - "Tool to determine project emissions from flaring gases containing methane" – version adopted at EB28.

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

>>

ACM 0001 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; and/or
b) The captured gas is used to produce energy (e.g. electricity/thermal energy);
c) The captured gas is used to supply consumers through natural gas distribution network. If emissions reductions are claimed for displacing natural gas, project activities may use approved methodologies AM0053.

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

The project activity consists of collecting and flaring the landfill gas emitted in the project site. Therefore, situation a) described above is chosen.

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

>>

	Source	Spatial boundary	Gas	Included?	Justification
Baseline	Landfill Gas	Landfill site	CH_4	Yes	CH_4 is produced in landfills
	Electricity generation	Brazilian Interconnected Grid (S-SE-CO)	CO_2	No	There will be no electricity generation in the project boundary.
Project Activity	Electricity consumption	Brazilian Interconnected Grid (S-SE-CO)	CO_2	Yes	CO_2 is emitted for the consumption of electricity from the grid
	Fossil fuel consumption	Landfill site	CO_2	No	There isn't combustion of fossil fuel in the project boundary

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

>>

The methodology ACM0001 provides a procedure for the selection of the most plausible baseline scenario which is applied as follows.

STEP 1: identification of the alternative scenarios.

According to the methodology project participants should use step 1 of the latest version of the "Tool for the demonstration and assessment of additionality" (version 04, adopted at EB36), to identify all realistic and credible baseline alternatives. In applying such tool the outcome is given as follows.

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

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

So far, there is no obligation for an efficient treatment of the LFG in Brazil, neither a national model governing landfill practices. There are only technical norms as provisioned by the Brazilian Association of Technical Norms (ABNT), without any requirement regarding LFG management, besides gas venting.

A new National Waste Management Policy (*Política Nacional de Resíduos Sólidos*) is under discussion, but no change is foreseen for the next years. Even the project of such Policy does not specify when and how its legal requirements would be implemented. And it is unlikely to occur for the next years, since the landfills are in need for financial assistance from public and private sectors to operate and to comply with the basic requirements, such as monitoring, groundwater contamination prevention and leachate proper treatment.

The alternatives to the disposal of the waste considered are:

LFG1. The landfill owner could implement the proposed project activity without being registered as a CDM project activity, and

LFG2. Since there is no legislation obligating the landfill to destroy the methane, the landfill owner could continue the current business as usual: final disposal of solid waste with the practice of passive venting (i.e., not collecting and flaring) LFG directly to the atmosphere.

The project activity will neither generate power nor heat. Hence, there are no alternatives scenarios for these components.

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

All the alternatives listed above, which are to continue with the business as usual situation or implement the proposed CDM project activity without CDM incentives are consistent with Brazilian laws and regulations.

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

There will be no use of fossil fuel in the baseline in the project boundary. As a consequence this step is not applicable.

STEP 3: Step 2 and/or step 3 of the latest approved version of the "Tool for demonstration and assessment of additionality" shall be used to assess which of these alternatives should be excluded from further consideration.

Step 2 of the "Tool for demonstration and assessment of additionality" was applied under the section B.5. The outcome of it is that without carbon credit revenues, the project activity is not financially attractive. Hence, the most plausible scenario is the continuation of the present situation which is atmospheric release of landfill gas.

For more details, please refer to section B.5. below.

STEP 4: Where more than one credible and plausible alternative remains, project participants shall, as a conservative assumption, use the alternative baseline scenario that results in the lowest baseline emissions as the most likely baseline scenario. The least emission alternative will be identified for each component of the baseline scenario. In assessing these scenarios, any regulatory or contractual requirements should be taken into consideration.

There is only one credible and plausible alternative to the project activity which is the continuation of the current condition of operation of the landfill.

Identified Baseline Scenario:
LFG2: Partial capture of landfill gas and destruction to comply with regulations requirements.

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

>>

The project activity is not implemented yet. Project owner's first real action towards the development of the CDM Project Activity was the signature of the service contract with Ecoinvest Carbon Brasil Ltda. on June, 6th, 2006. The validation process started on August 15th, 2006. The tentative schedule of implementation as presented in section A.4.3. herein estimates the initial date of the project activity for the same period of expected registration by the CDM Executive Board.

The additionality of the project activity is demonstrated using the most recent version of the "Tool for demonstration and assessment of additionality" (version 4). Step 1 of the mentioned tool was covered in section B.4. above. Following the application of the tool, project participants decided to apply step 2 instead of step 3 as described below.

Step 2 - Investment analysis

Following ACM0001 baseline methodology, it must be determined whether the proposed project activity is the economically or financially less attractive than other alternatives without the revenue from the sale of certified emission reductions (CERs). To conduct the investment analysis, the following sub-steps are used:

Sub-step 2a. Determine appropriate analysis method

Once the CDM project activity only involves the collection and flaring of the LFG, it does not generate any financial or economic benefit other than CDM related income, the simple cost analysis scenario is applied.

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

The estimated costs of the project activity for the SANTEC Resíduos landfill are documented in the table below.

Table 2 - Costs related to project activity in the SANTEC Resíduos landfill[1].

Amount	Item description	Price/unit (USD)	Total (USD)
1	Implementation of the electric/automation system of the pump station	23,557.13	23,557.13
1	Pump station construction	35,335.69	35,335.69
1	Blower 1.200 Nm³/h	47,114.25	47,114.25
1	Flare 1.200 Nm³/h	88,339.22	88,339.22
3500	90 mm pipeline	14.72	51,531.21
3700	250 mm pipeline	47.11	174,322.73
7	Collectors acquisition and installation	2,061.25	14,428.74
58	PEAD collectors acquisition and installation	2,355.71	136,631.33
1	Valves	70,671.38	70,671.38
1	Labor	58,892.82	58,892.82
6	Demistors acquisition and installation	294.46	1,766.78
			USD 702,591.28

1 USD =	BRL 1.698

	Monthly	Annually
Maintenence costs	USD 14,051.83	USD 168,621.91

By investing in a landfill gas collection and flaring system the Project would not generate any revenues other than the CDM related ones. Therefore, the project activity is not economically attractive and not a realistic baseline scenario.

The outcome is that the project is demonstrably additional and would not be implemented without the CDM revenues. Hence, the continuation of the current situation which is collecting the landfill gas trough the passive venting system continues to be the only realistic and credible alternative.

Step 3. Barrier analysis

Not applicable.

step 4. Common Practice Analysis

Sub-step 4a: Analyse other activities similar to the proposed project activity

According to the latest official statistics on urban solid waste in Brazil – *Pesquisa Nacional de Saneamento Básico 2000* (PNSB 2000) – the country produces 228,413 tons of waste per day, which corresponds to 1.35 kg/inhabitant/day. And though there is a worldwide trend towards reducing, reusing and recycling, therefore decreasing the amount of urban solid waste to be disposed in landfills, the situation in Brazil is peculiar. A large part of the waste produced in the country is sent to open dumps which are, in most of the cases, areas without any sort of proper infrastructure to avoid environmental hazards. The Figure below shows the final disposal of waste, according to PNSB 2000.

[1] Technical Project Design "Aproveitamento do Biogás do Aterro Sanitário de Içara - SC" elaborated by CEPOLLINA Engenheiros Consultores S/S Ltda. in October, 2007.

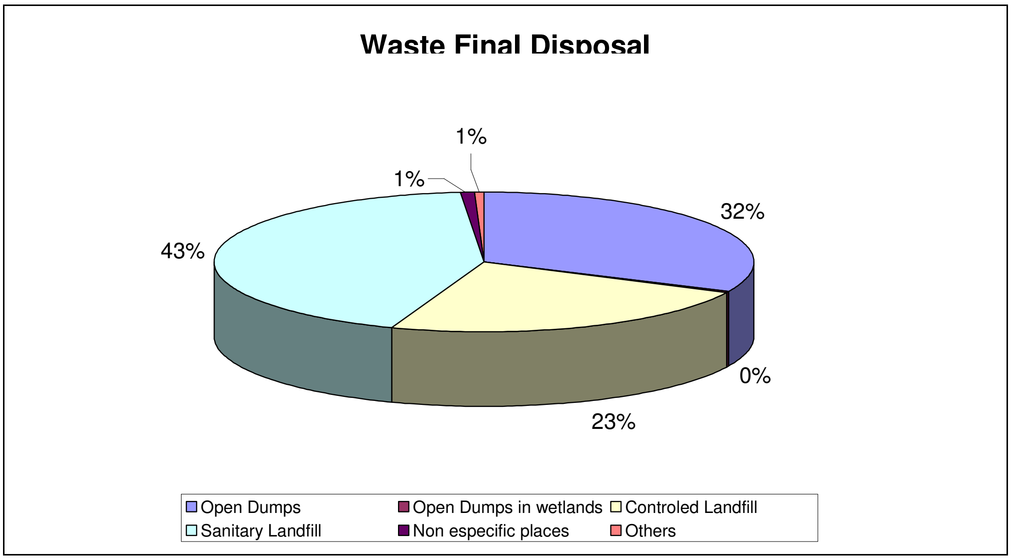

Figure 5 - Waste Final Destination per Municipality in Brazil (Source: PNSB, 2000).

Only few of the existing Brazilian landfills have installed a collecting and flaring methane system. The majority of landfills operate with natural emission of methane to the atmosphere, through concrete wells. This situation also can be evidenced when analyzing the *Diagnóstico do Manejo de Resíduos Sólidos Urbanos* elaborated by the Brazilian Ministry of the Cities in 2005[2].

This research was conducted considering a sample of the major municipalities of the country. It indicates the sanitation situation of the Brazilian municipalities and is part of the National System of Sanitation Information. From the collected sample, the results were the following:

- Only 40.3% of the final waste disposal units in the sample corresponded to sanitary landfills (*Diagnóstico do Manejo de Resíduos Sólidos Urbanos*, table 6.14, page 80), which is approximately the same value presented by the *Pesquisa Nacional de Saneamento Básico 2000* (PNSB 2000);
- Among all the units used to dispose urban solid residues analyzed by this research which includes beyond the sanitary landfills, open dumps and controlled landfills, only 53.2% of the 40.3% landfills of the country have a system to collect the landfill gas which not necessarily consist of a forced capture system (*Diagnóstico do Manejo de Resíduos Sólidos Urbanos*, table 6.16, page 81);
- The landfill gas is used/flared in only 5.9% of units of final waste disposal sites (*Diagnóstico do Manejo de Resíduos Sólidos Urbanos*, table 6.16, page 81). Disregarding the CDM projects from the sample of this research - which are Salvador da Bahia Landfill, Marca Landfill, Gramacho Landfill (not registered as CDM yet), Nova Gerar Landfill, Bandeirantes Landfill, Caximba Landfill – only 2,35% of the landfills use/flare the gas but are not CDM projects.

From these results, it is demonstrated that using the landfill gas can not be considered the common practice in the country.

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

As demonstrated above this kind of project activity is not widely spread in the host country and the landfills that operate this way represent only a small portion of the total existing landfills. From the total amount of waste that is generated in the country presented in the PNSB, only 20% of the waste is disposed

[2] Sistema Nacional de Informações sobre Saneamento: diagnóstico do manejo de resíduos sólidos urbanos – 2005. Brasília: MCIDADES.SNSA, 2007. Available at http://www.snis.gov.br/.

into Sanitary Landfills which are not registered as CDM Projects Activities. In addition, it is important to mention that among them there must be some which do not have forced system collecting methane.

Moreover, the installation of a LFG capture and flaring system, even undeveloped ones, are very costly for the landfill operator and bring no financial compensation. Therefore, this kind of project is only possible with CDM revenues and can not be considered as a business as usual activity.

B.6. Emission reductions:

B.6.1. Explanation of methodological choices:

The methodology ACM0001 requires that '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'.

The quantity of landfill gas flared by the project is estimated ex ante using the US EPA First Order Decay Model, using Lo (methane generation potential) and k (methane generation rate constant) values appropriate for Brazil. This ex ante estimate is only for illustrative purposes, as actual emissions reductions will be monitored directly, ex-post, according to the methodology.

The formulae used to calculate emissions reductions are detailed below. The data used to determine the emission reductions in the project scenario are:

- Total amount of LFG captured
- Amount of LFG flared
- Methane fraction in the LFG
- Temperature of the LFG
- Pressure of the LFG
- Methane fraction in the exhaust gas of the flare;
- Temperature in the exhaust gas of the flare;

According to ACM0001, version 6, 06 July 2007, emission reductions can be calculated using the following formula:

$$ER_y = (MD_{project,y} - MD_{reg,y}) \times GWP_{CH4} + EL_{LFG,y} \times CEF_{elec,BL,y} - EL_{PR} \times CEF_{elec,PR,y} + ET_{LFG,y} \times CEF_{ther,BL,y} - ET_{PR,y} \times EF_{fuel,PR,y} \quad \textbf{\textit{(1)}}$$

Where:

ER_y	: is emissions reduction, in tonnes of CO_2 equivalents (tCO_2e)
$MD_{project,y}$	: the amount of methane that would have been destroyed/combusted during the year, in tonnes of methane (tCH4)
$MD_{reg,y}$	: the amount of methane that would have been destroyed/combusted during the year in the absence of the project, in tonnes of methane (tCH4)
GWP_{CH4}	: Global Warming Potential value for methane for the first commitment period is 21 tCO_2e/tCH_4
$EL_{LFG,y}$	: Net quantity of electricity produced using LFG, which in the absence of the project activity would have been produced by power plants connected to the grid or by an on-site/off-site fossil fuel based captive

power generation, during the year y, in megawatt hours (MWh).

$CEF_{elec,BL.,y}$: CO_2 emissions intensity of the baseline source of electricity displaced, in tCO_2e/MWh.

ET_{LFGy} : the quantity of thermal energy produced utilizing the landfill gas, which in the absence of the project activity would have been produced from on-site/off-site fossil fuel fired boiler, during the year y in TJ.

$CEF_{therm,BL,y}$: CO2 emissions intensity of the fuel used by the boiler to generate thermal energy, which is displaced by LFG, based thermal energy generation, in tCO_2e/TJ. This is estimated as per equation (7) below

$EL_{PR,y}$: is the amount of electricity generated in an on-site fossil fuel fired power plant or imported from the grid as a result of the project activity, measured using an electricity meter (MWh)

$CEF_{elec,y,PR,y}$: is the carbon emissions factor for electricity generation in the project activity (tCO2/MWh)[3].

$ET_{PR,y}$ is the fossil fuel consumption on site during project activity in year y (tonne)

$EF_{fuel,PR,y}$ $EF_{fuel,PR,y}$ CO2 emissions factor of the fossil fuel used by boiler to generate thermal energy in the project activity during year y.

Determination of $MD_{project,y}$

$$MD_{project,y} = MD_{flared,y} + MD_{electricity,y} + MD_{thermal,y} \quad (2)$$

Where:

$MD_{project,y}$: the amount of methane that would have been destroyed/combusted during the year, in tonnes of methane (tCH4)

$MD_{flared,y}$: is the quantity of methane destroyed by flaring

$MD_{electricity,y}$: is the quantity of methane destroyed by generation of electricity

$MD_{thermal,y}$: is the quantity of methane destroyed for the generation of thermal energy

Determination of $MD_{flared,y}$

$$MD_{flared,y} = \left(LFG_{flare,y} \times w_{CH4,y} \times D_{CH4}\right) - \left(PE_{flare,y} / GWP_{CH4}\right) \quad (3)$$

Where:

$MD_{flared,y}$: is the quantity of methane destroyed by flaring

$LFG_{flare,y}$: is the quantity of landfill gas flared during the year measured in cubic meters (m^3)

$w_{CH4,y}$: is the average methane fraction of the landfill gas as measured during the year and expressed as a fraction (in m^3CH_4/m^3LFG)

D_{CH4} : is the methane density expressed in tonnes of methane per cubic meter of methane (tCH_4/m^3CH_4)[4]

---

[3] The electricity consumed by the project activity is purchased from the grid. Hence, the emission factor is calculated according to the methodology ACM0002.

$PE_{flare,y}$	: are the project emissions from flaring of the residual gas stream in year y (tCO_2), determined following the procedure described in the "Tool to determine project emissions from flaring gases containing methane";
GWP_{CH4}	: Global Warming Potential value for methane for the first commitment period is 21 tCO_2e/tCH_4

Not all the methane that reaches the flare is destroyed, and the methodology ACM0001 establishes that project emissions related to this matter shall be determined following the procedures described in the *"Tool to determine project emissions from flaring gases containing methane"*.
The mentioned tool is applicable under the following conditions:

- *The residual gas stream to be flared contains no other combustible gases than methane, carbon monoxide and hydrogen;*

- *The residual gas stream to be flared shall be obtained from decomposition of organic material (through landfills, bio-digesters or anaerobic lagoons, among others) or from gases vented in coal mines (coal mine methane and coal bed methane).*

The project activity consists of destroying gases released by a landfill. Hence, both applicability conditions are satisfied.

The tool also differentiates between open and enclosed flares. The proposed project will use an enclosed flare, since these are more effective in destroying methane.

For enclosed flares, the Tool proposes two options to determine the flare efficiency:
a) *To use a 90% default value. Continuous monitoring of compliance with manufacturer's specification of flare (temperature, flow rate of residual gas at the inlet of the flare) must be performed. If in a specific hour any of the parameters are out of the limit of manufacturer's specifications, a 50% default value for the flare efficiency should be used for the calculations for this specific hour.*
b) *Continuous monitoring of the methane destruction efficiency of the flare (flare efficiency).*

The project activity will use an enclosed flare and continuous monitoring of compliance with the manufacturer's specification of flare (option **a** above), in which case the Tool provides the steps described below.

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

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

Where:

$FM_{RG,h}$	Mass flow rate of the residual gas in hour h (kg/h)
$\rho_{RG,n,h}$	Density of the residual gas at normal conditions in hour h (kg/m³)
$FV_{RG,h}$	Volumetric flow rate of the residual gas in dry basis at normal conditions in the hour h (m³/h)

[4] At standard temperature and pressure (0 degree Celsius and 1,013 bar) the density of methane is 0.0007168 tCH_4/m^3CH_4.

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

Where:

$\rho_{RG,n,h}$	Density of the residual gas at normal conditions in hour h (kg/m³)
P_n	Atmospheric pressure at normal conditions (101,325) (Pa)
R_u	Universal ideal gas constant (8,314) (Pa.m³/kmol.K)
$MM_{RG,h}$	Molecular mass of the residual gas in hour h (kg/kmol)
T_n	Temperature at normal conditions (273.15) (K)

$$MM_{RG,h} = \sum_i fv_{i,h} \times MM_i$$

Where:

$MM_{RG,h}$	Molecular mass of the residual gas in hour h (kg/kmol)
$fv_{i,h}$	Volumetric fraction of component i in the residual gas in the hour h (-)
MM_j	Molecular mass of residual gas component I (kg/kmol)
i	The components CH_4, CO, CO_2, O_2, H_2, N_2

As a simplified approach, project participants will only measure the volumetric fraction of methane and consider the difference to 100% as being nitrogen (N_2).

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

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

Where:

$fm_{j,h}$	Mass fraction of element *j* in the residual gas in hour *h*
$fv_{i,h}$	Volumetric fraction of component *i* in the residual gas in the hour *h*
AM_j	Atomic mass of element *j* (kg/kmol)
$NA_{j,i}$	Number of atoms of element *j* in component *i*
$MM_{RG,h}$	Molecular mass of the residual gas in hour *h*
j	The elements carbon, hydrogen, oxygen and nitrogen
i	The components CH_4, CO, CO_2, O_2, H_2, N_2

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

Not applicable once the project will not continuously monitor the flare efficiency.

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

Not applicable once the project will not continuously monitor the flare efficiency.

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

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

Where:

$TM_{RG,h}$	Mass flow rate of methane in the residual gas in the hour *h* (kg/h)
$FV_{RG,h}$	Volumetric flow rate of the residual gas in dry basis at normal conditions in hour h (m³/h)
$fv_{RG4,RG,h}$	Volumetric fraction of methane in the residual gas on dry basis in hour h (NB: this corresponds to $fv_{i,RG,h}$ where i refers to methane). (-)
$\rho_{CH4,n}$	Density of methane at normal conditions (0.716) (kg/m³)

STEP 6. Determination of the hourly flare efficiency

In case of **enclosed flares and use of the default value** for the flare efficiency, as the case of the project activity, the flare efficiency in the hour *h* (η*flare,h*) is:

- 0% if the temperature of the exhaust gas of the flare (T_{flare}) is below 500 °C during more than 20 minutes during the hour *h*.

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

- 90%, if the temperature in the exhaust gas of the flare (T_{flare}) is above 500°C for more than 40 minutes during the hour *h* and the manufacturer's specifications on the proper operation of the flare **are met** continuously during the hour *h*.

STEP 7. Calculation of annual project emissions from flaring

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

Where:

$PE_{flare,y}$	Project emissions from flaring of the residual gas stream in year *y* (tCO_2)
$TM_{RG,h}$	Mass flow rate of methane in the residual gas in the hour *h* (kg/h)
$\eta_{flare,h}$	Flare efficiency in hour *h* (0.9, according with the "*Tool to determine project emissions from flaring gases containing methane*")
GWP_{CH4}	Global Warming Potential value for methane for the first commitment period is 21 tCO_2e/tCH_4

<u>Determination of $MD_{electricity,y}$</u>

$$MD_{electricity,y} = LFG_{electricity,y} \times w_{CH4,y} \times D_{CH4} \qquad (4)$$

Where:

$MD_{electricity,y}$	: is the quantity of methane destroyed by generation of electricity
$LFG_{electricity,y}$	: is the quantity of landfill gas fed into electricity generator
$w_{CH4,y}$	: is the average methane fraction of the landfill gas as measured during the year and expressed as a fraction (in m^3CH_4/m^3LFG)
D_{CH4}	: is the methane density expressed in tonnes of methane per cubic meter of methane (tCH_4/m^3CH_4)

Once the landfill does not generate electricity, $\underline{MD_{electricity,y}} = 0$.

<u>Determination of MD_{thermal}</u>

$$MD_{thermal,y} = LFG_{thermal,y} \times w_{CH4,y} \times D_{CH4} \tag{5}$$

Where:

$MD_{thermal,y}$	: is the quantity of methane destroyed for the generation of thermal energy
$LFG_{thermal,y}$	: is the quantity of methane gas fed into the boiler
$w_{CH4,y}$	: is the average methane fraction of the landfill gas as measured during the year and expressed as a fraction (in m^3CH_4/m^3LFG)
D_{CH4}	: is the methane density expressed in tonnes of methane per cubic meter of methane (tCH_4/m^3CH_4)

Once the landfill does not generate heat, $\underline{MD_{thermal,y}} = 0$.

Determination of MD_{reg}

$$MD_{reg,y} = MD_{project,y} * AF \tag{6}$$

Where:

MD_{reg}	: the amount of methane that would have been destroyed/combusted during the year in the absence of the project, in, tonnes of methane (tCH4)
$MD_{project,y}$	: the amount of methane that would have been destroyed/combusted during the year, in tonnes of methane (tCH4)
AF	: Adjustment factor

$MD_{reg,y}$ is neither given/defined as a quantity nor specified by regulatory or contractual requirements. Hence, the "Adjustment Factor" will be used as described in the above formula. It was estimated following the example provided by the methodology ACM0001, version 6, which is:

"*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 Brazil, sanitary landfills have to operate with a passive venting system. So, the Adjustment Factor was estimated following the below assumptions.

1. The percentage of methane collected in the baseline scenario using the passive venting system is 18.5%. The IPCC guidelines 2006 measured in 11 closed landfill sites (where the collection efficiency is greater than in operational landfill site) an average collection efficiency of 37% for active systems. The active systems avoid the LFG leakage through the surface by creating a negative pressure gradient (suction) in the landfill cells. In a conservative manner, it seems reasonable to estimate that 50% of the LFG collected in active systems are collected in passive systems. So, the percentage of the LFG that flows to the passive wells is 37% x 50% = 18.5%.
2. Destruction of the methane in the baseline scenario is 50%. The methane is combusted at the top of the wells, by means of destruction in a low efficiency manner. The "tool to determine project emissions from flaring gases containing methane", used as a conservative reference, says that for open flares, 50% of destruction efficiency should be used. It will also be considered that all of the wells will be burning methane continuously, which is also conservative.
3. The collection efficiency of the system implemented in the project activity is estimated to extract the LFG at a rate of 64% with a burning efficiency in the enclosed flare of 90%.

Therefore the adjustment factor is:

$$\boxed{AF = \frac{(37\% \times 50\%) \times 50\%}{64\% \times 90\%} = 16.1\%}$$

In order to be conservative, the AF used for the project activity was 20%.

Determination of $CEF_{ther,BL,y}$

$$CEF_{therm,BL,y} = \frac{EF_{fuel,BL}}{\varepsilon_{boiler}.NCV_{fuel,BL}} \qquad (7)$$

Where:

ε_{boiler}	: the energy efficiency of the boiler used in the absence of the project activity to generate the thermal energy
$NCV_{fuel,BL}$	: Net calorific value of fuel, as identified through the baseline identification procedure, used in the boiler to generate the thermal energy in the absence of the project activity in TJ per unit of volume or mass
$EF_{fuel,\ BL}$	: Emission factor of the fuel, as identified through the baseline identification procedure used in the boiler to generate the thermal energy in the absence of the project activity in tCO2/unit of volume or mass of the fuel

The final formula is:

$$ER_y = \left[MD_{project,y} - \left(MD_{project,y} \times AF\right)\right] \times GWP_{CH4} + EL_{LFG,y} \times CEF_{elec,BL,y} - EL_{PR}.CEF_{elec,PR,y} + ET_{LFG,y} * CEF_{therm,BL,y} - ET_{PR,y} \times EF_{fuel,PR,y} \quad \textit{(8)}$$

Considerations:

- The landfill does not have any contractual obligations to burn methane; so MD_{reg}, y is calculated based on the "Adjustment Factor", a value estimated as 20%;
- The GWP_{CH4} is 21 tCO_2/tCH_4;
- The landfill does not generate electricity, so $EL_{LFG,y} = 0$.
- The landfill does not generate heat, so $ET_{LFG,y} = 0$.
- There is no fossil fuel consumption on site during the project activity, hence $ET_{PR,y} = 0$

So the formula is simplified to:

$$ER_y = (MD_{project,y} - 0{,}2 MD_{project,y}) \times 21 - EL_{PR}.CEF_{elec,PR,y} \quad \textit{(9)}$$

Moreover, in the equation (2):

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

there is neither generation of energy nor heat, so $MD_{electrical,y} = 0$ and $MD_{thermal,y} = 0$.

Thus,

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

Where:

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

Therefore,

$$MD_{project,y} = (LFG_{flare,y} \times w_{CH4,y} \times D_{CH4}) - (PE_{flare,y} / GWP_{CH4}) \quad \textbf{(10)}$$

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

Data / Parameter:	**$CEF_{elec,y,PR,y}$**
Data unit:	tCO_2/MWh
Description:	Carbon emission factor of electricity
Source of data used:	ONS (*Operador Nacional do Sistema Elétrico* – Operator of the Brazilian Electric System)
Value of applied:	0.2826 tCO_2/MWh
Justification of the choice of data or description of measurement methods and procedures actually applied:	The electricity consumed in the project is generated by plants connected to the grid. Hence, the emission factor is calculated accordingly to ACM0002 (version 6) and for the first crediting period, emission factor will be calculated ex-ante.
Any comment:	

Data / Parameter:	**GWP_{CH4}**
Data unit:	tCO_2e/tCH_4
Description:	Methane Global Warming Potential
Source of data used:	Approved methodology ACM0001
Value applied:	21
Justification of the choice of data or description of measurement methods and procedures actually applied :	Parameter defined within the methodology ACM0001 / version 6.
Any comment:	

Data / Parameter:	**Methane density**
Data unit:	tCH_4/m^3CH_4
Description:	Conversion factor
Source of data used:	ACM0001 / version 6
Value applied:	0.0007168
Justification of the choice of data or description of measurement methods and procedures actually applied :	Parameter defined within the methodology ACM0001 / version 6. This factor will be adjusted depending on the on-site pressure and temperature conditions.
Any comment:	At standard temperature and pressure (0 degree Celsius and 1.013 bar).

Data / Parameter:	**Adjustment Factor**
Data unit:	%
Description:	Adjustment factor of the amount of methane that would have been destroyed in the absence of the project.
Source of data used:	Calculation of section B.6.1.
Value applied:	20
Justification of the choice of data or	There are no regulatory or contractual requirements to burn the methane in the country. This adjustment factor was already applied in similar CDM projects in

description of measurement methods and procedures actually applied :	Brazil.
Any comment:	

B.6.3 Ex-ante calculation of emission reductions:

From equation (9):

$$ER_y = (MD_{project,y} - 0{,}2MD_{project,y}) \times 21 - EL_{PR}.CEF_{elec,PR,y}$$

SANTEC Resíduos landfill will generate emissions due to the electricity consumption for their operation. The equipment which consumes more energy among all the components of the forced system is the blower. Although the model of this equipment is not defined yet, the basic characteristics it may have were quantified: extraction capacity of 1,200 Nm^3/h and operational pressure of 200mbar.

According to the engineer responsible for the project, the blower will consume approximately 14 kW and the whole system 20 kW.

Table 3 below shows the quantity of electricity imported and the associated project emissions:

Table 3 - Quantity of electricity imported and the project emissions in tCO_2

Year	Quantity of electricity consumption (MWh)	Emission factor for the Brazilian Interconnected Grid (tCO2/MWh)	Estimation of project emission due electricity consumption (tonnes of CO2e)
2008 (from October 1st)	44	0.2826	12
2009	175	0.2826	50
2010	175	0.2826	50
2011	175	0.2826	50
2012	175	0.2826	50
2013	175	0.2826	50
2014	175	0.2826	50
2015 (until September 30 st)	131	0.2826	37
TOTAL	**1,226**	**----**	**347**

The calculation details are in Annex 3.

Emissions reduction for the methane destruction component:
From the equation (10):

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

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

For ex-ante estimation is assumed a flare efficiency of 90% to calculate project emissions from the flare.

The estimative of the amount of landfill gas produced during year y and the data used to determine the baseline scenario is presented in Annex 3.

Emissions reductions (ER) are equal to **276,343 tCO_2e** over first 7 years crediting period**.** The estimated ER are expressed in the table in the following section and are equal to the baseline emissions - corresponding to the methane destroyed taking into account emissions associated with landfill gas flaring - minus the project activity emissions that are associated with electricity consumption.

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

The estimated results are expressed in the following table.

Table 4 - Summary of the estimation of emission reduction

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)
2008 (from October 1st)	12	2,298	0	2,286
2009	50	15,718	0	15,668
2010	50	25,344	0	25,294
2011	50	34,171	0	34,121
2012	50	42,484	0	42,434
2013	50	50,330	0	50,281
2014	50	57,752	0	57,703
2015 (until September 30 st)	37	48,593	0	48,556
TOTAL	**347**	**276,690**	**0**	**276,343**

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

B.7.1 Data and parameters monitored:

Data monitored and required for verification and issuance. All the information listed in this section will be kept for two years after the end of the crediting period or the last issuance of CER's for this project activity, whichever occurs later.

Data / Parameter:	$LFG_{Total,y}$
Data unit:	m^3
Description:	Total amount of landfill gas captured
Source of data to be used:	On-site measured by a flow meter.

Value of data applied for the purpose of calculating expected emission reductions in section B.6	**Year** / **$LFG_{Total,y}$**: 2008 – 424,142; 2009 – 2,900,474; 2010 – 4,676,817; 2011 – 6,305,731; 2012 – 7,839,793; 2013 – 9,287,683; 2014 – 10,657,375; 2015 – 8,967,149
Description of measurement methods and procedures to be applied:	Measured by a flow meter. Data to be aggregated monthly and yearly
QA/QC procedures to be applied:	Uncertainty level: Low Flow meter will be calibrated yearly, according to the Brazilian standard *NBR 10396 - Medidores de vazão de fluidos* (Flowmeters). Flow meters will be subject to a regular maintenance and testing regime in accordance with manufacturer specifications. Flow meters available in the Brazilian market have accuracy of +/- 1%.
Any comment:	This parameter corresponds to the Volumetric flow rate of the residual gas in dry basis at normal conditions in the hour *h* ($FV_{RG,h}$) of the "*Tool to determine project emissions from flaring gases containing methane"* and will be monitored considering the recommendations of the referred tool.

Year	$LFG_{Total,y}$
2008	424,142
2009	2,900,474
2010	4,676,817
2011	6,305,731
2012	7,839,793
2013	9,287,683
2014	10,657,375
2015	8,967,149

Data / Parameter:	**$LFG_{Flare,y}$**
Data unit:	m³
Description:	Amount of landfill gas flared.
Source of data to be used:	On-site measured by a flow meter.
Value of data applied for the purpose of calculating expected emission reductions in section B.6	(see table below)
Description of measurement methods and procedures to be applied:	The gas fed to the flare will be measured continuously by a flow meter. Data will be aggregated monthly and yearly.
QA/QC procedures to be applied:	Uncertainty level: Low Flow meter will be calibrated yearly, according to the Brazilian standard *NBR 10396 - Medidores de vazão de fluidos* (Flowmeters). Flow meters will be

Year	$LFG_{Flare,y}$
2008	424,142
2009	2,900,474
2010	4,676,817
2011	6,305,731
2012	7,839,793
2013	9,287,683
2014	10,657,375
2015	8,967,149

	subject to a regular maintenance and testing regime in accordance with manufacturer specifications. Flow meters available in the Brazilian market have accuracy of +/- 1%.
Any comment:	Considering that all the LFG is flared, this parameter also corresponds to the Volumetric flow rate of the residual gas in dry basis at normal conditions in the hour *h* ($FV_{RG,h}$) of the "*Tool to determine project emissions from flaring gases containing methane*" and will be monitored considering the recommendations of the referred tool.

Data / Parameter:	$PE_{flare,y}$
Data unit:	tCO_2
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.6	(see table below)
Description of measurement methods and procedures to be applied:	The approach selected from the "Methodological Tool to determine project emissions from flaring gases containing methane – version 1" was to monitor the temperature of the exhaust gas of the flare and the flow rate of residual gas at the inlet of the flare. The temperature will be done continuously. The measure will be done by a Type N thermocouple. The readings of temperature will be made by a computer based system, with continuous storage. If the temperature read is below 500ºC for any particular hour, then the flare efficiency during that hour is zero. By the time of validation the flare was not installed. Thus, the specifications of the flare's manufacturer will be available during the verification stage.
QA/QC procedures to be applied:	Thermocouples will be replaced or calibrated according with the manufacturer's specifications.
Any comment:	Monitoring of under responsibility of the SANTEC Residuos operators (the team, the organizational structure and the management structure will be defined after the project's implementation).

Years	**PEflare**
2008	319
2009	2,183
2010	3,520
2011	4,746
2012	5,901
2013	6,990
2014	8,021
2015	6,749

Data / Parameter:	W_{CH4}
Data unit:	m³ CH4/m³ LFG
Description:	Methane fraction in the landfill gas.
Source of data to be used:	On-site gas analyzer.
Value of data applied	50%

for the purpose of calculating expected emission reductions in section B.6	
Description of measurement methods and procedures to be applied:	Continuous measurement by a gas analyzer. Data to be aggregated monthly and yearly. As a simplified approach, project participant will measure only the fraction of methane and consider the difference to 100% as being nitrogen (N_2). In addition, project participants will check that the same basis (dry or wet) is considered for this measurement and the measurement of the volumetric flow rate of the residual gas ($FV_{RG,h}$) when the residual gas temperature exceeds 60 ºC.
QA/QC procedures to be applied:	Uncertainty level: Low The gas analyzer will be subject to a regular maintenance, testing and calibration regime in accordance with manufacturer specifications to ensure accuracy. Calibration will be done either manually or automatically on a weekly basis. Once a year the gas analyser will be calibrated by an independent company. A zero check and a typical value check will be performed by comparison with a standard certified gas.
Any comment:	This parameter corresponds to the Volumetric fraction of component *i* in the residual gas in the hour *h* where *i* = CH_4 ($fv_{i,h}$) of the "*Tool to determine project emissions from flaring gases containing methane*".

Data / Parameter:	**T**
Data unit:	°C
Description:	Temperature of the landfill gas.
Source of data to be used:	On-site meter
Value of data applied for the purpose of calculating expected emission reductions in section B.6	0ºC
Description of measurement methods and procedures to be applied:	Thermocouple attached to the Flow meter
QA/QC procedures to be applied:	Uncertainty level: Low Flowmeter will be calibrated yearly, according to the brazilian standard *NBR 10396 - Medidores de vazão de fluidos* (Flowmeters). Flowmeters will be subject to a regular maintenance and testing regime in accordance with manufacturer specifications. Flowmeters available in the brazilian market have accuracy of +/- 1%.
Any comment:	

Data / Parameter:	**P**
Data unit:	bar
Description:	Pressure of the landfill gas.
Source of data to be used:	On-site meter.
Value of data applied	1,013

for the purpose of calculating expected emission reductions in section B.6	
Description of measurement methods and procedures to be applied:	Pressure meter attached to the Flow meter
QA/QC procedures to be applied:	Uncertainty level: Low The pressure gauge will be calibrated as per manufacturer recommendations. It will be subject to a regular maintenance, testing and calibration regime in accordance with manufacturer specifications to ensure accuracy.
Any comment:	

Data / Parameter:	**EL_{PR}**
Data unit:	MWh
Description:	Total amount of electricity required to meet project requirement
Source of data to be used:	Energy meter and receipt of electricity purchase
Value of data applied for the purpose of calculating expected emission reductions in section B.6	175 MWh/year
Description of measurement methods and procedures to be applied:	The information about yearly consumption of electricity will be recorded by the project owner on a monthly basis. The electricity consumption can be cross-checked with the electricity invoices issued by the local electricity distribution company.
QA/QC procedures to be applied:	Uncertainty level: Low.
Any comment:	The meter will be subject to a regular maintenance, testing and calibration regime in accordance with manufacturer specifications to ensure accuracy

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:	n/a
Value of data applied for the purpose of calculating expected emission reductions in section B.6	n/a
Description of measurement methods and procedures to be applied:	The information though recorded annually, is used for changes to the adjustment factor (AF) or directly $MD_{reg,y}$ at renewal of the credit period.
QA/QC procedures to	All support documentation, assumptions and/or calculation will be made

be applied:	available for review by a verifier.
Any comment:	

The following variable is required to determine flare efficiency using the "*Tool to determine project emissions from flaring gases containing methane*"

Data / Parameter:	T_{flare}
Data unit:	ºC
Description:	Temperature in the exhaust gas of the flare.
Source of data to be used:	On-site measurement.
Value of data applied for the purpose of calculating expected emission reductions in section B.6	Higher than 500ºC
Description of measurement methods and procedures to be applied:	The measurement of the temperature of the exhaust gas stream in the flare will be done using 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. This parameter will be registered 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:

This section details the steps taken to monitor on a regular basis the GHG emissions reductions from the SANTEC Resíduos landfill gas capture project. The main components covered within the monitoring plan (MP) are:

1. Parameters to be monitored, and how the data will be collected
2. The equipment to be used in order to carry out monitoring
3. Operational procedures and quality assurance responsibilities

The requirements of this MP correspond to the kind of information routinely collected by companies managing landfill gas collection and destruction systems, so following the calibration procedures shown in Table in section B7.1 should be simple and straightforward. If necessary, the MP can be updated and adjusted to meet operational requirements, provided that a Designated Operational Entity approves such modifications during the process of verification.

Monitoring for SANTEC Residuos landfill gas capture project will begin with the start of operation in October 2008. The monitoring plan details the actions necessary to record all the variables and factors required by the methodology ACM0001, version 6, 06 July 2007. All data will be archived electronically, and data will be kept for the full crediting period, plus two years. Monitoring and calibration procedures are shown in the Tables in section B7.1.

Credit owner and project operator, SANTECH (listed under A.3. Project participants), is author and the responsible for all activities related to the project management, registration, monitoring, measurement and reporting.

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)

Date of completion: 27/08/2007
Person/entity determining the baseline:

Ecoinvest Carbon Brasil Ltda.
Rua Padre João Manoel 222
01411-000 São Paulo – SP
Brazil

Ana Paula Beber Veiga
ana.veiga@ecoinvestcarbon.com
Phone: +55 (11) 3063-9068
Fax: +55 (11) 3063-9069

Ecoinvest is the Project Advisor and also a Project Participant.

Detailed baseline information is attached in Annex 3.

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:

>> 06/June/2006.

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

>> 21 years

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

C.2.1. Renewable crediting period

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

>> The crediting period will start on 01/October/2008, or on the date of registration of the CDM project activity, whichever is later.

C.2.1.2. Length of the first crediting period:

>> 7 years

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 proponent of any project that involves the construction, installation, expansion, and operation of any polluting or potentially polluting activity or any activity capable of causing environmental degradation is required to secure a series of permits from the respective state environmental agency. In addition, any such activity requires the preparation of an environmental assessment report, prior to obtaining construction and operation permits. Three types of permits are required. The first is the preliminary permit (*Licenca Prévia* or L.P.) issued during the planning phase of the project and which contains basic requirements to be complied with during the construction, and operating stages. The second is the construction permit (*Licença de Instalação* or L.I.) and, the final one is the operating permit (*Licenca de Operação* or L.O.).

Regarding the operation of the landfill, the project has all the necessary environmental licenses. Operating permits were issued by the state of Santa Catarina environmental agency - FATMA (*Fundação do Meio Ambiente*) - LO nr. 116/2006, and by the municipality environmental agency – FUNDAI (*Fundação Municipal de Meio Ambiente de Içara*) – LO nr. 012/07.

Concerning the system of collecting and destroying the landfill gas, Santec is now requiring a new permit (on going process protocol nr.3604/07). All documents related to operational and environmental licensing are public and can be obtained at the state environmental agency (FATMA). Once Santec has received all the licenses it can be said that the project activity does not have significant transboundary environmental impact.

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:

>>

Collection and flaring of landfill gas results in destruction of other gases besides methane. These emissions include over 150 trace components of volatile organic compounds and sulfur dioxides, among others (not considered in this assessment) that can cause odor nuisances, stratospheric ozone layer depletion, and ground-level ozone creation. Besides, emissions reduction of LFG can also have significant health and safety implications at the local level. For example:

• Although the majority of LFG emissions are quickly diluted in the atmosphere, in confined spaces there is a risk of explosion and/or fire, either within the landfill or outside its boundaries.

• Potential threat of concentrated emissions of LFG is asphyxiation and/or toxic effects in human beings.

The installation of a well-designed landfill gas collection and destruction system, and its proper operation, will therefore reduce the risks faced by the surrounding communities. It is part of a broader effort by the Municipal Government to continue improving its waste management practices. Overall, sustainable management of the landfills will result in accelerating waste stabilization, so that the full decomposition of the waste in the landfills will be complete within 30-50 years.

SECTION E. Stakeholders' comments

>>

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

>>

Public discussion with local stakeholders is compulsory for obtaining the environmental construction and operating licenses which are necessary for the landfill operation. The public audience took place in the community center Rio dos Anjos, on June 15th, 2004 (Figure 6).

Figure 6 - Public audience compulsory for obtaining the environmental permits.

The legislation also requests the announcement of the issuance of the licenses (LP, LI and LO) in the local state official journal (*Diário Oficial*) and in the regional newspaper to make the process public and allow public information and opinion.

Regarding specifically the CDM Project Activity, the Brazilian Designated National Authority, *Comissão Interministerial de Mudanças Globais do Clima*, requires the compulsory invitation of selected stakeholders to comment the PDD sent to validation in order to provide the letter of approval.

Letters inviting local stakeholders for comments on the project were sent - by postal - on July 28th, 2006 to the organizations and entities listed below:

– Içara City Hall
– Içara City Council.
– State of Santa Catarina Environmental Agency.

- Environmental Department of Içara
- Local community association : Associação de Moradores do Bairro Rio dos Anjos
- Santa Catarina State Public Attorney
- FBOMS – *Fórum Brasileiro de ONGs e Movimentos Sociais*

No concerns were raised in the public calls regarding the project.

Besides, during the Global Stakeholders Process, SANTEC Residuos landfill PDD was available for comments in the United Nations Framework Convention on Climate Change website (http://www.unfccc.int/), where anyone could have access to the mentioned document from a legitimate source and will be able to express their opinion regarding the project activity.

E.2. Summary of the comments received:

>>

A letter from FBOMS was received, suggesting the use of Gold Standard or similar tools.

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

>>

The project participants consider that requests made by the Brazilian Government are sufficient to be used as sustainable indicators which are attended by this CDM project activity.

Annex 1

CONTACT INFORMATION ON PARTICIPANTS IN THE PROJECT ACTIVITY

Organization:	SANTECH - Saneamento & Tecnologia Ambiental Ltda.
Street/P.O.Box:	Rua Afonso Brás , 900/conj.71 - Vila Nova Conceição
Building:	
City:	São Paulo
State/Region:	São Paulo
Postfix/ZIP:	04511 - 001
Country:	Brazil
Telephone:	+55 (48) 3432 7636 - +55 (48) 3439 0507
FAX:	+55 (48) 3439 0507
E-Mail:	santec@santecresiduos.com.br
URL:	http://www.santecresiduos.com.br
Represented by:	
Title:	
Salutation:	Mr.
Last Name:	de Lima
Middle Name:	Wagner
First Name:	William
Department:	
Mobile:	
Direct FAX:	
Direct tel:	
Personal E-Mail:	santec@santecresiduos.com.br

Organization:	Ecoinvest Carbon Brasil Ltda.
Street/P.O.Box:	Rua Padre João Manoel, 222
Building:	
City:	São Paulo
State/Region:	São Paulo
Postfix/ZIP:	01411-000
Country:	Brazil
Telephone:	+55 (11) 3063-9068
FAX:	+55 (11) 3063-9069
E-Mail:	cmm@ecoinvestcarbon.com
URL:	http://www.ecoinvestcarbon.com/
Represented by:	
Title:	
Salutation:	Mr.
Last Name:	Martins
Middle Name:	de Mathias
First Name:	Carlos
Department:	
Mobile:	
Direct FAX:	
Direct tel:	
Personal E-Mail:	cmm@ecoinvestcarbon.com

Annex 2

INFORMATION REGARDING PUBLIC FUNDING

No public funding is involved in the present project.

This project is not a diverted ODA from an Annex 1 country.

Annex 3

BASELINE INFORMATION

The quantity of landfill gas flared by the project is *ex-ante* estimated using the US EPA First Order Decay Model[5], using Lo (methane generation potential) and k (methane generation rate constant) values appropriate for Brazil. GHG emissions by sources in the baseline were estimated using the 2006 IPCC Guidelines for National Greenhouse Gas Inventories.

1) Estimate of MSW flow

$$R_x = R_n * (1 + i)^{(x - y)}$$

Variable	Description	Unit
Rn	Amount of MSW deposited in the year of reference	[kg]
Rx	Estimate of the amount of MSW deposited in other years	[kg]
i	Rate of population growth during the period	[1/year]
x	Year	[year]
y	Year of the reference information	[year]

2) Estimate of methane generation (First Order Decay model)

$$\Sigma Q_x = R_x * k * L_o * e^{-k (x - T)}$$

Variable	Description	Unit
Q_x	Flow of methane of MSW deposited in year x	[m^3CH_4/year]
ΣQ_x	Sum of n flows of CH4	[m^3CH_4]
k	Decay constant	[1/year]
Rx	Flow of waste disposed in year x	[kg]
L_0	Potencial of methane generation	[m^3/kg]
x	Year of MSW depositing	[year]
n	Number of years	[year]
T	Present year	[year]

3) Estimate of total methane for Carbon Credits

$$CH_{4CC} = \Sigma Q_x * LB * TC * EQ * PE_{CH4}$$

Variable	Description	Unit
CH_{4CC}	Total methane for CC	[$kgCH_4$]
ΣQ_x	Sum of n flows of CH4	[m^3CH_4]
LB	Baseline	[%]
TC	Rate of colletion of CH4	[%]
EQ	Efficiency of CH4 burning	[%]
PE_{CH4}	Specific weight of CH4	[$kgCH_4/m^3CH_4$]

4) Total estimate of CO2eq

$$CO_2eq = (CH_{4CC} * GWP) / 1.000$$

Variable	Description	Unit
CO_2eq	Total carbon dioxide	[tCO_2eq]
CH_{4CC}	Total methane for CC	[$kgCH_4$]
GWP	GWP CH_4	[tCO_2/tCH_4]

[5] 2006 IPCC Guidelines for National Greenhouse Gas Inventories (Volume 5 - Chapter 3).

Table 5 - Landfill calculation parameters

Parameter	Units	Value	Source
Landfill data			
Year landfill started operation	year	2005	**SANTEC Residuos Landfill**
Waste in place at the beginning of project	Tonnes	78,900	
Density of waste	tonne/m³	1,0	
Area of site	ha	58	
Average daily waste rate	Tonnes/day	300	
Date gas collection project starts		1-Oct-08	
Operational data			
Gas collection efficiency[6]	%	64%	
Flare efficiency [7]	%	90%	
General data			
Lo	m³ CH_4/tonne	83	**IPCC[8]**
K	1/yr	0.09	
w_{CH4}	%	50	
CH_4 GWP	t CO_2/t CH_4	21	
D_{CH4}	Tonne/m³CH_4	0.0007168	
MCF	%	1.0	
Baseline data			
Proportion of methane flared in Baseline (Adjustment Factor - AF)[a]	%	20%	

a) Please refer to section B.6.1. for details on how this value was estimated.

6 Technical Project Design "Aproveitamento do Biogás do Aterro Sanitário de Içara - SC" elaborated by CEPOLLINA Engenheiros Consultores S/S Ltda. in October, 2007

7 “Methodological Tool to determine project emissions from flaring gases containing methane – version 1”

8 2006 IPCC Guidelines for National Greenhouse Gas Inventories (Volume 5 - Chapter 3)

Table 6 below presents the waste tonnage Options to Reduce Methane Emissions accepted at the SANTEC Residuos landfill.

Table 6 - Yearly waste disposal in SANTEC Residuos landfill

Year	Waste deposition[9] (tonnes)
2005	2,795
2006	78,900
2007	109,500
2008	146,000
2009	219,000
2010	219,000
2011	223,380
2012	227,848
2013	232,405
2014	237,053
2015	241,794
2016	246,630
2017	251,562

Project emissions associated with electricity import:

For the electricity import component, the emissions of the project activity (PE_y, in tCO_2e) during a given year y are the product of the baseline emissions factor (EF_y, in $tCO2e/MWh$) times the electricity imported by the project in the baseline ($EL_{IMP,y}$, in MWh), as follows:

$$PE_{y,electricity\_import} = EF_y \cdot EL_{IMP,y}$$

According to approved methodology ACM0002, version 6, May 19, 2006 a baseline emission factor (EF_y) is calculated as a combined margin (CM), consisting of the combination of operating margin (OM) and build margin (BM) factors according to the following three steps:

- **STEP 1** - Calculate the operating margin emission factor(s), based on one of the following methods
    - Simple operating margin
    - Simple adjusted operating margin
    - Dispatch data analysis operating margin
    - Average operating margin.

[9] In 2005, annual waste disposal data provided by SANTECH. Data for 2006 estimated by SANTECH.

Dispatch data analysis operating margin should be the first methodological choice. Since not enough data was supplied by the Brazilian national dispatch center, the choice is not currently available. The simple operating margin can only be used where low-cost/must-run resources[10] constitute less than 50% of total grid generation in: 1) average of 5 most recent years, or 2) based on long-term normals for hydroelectricity production. The share of hydroelectricity in the total electricity production for the Brazilian South-Southeast-Midwest interconnected system is much higher than 50% (see Table 7 below), resulting in the non-applicability of the simple operating margin to the project.

Table 7 - Share of hydroelectricity generation in the Brazilian S-SE-MW interconnected system, 1999 to 2003 (ONS, 2004).

Year	Share of hydroelectricity (%)
1999	*94.0*
2000	*90.1*
2001	*86.2*
2002	*90.0*
2003	*92.9*

The fourth alternative, an average operating margin, is an oversimplification and does not reflect at all the impact of the project activity in the operating margin. Therefore, the simple adjusted operating margin will be used in the project.

The simple adjusted operating margin emission factor ($EF_{OM,adjusted,y}$ in tCO_2/MWh) is a variation on the simple operating margin, where the power sources (including imports) are separated in low-cost/must-run power sources (*k*) and other power sources (*j*):

$$EF_{OM,simple-adjusted,y} = (1-\lambda_y)\frac{\sum_{i,j} F_{i,j,y} \cdot COEF_{i,j}}{\sum_j GEN_{j,y}} + \lambda_y \cdot \frac{\sum F_{i,k,y} \cdot COEF_{i,k}}{\sum_k GEN_{k,y}}$$ **Equation 1**

Where:

- λ_y is the share of hours in year *y* (in %) for which low-cost/must-run sources are on the margin.
- $F_{i,j,y}$ is the amount of fuel *i* (in mass or volume unit) consumed by relevant power sources *j* (analogous for sources *k*) in year(s) *y*,
- *j* refers to the power sources delivering electricity to the grid, not including low-operating cost and must-run power plants, and including imports to the grid. For imports from connected electricity system located in another country, the emission factor is 0 (zero).

[10] Low operating cost and must run resources typically include hydro, geothermal, wind, low-cost biomass, nuclear and solar generation (AM0015, 2004).

- k refers to the low-operating cost and must-run power sources.
- $COEF_{i,j}$ is the CO_{2e} coefficient of fuel i (tCO_{2e}/mass or volume unit of the fuel), taking into account the carbon dioxide equivalent emission potential of the fuels used by relevant power sources j (analogous for sources k) and the percent oxidation of the fuel in year(s) y and,
- $GEN_{j,y}$ is the electricity (MWh) delivered to the grid by source j (analogous for sources k),

The most recent numbers for the interconnected S-SE-MW system were obtained from the Brazilian national dispatch center, ONS (from the Portuguese *Operador Nacional do Sistema Elétrico)* in the form of daily consolidated reports (ONS-ADO, 2004). Data from 120 power plants, comprising 63.6 GW installed capacity and around 828 TWh electricity generation over the 3-year period were considered. With the numbers from ONS, Equation 2 is calculated, as described below:

$$EF_{OM-LCMR,y} = \frac{\sum_{i,k} F_{i,k,y} \cdot COEF_{i,k}}{\sum_{k} GEN_{j,k}}$$ **Equation 2**

Where:

- $EF_{OM\text{-}LCMR,y}$ is emission factor for low-cost/must-run resources(in tCO_2/MWh) by relevant power sources k in year(s) y.

Low-cost/must-run resources in Brazilian S-SE-MW interconnected system are hydro and thermonuclear power plants, considered free of greenhouse gases emissions, i.e., $COEF_{i,j}$ for these plants is zero. Hence, the emission factor for low-cost/must-run resources results, $EF_{OM,y} = 0$.

$$EF_{OM,y} = (1-\lambda_y)\frac{\sum_{i,j} F_{i,j,y} \cdot COEF_{i,j}}{\sum_{j} GEN_{j,y}}$$ **Equation 3**

Where:

- $EF_{OM,y}$ is the simple operating margin emission factor (in *tCO_2/MWh*), or the emission factor for non-low-cost/must-run resources by relevant power sources j in year(s) y.

Non-low-cost/must-run resources in Brazilian S-SE-MW interconnected system are thermo power plants burning coal, fuel oil, natural gas and diesel oil. These plants result in non-balanced emissions of greenhouse gases, calculated as follows:

These plants result in non-balanced emissions of greenhouse gases. The product $\sum_{i,k} F_{i,k,y} \cdot COEF_{i,k}$ for each one of the plants was obtained from:

$$F_{i,k,y} = \frac{GEN_{i,k,y} \cdot 3.6 \times 10^{-6}}{\eta_{i,k,y} \cdot NCV_i}$$ **Equation 4**

$$COEF_{i,k} = NCV_i \cdot EF_{CO2,i} \cdot 44/12 \cdot OXID_i$$ **Equation 5**

$$\textit{Hence, } F_{i,k,y} \cdot COEF_{i,k} = \frac{GEN_{i,k,y} \cdot EF_{CO2,i} \cdot OXID_i \cdot 44/12 \cdot 3.6 \times 10^{-6}}{\eta_{i,k,y}}$$ **Equation 6**

Where variable and parameters used are:

- $\sum_{i,j} F_{i,j,y}$ is given in [kg], $COEF_{i,j}$ in [tCO_2e/kg] and $F_{i,k,y} \cdot COEF_{i,k}$ in [tCO_2e]
- $GEN_{i,k,y}$ is the electricity generation for plant *k*, with fuel *i*, in year *y*, obtained from the ONS database, in MWh
- $EF_{CO2,i}$ is the emission factor for fuel *i*, obtained from the Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories, in tC/TJ.
- $OXID_i$ is the oxidization factor for fuel *i*, obtained from the Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories, in %.
- 44/12 is the carbon conversion factor, from tC to tCO_2.
- 3.6×10^{-6} is the energy conversion factor, from MWh to TJ.
- $\eta_{i,k,y}$ is the thermal efficiency of plant *k*, operating with fuel *i*, in year *y*, obtained from PCF (2003).
- NCV_i is the net calorific value of fuel *i* [TJ/kg].

$\sum_{k,y} GEN_{k,y}$ is obtained from the UT database, as the summation of non-low-cost/must-run resources electricity generation, in MWh.

Table 8 - Share of hours in year *y* (in %) for which low-cost/must-run sources are on the margin in the S-SE-MW system for the period 2003-2005 (ONS-ADO, 2005).

Year	$\frac{\sum_{i,k} F_{i,k,y} \cdot COEF_{i,k}}{\sum_k GEN_{k,y}}$ [tCO_2/MWh]	λ_y [%]
2003	0.9823	0.5312
2004	0.9163	0.5055
2005	0.8086	0.5130

With the numbers from ONS, the first step was to calculate the lambda and the emission factors for the simple operating margin. The λ_y factors are calculated as indicated in methodology ACM0002, with data obtained from the ONS database. The results for years 2003, 2004 and 2005 are presented in Table 8.

Finally, applying the obtained numbers to calculate $EF_{OM,simple\text{-}adjusted,2002\text{-}2004}$ as the weighted average *of* $EF_{OM,simple\text{-}adjusted\ 2003}$, $EF_{OM\ simple\text{-}\ adjusted,2004}$ *and* $EF_{OM,simple\text{-}adjusted,2005}$ and λ_y to Equation 3:

- $EF_{OM,simple\text{-}adjusted,2003\text{-}2005} = 0.4749\ tCO_{2e}/MWh$

- **STEP 2** – Calculate the build margin mission factor ($EF_{BM,y}$) as the generation weighted average emission factor (tCO_{2e}/MWh) of a sample of power plants *m*, as follows:

$$EF_{BM,y} = \frac{\sum_{i,m} F_{i,m,y} \cdot COEF_{i,m}}{\sum_{m} GEN_{m,y}} \qquad \textbf{Equation 7}$$

Where $F_{i,m,y}$, $COEF_{i,m}$ and $GEN_{m,y}$ are analogous to the variables described for the simple OM method (ACM-0002) for plants *m*, based on the most recent information available on plants already built. The sample group m consists of either:

- The five power plants that have been built most recently, or
- The power plants capacity additions in the electricity system that comprise 20% of the system generation (in MWh) and that have been built most recently.

Project participants should use from these two options that sample group that comprises the larger annual generation.

Applying the data from the Brazilian national dispatch center to the equation above:

$EF_{BM,2005} = 0.0903\ tCO_{2e}/MWh$

- **STEP 3** – Calculate the baseline emission factor EF_y, as the weighted average of the operating margin factor ($EF_{OM,y}$) and the build margin factor ($EF_{BM,y}$):

$$EF_y = w_{OM} \cdot EF_{OM,y} + w_{BM} \cdot EF_{BM,y} \qquad \textbf{Equation 8}$$

Finally, the electricity baseline emission factor is calculated through a weighted-average formula, considering both the OM and the BM, being the weights 50% and 50% by default:

$$EF_y = 0.5 \times 0.4749 + 0.5 \times 0.0903 \qquad \textbf{Equation 9}$$

$EF_y = 0.2826\ tCO_2/MWh$

Table 9 - Emission factors for the Brazilian South-Southeast-Midwest interconnected grid (simple adjusted operating margin factor)

Emission factors for the Brazilian South-Southeast-Midwest interconnected grid			
Baseline	EF_{OM} [tCO_2/MWh]	λ_y	Generation [MWh]
2006	0.8071	0.4185	315,192,117
2005	0.9653	0.5275	315,511,628
2004	0.9886	0.4937	301,422,617
	$EF_{OM,simple-adjusted}$ [tCO_2/MWh]	$EF_{BM,2006}$	Default EF_y [tCO_2/MWh]
	0.4749	0.0903	0.2826
	Alternative weights	Default weights	
	w_{OM} = 0.75	w_{OM} = 0.5	Alternative EF_y [tCO_2/MWh]
	w_{BM} = 0.25	w_{BM} = 0.5	0.379

$EF_{OM,average}$ [tCO_2/MWh]		Imports (MWh) net intl	Imports (MWh) net national
2006	0.0585	0	3,865,158
2005	0.0546	0	0
2004	0.0596	0	0

Using the numbers in the Table above, EFy=0.2826 tCO_2/MWh

EL_{IMP} = 175 MWh

EL_y = 50 tCO_2

The results obtained when applying the methods for estimating project emission reductions explained are presented in the next table. The spreadsheet with all the calculations is available upon request with project participants.

Table 10 - Results of the calculation of the project activity emissions reductions.

YEAR	2008	2009	2010	2011	2012	2013	2014	2015
LFG total (m^3)	1,696,568	2,900,474	4,676,817	6,305,731	7,839,793	9,287,683	10,657,375	11,956,198
Consumption electricity on site (MW)	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020
Install Capacity (MW)	0	0	0	0	0	0	0	0
LFG flare(m^3)	1,696,568	2,900,474	4,676,817	6,305,731	7,839,793	9,287,683	10,657,375	11,956,198
LFG eletricity (m^3)	0	0	0	0	0	0	0	0
LFG thermal (m^3)	0	0	0	0	0	0	0	0
MD flare (tCH4)	547	936	1,509	2,034	2,529	2,996	3,438	3,857
MD electricity (tCH4)	0	0	0	0	0	0	0	0
MD thermal (tCH4)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
MD project (tCH4)	547	936	1,509	2,034	2,529	2,996	3,438	3,857
Mdreg (tCH4)	109	187	302	407	506	599	688	771
ELy (MWh)	(175)	(175)	(175)	(175)	(175)	(175)	(175)	(175)
ETy (TJ)	0	0	0	0	0	0	0	0
Peflare (tCO2)	1,277	2,183	3,520	4,746	5,901	6,990	8,021	8,999
ERy (tCO_2)	9,144	15,668	25,294	34,121	42,434	50,281	57,703	64,741

Note: In the above table the values of all parameters in 2008 considers the whole year. Once the project starts in October, the values are different. The same applies to 2015 in which emissions reductions in this year must be considered until October but the table presents the results for the whole year.

Annex 4

MONITORING INFORMATION

From the monitoring methodology, it could be seen that there are five main variables to be measured:

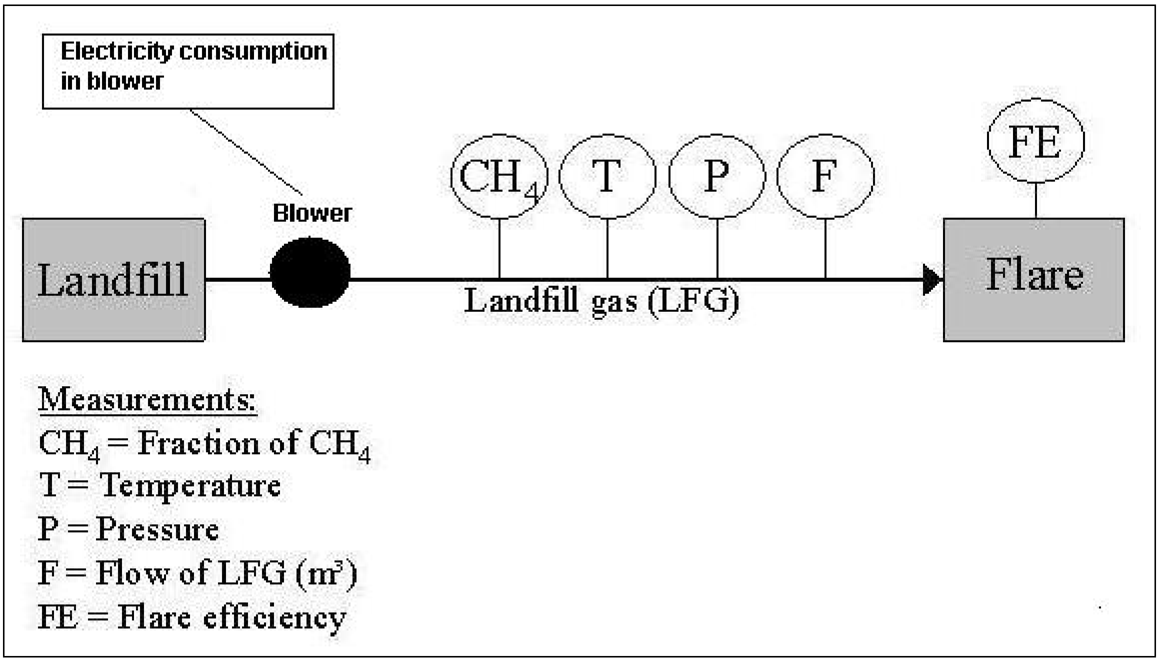

Figure 7 - Monitoring plan – Illustrative Picture

- The amount of landfill gas being sent to the flare (F);
- The amount of methane in the landfill gas (CH_4);
- The flare efficiency (FE).
- The pressure of the gas (P);
- The temperature of the gas (T);
- Project activity electricity consumption, in MWh (Blower);

The project is installed with most up-to-date equipment to perform measures continually and allow for remote access to equipment and data. The system equipments are connected through a Programmable Logic Control tool that lets operators quickly check the unit's main variables through a user-friendly interface. Through the PLC, users have also access to continuously measured data, such as methane content in the landfill gas and the methane flows.

The amount of landfill gas being sent to flare

The amount of landfill gas generated (in m³, using a continuous flow meter), where the total quantity ($LFG_{total,y}$) is measured continuously. Using data of the temperature and pressure, the flow is converted to Nm³ (methane in the normal conditions – 0°C and 1,013 bar) and multiplied by the methane percentage into the landfill gas (measured for continuous gas analyzer) to result Nm³ methane. Discounting such number by 20% (Effectiveness Adjustment Factor), the baseline emissions of the project are determined.

The amount of methane in the landfill gas

The fraction of methane in landfill gas (wCH_4) will be measured with a continuous analyzer The continuous methane analyzer is the preferred option because the methane content of landfill gas captured can vary by more than 20% during a single day due to gas capture network conditions (dilution with air at wellheads, leakage on pipes, etc.).

The flares' efficiencies:
The approach selected from the "Methodological Tool to determine project emissions from flaring gases containing methane – version 1" is the continuous monitoring of compliance with manufacturer's specification of flare. If in any moment these specifications could not be observed the flare efficiency will be considered as equal to 50%.
Additionally, according to this approach, the temperature of the exhaust gas of the flare will also be monitored. If the temperature read is below 500ºC for any particular hour, then the flare efficiency during that hour is zero. The 90 % default value for flare efficiency will be only considered if the temperature in the exhaust gas of the flare is above 500°C for more than 40 minutes during the hour h and the manufacturer's specifications on proper operation of the flare are met continuously during the hour h.

The pressure and temperature of the residual gas:
The pressure and temperature will be measured by continuous analyzers to determine the density of the methane.

Project activity electricity consumption, in MWh.
The amount of electricity consumed for the project activity will be monitored by an electricity meter and consolidated in a monthly basis. This information can be cross-checked with the invoices issued by the local electricity distribution company.

Annex 5

BIBLIOGRAPHY

ACM0001 (2007). Consolidated baseline methodology for landfill gas project activities. Version 6; 06th July 2007. Web-site: http://cdm.unfccc.int/.

DGXI (1998) - Options to Reduce Methane Emissions (Final Report).

Eletrobrás (1999). Diretrizes para estudos e projetos de pequenas centrais hidrelétricas. Centrais Elétricas Brasileiras S/A Web-site: http://www.eletrobras.gov.br/.

IBGE (2006). Banco de dados Cidades@,. Instituto Brasileiro de Geografia e Estatística (http://www.ibge.gov.br/).

IPCC (2006). 2006 IPCC Guidelines for National Greenhouse Gas Inventories (Volume 5) (http://www.ipcc.ch/).

Ministério das Cidades. Programa de Modernização do Setor Saneamento Sistema Nacional de Informações sobre Saneamento: diagnóstico do manejo de resíduos sólidos urbanos – 2005. Brasília: MCIDADES.SNSA, 2007. 394 p. (http://www.snis.gov.br/).

OECD (2004). Environmental Outlook. Organization for Economic Cooperation and Development. Web-site: http://www.oecd.org/env/

OECD (2005). OECD Economic Survey of Brazil 2005: Regulation of the electricity sector. Organization for Economic Co-Operation and Development, Paris, France

ONS (2004). De olho na energia: Histórico da energia, carga própria de energia 1999-2003. Operador Nacional do Sistema Elétrico Brasileiro. Web-site: http://www.ons.gov.br/.

ONS-ADO (2004). Acompanhamento Diário da Operação do Sistema Interligado Nacional. ONS-CNOS, Centro Nacional de Operação do Sistema. Daily reports on the whole interconnected electricity system from Jan. 1, 2001 to Dec. 31, 2003. Web-site: http://www.ons.gov.br/.

Schaeffer, R., J. Logan, A. S. Szklo, W. Chandler and J. C. de Souza (2000). Electric Power Options in Brazil. Pew Center on Global Climate Change.

WCED (1987). Our Common Future. The World Commission on Environment and Development. Oxford University Press.

World Bank (2003) - Handbook for preparing LFG-to-Energy Projects in Latin America and the Caribbean.