PROJECT DESIGN DOCUMENT

Proactiva Tijuquinhas Landfill Gas Capture and Flaring Project

CLEAN DEVELOPMENT MECHANISM PROJECT DESIGN DOCUMENT

TIJUQUINHAS LANDFILL SANTA CATARINA, BRAZIL

Version 4

-

JANUARY 2007

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

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Annexes

SECTION A. General description of project activity

A.1 Title of the project activity:

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Proactiva Tijuquinhas Landfill Gas Capture and Flaring project, January 2007, version 4

A.2. Description of the project activity:

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The project involves landfill gas capture and flaring at the Tijuquinhas municipal solid waste landfill site in Biguaçu in the state of Santa Catarina in Brazil. The Tijuquinhas Landfill started to receive waste in 1991. The landfill is used for disposal of the waste generated by the 950 000 inhabitants of 21 municipalities in the county of Florianópolis.

Figure 1: view of gas wells at the boarder of zone 2

The landfill is currently owned and operated by Proactiva Brasil. Proactiva Brasil, the project developer, is the Brazilian subsidiary of Proactiva Medio Ambiente, a Spanish company headquartered in Madrid. Proactiva Medio Ambiente is a leading environmental service provider in South America, offering waste management to water and wastewater services. Proactiva was created in 1996 when its two 50% shareholders Fomento de Construcciones y Contratas, S.A. (FCC) and Veolia Environnement decided to join forces to establish their environmental services activities in South America. Both companies are international references.

Proactiva provides waste management services to 7,100 industrial clients and 90 municipalities that account for 26 millions people. To offer integrated solutions to its clients, Proactiva has developed advanced know-how and capabilities covering the full spectrum of waste management activities: municipal solid waste collection, industrial waste recycling, landfill construction and operation, waste final disposal, urban cleaning, hospital waste collection and treatment and operation of waste transfer plants.

Present in 6 countries in South America, Proactiva operates 13 landfills that treated 5.5 million tonnes of waste in 2005. All of these landfills are equipped with safe and modern systems for treatment and final disposal of solid waste: liner systems, stormwater drainage, leachate collection and treatment, best practices for passive landfill gas venting, monitoring of surface and groundwater.

Proactiva acquired the landfill and commenced operation in 2002. It provides adequate solution to dispose an average of 240,000 tonnes of household waste per year.

The environmental management of the Tijuquinhas landfill is recognised to be one of the best in the state of Santa Catarina. In a recent study, mandated by the Public Minister of the Santa Catarina State, the ABES[1] classified the State's landfills according to area's characteristics, existing infrastructures and management techniques. This evaluation results in an aggregated index of quality for the landfills ranging from 0 to 10. Tijuquinhas landfill was qualified with an index of 9 that stands for sanitary landfills with excellent management conditions.

Project objective:
The project objective is to maximise the capture of landfill gas (LFG) from the landfill site and to flare it. In addition to reducing the potential local impacts of odours and explosion or fire hazard associated with landfill gas, the project is aimed at reducing the fugitive emissions of methane, a greenhouse gas which contributes to global warming and climate change.

Project activity:
The project activity includes the installation of enhanced landfill gas extraction and flaring equipment for the destruction of the landfill methane that will be collected from the existing and future disposal areas instead of releasing it to the atmosphere.

The extraction system will consist of a network of HDPE gas wells connected to a main collector. The gas will be driven to the flare thanks to a blower and then flared. The flare will be enclosed allowing the full combustion of methane at high temperature.

The project will have several sustainable development benefits.

<u>Environmental Benefits:</u>
The project activity will contribute to enhanced environmental improvements by providing infrastructure to reduce greenhouse gas emissions from the landfill site.

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[1] Source: ABES (Associação Brasileira de Engenharia Sanitária e Ambiental) on request of the Public Minister of the Santa Catarina State. *Relatório do Projeto de Verificação da Sustentabilidade do Programa Lixo Nosso de Cada Dia, do Ministério Público do Estado de Santa Catarina*, April 2006.

The implementation of a CDM project at the Tijuquinhas landfill will continue the environmental improvements and will make a positive contribution to the global issue of climate change by reducing greenhouse gas emissions.

In addition, flaring of the collected LFG does not only destroy methane, but will also destroy compounds in the LFG such as volatile organic compounds and ammonia. This project will prevent the following risks associated with landfill gas at uncontrolled landfills:

- Risk of explosion
- Risk of fire
- Unpleasant odours nuisances
- GHG emission effects
- Potential atmospheric pollution
- Damage to vegetation by asphyxia

Technology transfer:
Besides improving overall management of landfill, the project will support efforts aimed at facilitating the dissemination of design and operational experience gained at Tijuquinhas landfill for possible use throughout the country or region.

Social benefit:
Social benefits of the project will be diversified. The expected effects are :

- effects in terms of enhancing human resources through introduction of new technology and trainings
- effects in terms of employments creation.

Recovering and flaring landfill gas with an active system will not only contribute to the mitigation of climate change, but also to the improvement of health and quality of life in the neighbouring area. Beyond environmental benefits, this project will also support the local economic development thanks to technology transfer and local employment conditions.
Indeed, the implementation of the project and its operation over 21 years will create direct and indirect jobs. A technician will be required in order to look after the landfill gas network and flare. This technician will be trained in advanced landfill operation techniques in order to optimize the landfill gas collection system on a daily basis.
In addition, indirect activities will be created in Brazil for the implementation and the control of the project, leading to more employment.

Taking into account the improvements in social, economic, environmental and technological well-being that the project activity is potentially able to offer, the project participants Proactiva Brasil, Proactiva Medio Ambiente and Veolia Propreté are convinced of the positive and long-term contribution of the CDM to sustainable development in Santa Catarina State and, more widely, in Brazil.

A.3. Project participants:

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Project participants are described below. For full contact details, please, refer to Annexe 1 of this document.

Name of Party involved (*) ((host) indicates a host party)	Private and/or public entity(ies), project participant (*) (as applicable)	Kindly indicate if the party involved wishes to be considered as a project participant (Yes/No)
Brazil (Host Country)	Proactiva Brasil	No
Spain	Proactiva Medio Ambiente	No
France	Veolia Propreté	No
(*) In accordance with the CDM modalities and procedures, at the time of making the CDM-PDD public at the stage of validation, a Party involved may or may not have provided its approval. At the time of requesting registration, the approval by the Party(ies) involved is required.		

A.4. Technical description of the project activity:

A.4.1. Location of the project activity:

A.4.1.1. Host Party(ies):

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Brazil

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

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Santa Catarina

A.4.1.3. City/Town/Community etc:

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Tijuquinhas

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

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The landfill associated with the project activity is located in the municipality of Biguaçu, around 30 km northwest of Florianópolis on the continental side of the Santa Catarina coast, as shown in figure 2. The site access is by BR 101, km 177.6. The landfill area is delimited by the following coordinates: 732;734 East and 6970;6972 South. Land occupation around the site is characterised by the predominance of rural activities as there is no urban centre within 8 km from the landfill.

The landfill operation covers an area of approximately 200,000 m^2.

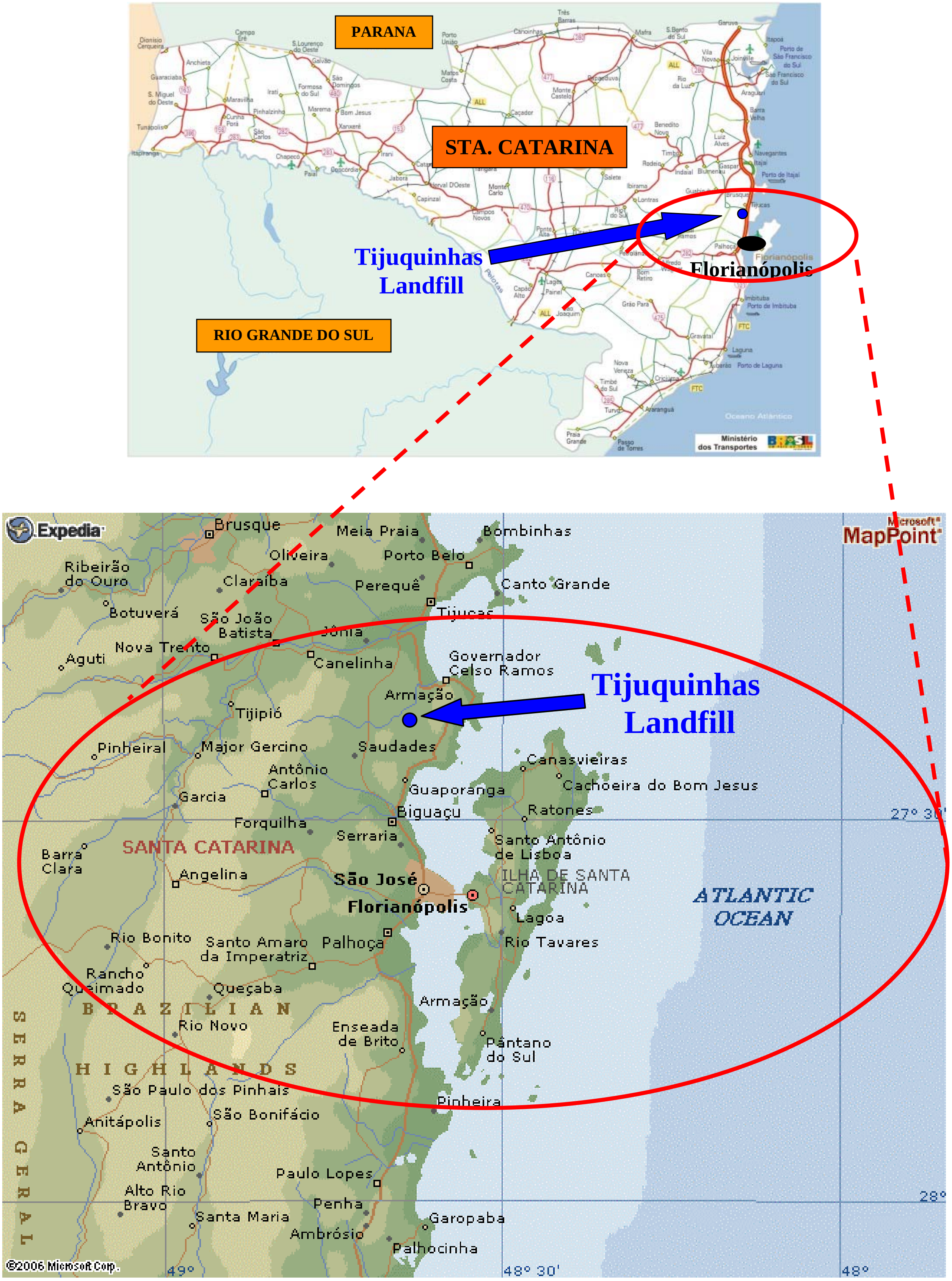

Figure 2: detail on the landfill physical location

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

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Waste handling and disposal

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

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The Tijuquinhas landfill can be described in 3 distinct zones based on the existing and proposed landfill gas collection system infrastructure. Zone 1 and 2 have been filled with waste. Zone 3 is the future lined disposal area being constructed above the existing filled zones. Figure 3 below shows a cross section of the landfill:

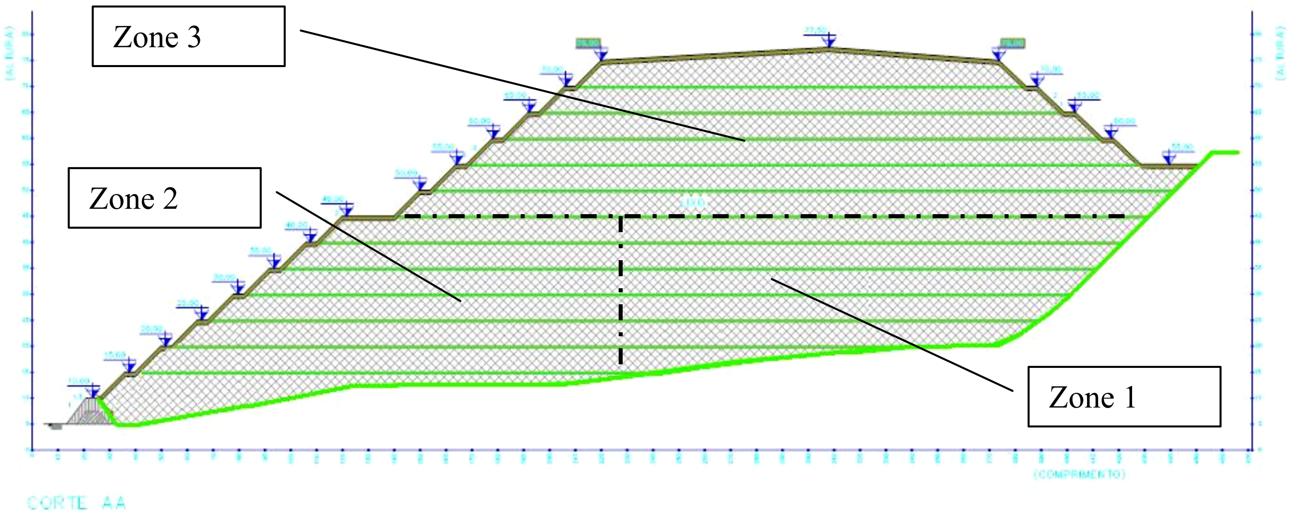

Figure 3: Cross section of the Tijuquinhas landfill

Zone 1 and 2 are areas that have already received waste. Filling at the site began in 1991. Approximately 2 million tonnes of waste have been landfilled to date.

Zone 3 overlies zones 1 and 2 and is the future disposal area. It is expected to landfill up to 1.8 million tonnes of waste in zone 3 until 2013.

A liner and leachate collection system will be installed at the base of zone 3 covering the older filled portions of the site.

Each of these 3 zones will be equipped with landfill gas collection systems as follows:

Zone 1: Horizontal collection trenches will be installed in advance of the placement of the Zone 3 liner system. This trench system will be interconnected to the existing vertical wells. The trenches will be spaced at 25 meters and will run the entire length of the zone.

Zone 2: Vertical concrete wells have been installed during landfill operations. These wells are currently acting as passive vents. At times, the emitted gas from the vents is ignited to reduce onsite odours.

A serie of horizontal trenches will also be installed in this zone prior to liner placement. The existing vertical wells and the horizontal trenches will be connected to the active extraction system.

Zone 3: Horizontal collection trenches will be installed in the active filling areas as landfilling progresses. This modern technique allows to improve gas collection by collecting landfill gas during operation and prior the cell completion. This technique should prevent a large amount of gas to be released to the atmosphere. In addition, vertical concrete wells will be installed as landfilling progresses.

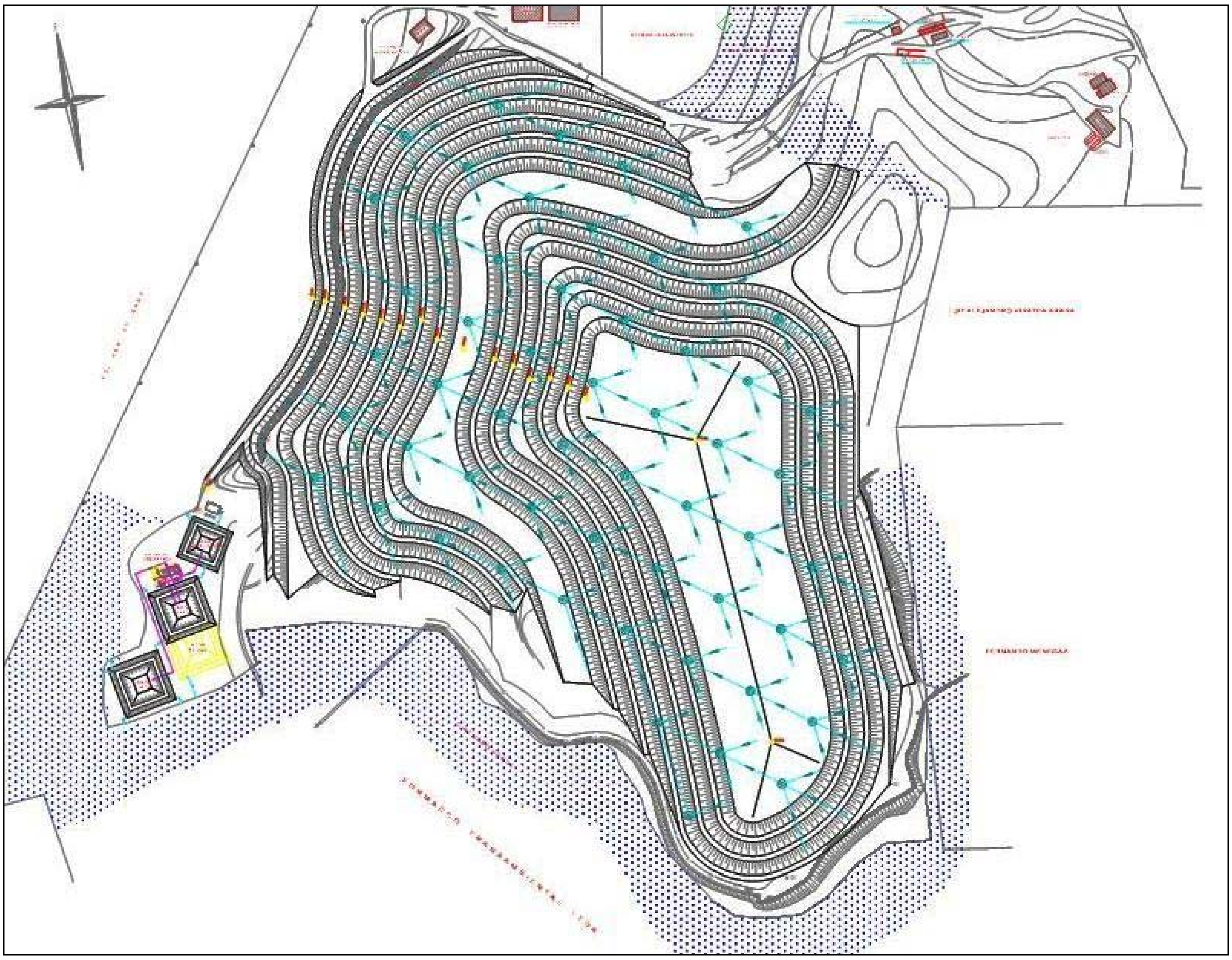

Figure 4 : Final elevation level of the Tijuquinhas site

Figure 5: Installation of geomembrane on top of zone 1

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

Lateral collection drains

Lateral collection drains will be placed at regular distance as landfilling progresses. The horizontal trenches will be installed every 5 meters in depth and spaced every 25 meters. They will consist of piping surrounded by gravel or other suitable drainage material.

Vertical wells

Verticals wells may also be drilled into the landfill once areas reach their final elevation and final cover has been applied. The vertical wells consist of a pipe perforated in its lower part, placed in a drilled borehole in the waste, backfilled with gravel and sealed at the surface.

Vertical wells advanced during filling will also be used. They will consist of cylindrical wire mesh baskets filled with stone and constructed with central concrete pipe.

Both well types will be equipped with wellheads that enable monitoring of gas flow and quality. Also valves are provided to allow adjustment of the available vacuum at each well.

Leachate pumping systems

In some cases, leachate can prevent proper collection of landfill gas. Consequently, leachate collection will be improved by enhancing the quality of the drainage layer and, if necessary, installing submersible leachate pumps in the LFG extraction wells. Pumping of the accumulated leachate will enhance LFG well collection efficiency.

Collection piping

A high-density polyethylene (HDPE) collection piping system will be installed to convey the landfill gas from the well network to the blower and flare system. The layout of the future systems will be implemented in order to minimise the low points which could disturb or prevent the gas collection (due to condensate blockages).

The landfill gas combustion system consists of the following equipment:

Enclosed flare

The project entails the installation of flaring units for the destruction of the captured LFG. The flare will be enclosed and provide a retention time above 0,3 second. Flare will be temperature controlled, at high temperature above 700°C, in order to assure methane destruction rate close to 100%.

Controls

The flare will be equipped with automatic safety and monitoring controls.

Blower

A blower will be used to create the required vacuum in the collection network to extract the LFG. The number of blowers will be adjusted in function of the quality and quantity of gas to be collected.

By implementing these technology approaches at Tijuquinhas Landfill, Proactiva, in partnership with Veolia Propreté, will transfer its expertise and experience with these systems to the local team who install and operate them. Numerous training programs have been and will be provided to our local staff. Technical support is always available to help resolve any difficulties.

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

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It is estimated that the enhanced collection and flaring capacity envisioned by the project activity will result in the yearly capturing and combustion of approximately 70% of the produced LFG for Zone 3. A conservative estimate has been used for the collection efficiency for Zones 1 and 2, collection efficiency for Zone 1 and Zone 2 has been estimated to 30%. The estimate of total emission reductions to be realised are 918 361 tCO_{2eq} over the first crediting period starting the 1st May 2008 ending the 30th April 2015 included**.** Expected Emission Reductions are described in the table below:

Year		Annual estimation of emission reductions in tonne of CO_{2e}
2008	8 months	54 656
2009	12 months	110 830
2010	12 months	104 338
2011	12 months	123 830
2012	12 months	143 670
2013	12 months	174 969
2014	12 months	158 318
2015	4 months	47 750
Total estimated reductions (tonnes of CO_{2e})		918 361
Total number of crediting years		7 years
Annual average over the crediting period of estimated reductions (tonnes of CO_{2e})		131 194

Table 1: Annual estimation of emission reductions in tonnes of CO_{2e}

The project developer aims to renew the crediting period for 2 additional 7-year crediting periods. The expected emission reductions from these 2 periods are described in the tables below:

Year		Annual estimation of emission reductions in tonne of CO_{2e}
2015	8 months	95 501
2016	12 months	129 619
2017	12 months	117 284
2018	12 months	106 124
2019	12 months	96 024
2020	12 months	86 886
2021	12 months	78 618
2022	4 months	23 713
Total estimated reductions (tonnes of CO_{2e})		733 769
Total number of crediting years		7 years
Annual average over the crediting period of estimated reductions (tonnes of CO_{2e})		104 824

Table 2 : Estimation of the emission reductions for the second 7-year crediting period

Year		Annual estimation of emission reductions in tonne of CO_{2e}
2022	8 months	47 426
2023	12 months	64 367
2024	12 months	58 241
2025	12 months	52 698
2026	12 months	47 685
2027	12 months	43 146
2028	12 months	39 041
2029	4 months	11 775
Total estimated reductions (tonnes of CO_{2e})		364 379
Total number of crediting years		7 years
Annual average over the crediting period of estimated reductions (tonnes of CO_{2e})		52 054

Table 3: Estimation of the emission reductions for the third 7-crediting period

Consequently, the project should be able to generate, over the 21-year period, **2,016,509 tCO_{2e}.**

A.4.5. Public funding of the project activity:

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None

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:

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"Consolidated baseline methodology for landfill gas project activities" – ACM0001 / version 05 will be used in conjunction with the "Consolidated monitoring methodology for landfill gas project activities" – ACM0001 / version 05.

According to the recommendation of this methodology, the Version 4 of the "Tool for the demonstration and assessment of additionality" and the Version 1 of the "Tool to determine project emissions from flaring gases containing methane" will be used.

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

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This methodology is applicable to LFG capture project activities, where the baseline scenario is the atmospheric release of the landfill gas and the project activity includes the following situations:

- The gas is captured and flared.
- There is no legal or contractual requirement to burn landfill gas.

The approved monitoring methodology ACM0001 / version 5 ("consolidated monitoring methodology for landfill gas project activities") will be used in conjunction with this baseline methodology.

Since the project aims to install and operate a gas collection and flaring unit on landfill, located in Brazil, a non-Annex 1 country, who has ratified the Kyoto protocol on the 23rd of August 2002, and where there is no legal or contractual requirements to do so, the conditions for use of the methodology ACM0001 / version 5 are met.

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

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	Source	Gas	Included ?	Justification / Explanation
Baseline	Landfill	CO_2	No	The emissions of CO_2 are neutral per convention since they are coming from the degradation of organic waste
		CH_4	Yes	
		N_2O	No	
	Existing	CO_2	No	No active extraction system is in place to date

	extraction system	CH_4	No	
		N_2O	No	
Project Activity	Landfill	CO_2	No	The emissions of CO_2 are neutral per convention since they are coming from the degradation of organic waste
		CH_4	Yes	Remaining fugitive emissions from methane
		N_2O	No	
	Extraction system (energy blower)	CO_2	Yes	From displaced emission due to electricity consumption from the grid.
		CH_4	No	
		N_2O	No	
	Flare emissions	CO_2	No	No fossil fuel will be used to ignite the flare Emissions of CO_2 generated by the waste fermentation are not taken into account
		CH_4	Yes	Unburnt methane, if any
		N_2O	No	

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

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The baseline scenario has been defined as the atmospheric release of the landfill gas produced by waste in anaerobic conditions after reviewing:

- Other alternatives
- Legal and contractual obligation (existing and forthcoming)
- Current practice of waste management sector in Brazil
- Current practice on site

Identification of alternative scenario

Alternative 1: Current situation on site, most common practice in Brazil

Landfill gas within a landfill is vented into the atmosphere, with occasional passive flaring. Landfill gas is not recovered for energy production onsite, or externally.

Alternative 2: Implementation of landfill gas collection flaring system, without the CDM revenue

The second option is to install an active gas collection and flaring system to burn the landfill gas without considering the CDM revenue. This alternative is unlikely to happen since the system represents a significant investment and no revenue, outside the sale of CERs, will be generated. The site has no incentive to modify its operational methods since there is no contractual or legal requirement to do so.

Alternative 3: Production and sale of electricity or heat from landfill gas

This alternative consists of the recovery of the landfill gas to produce either thermal energy or electricity and sale this energy to a customer.

The alternative scenario consisting of producing electricity from landfill gas is not a plausible solution for reasons linked to the lack of maturity of this technology in Brazil, insufficient financial incentive.
It is common practice to first install an active LFG capture and flaring system, to ensure that the quality, the stability and the quantity of landfill gas are compatible with the electricity generation. This first stage is as well necessary in order to train the landfill gas technician on the collection, capture and flaring technology.

In addition, current accessible electricity selling price in Brazil is very low (within the range of $0.029/kWh). Considering the small amount of electrical energy the site could produce over a 10-year period (a maximum 2 MW unit), this type of project is not feasible.[2]

Alternative 4: Collect landfill gas and sale the raw gas to a final customer
This alternative consists of investing into a gas collection system and selling the gas collected to a nearby final user.

No final users have been identified close to the site. Consequently this alternative will not be implemented.

Consequently, alternative 1, the continuation of actual practice on site, is the only remaining plausible alternative.

Current practice of waste management sector in Brazil:
According to the official statistics on urban solid waste in Brazil[3] – *Pesquisa Nacional de Saneamento Básico 2000* (PNSB 2000) – 58% of Municipal Solid Waste is disposed at uncontrolled open localities ("lixões") or landfills with minimal form of control, and 36% in engineered landfills[4], where waste is disposed in contained cells and leachate is controlled.

According to the same study, the situation in 2000 in the State of Santa Catarina was similar to in the rest of Brazil, where 45% of the waste was still disposed of in inappropriate sites. Active landfill gas collection and flaring was not practised on any site.

Since 2001, through the program called "Lixo Nosso de cada dia", the focus of the state authority has been to fight against uncontrolled dump sites, where no leachate control system exists. The

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[2] Similar findings and statements can be found in the *'The Landfill Gas-to-Energy Initiative for Latin America and the Caribbean'*, published by the World Bank

[3] IBGE – Instituto Brasileiro de Geografia e Estatística.

[4] In Brazil even in engineered landfill active gas collection system and flaring system is not practised.

ABES[5] audited 18 licensed landfills that where considered to be the most advanced in terms of environmental control. They concluded that 41% of these sites did not have sufficient management practices and controls.
Active landfill gas collection and flaring is not required and is not implemented at any landfill within the State of Santa Catarina. The priority has been given to close uncontrolled landfills within the State. Implementation of landfill gas control system is not the priority. Consequently, the situation is unlikely to change in the near future.

Legal and contractual Obligation:
There is no legislation to enforce active landfill gas flaring in Brazil at National level, or at state level. The only requirement is to vent the landfill gas to avoid the risk of explosion.

Considering the current practice in Brazil, the focus of the waste management policy is above all tackling the problem of illegal dumping and capturing of leachate. Capturing and flaring of LFG is not yet a priority. It is unlikely that legislation will be modified to enforce landfill gas flaring in the coming years since financial assistance is already lacking to operate and comply with the basic waste disposal practice such as monitoring, groundwater contamination prevention, leachate treatment, etc.

Current practice on site:
In the case of Tijuquinhas Landfill, there are no legal or contractual obligations to collect and combust landfill gas. Passive gas venting is the only mean used on site to collect landfill gas. Passive flaring is practised by igniting gas wells in order to diminish on site odour. As there is no suction applied on the wells, the efficiency of the actual gas collection is very low. In addition, passive flaring cannot be maintained and often the flame extinguishes itself after few minutes or few hours depending on the wells. Consequently, it has been estimated that less than 10% of the landfill gas is collected and burnt at the moment.

The improvements of the gas collection and combustion conditions are directly linked to investment for landfill collection, abstraction and flaring systems. Without the revenue generated by the sale of the CER’s, the situation will not change since there is no expected commercial usage of landfill gas nor any forthcoming new laws or policies.

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):

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The installation of the collection and flaring equipment will require increased costs without any expected additional revenues. Therefore, the approval and registration of the project as a CDM

[5] Source: ABES (Associação Brasileira de Engenharia Sanitária e Ambiental) on request of the Public Minister of the Santa Catarina State. *Relatório do Projeto de Verificação da Sustentabilidade do Programa Lixo Nosso de Cada Dia, do Ministério Público do Estado de Santa Catarina*, April 2006.

project will offer an economic incentive to the project participants from the revenue generated by the CER's which will encourage the implementation of the project.

As recommended by the methodology ACM0001 / version 5, the Tool for the demonstration and assessment of additionality" version 4 has been used.

The following steps describe the methodology used to assess the project additionality.

According to the project schedule, the project crediting period will start after the registration date, which is due to be completed prior 1st September 2007.

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

Step 1a: Define alternatives to the project activity

The 4 alternatives described within the section B.4 are identical to the demonstration of the baseline scenario.

As demonstrated in section B.4, alternative 1, the continuation of actual practice on site, is the only remaining plausible alternative.

Step 1b: Enforcement of applicable laws and regulations:

The Brazilian national and state legislation does not require landfill operators to flare or to burn LFG. The operation at Tijuquinhas site complies with all applicable legal requirements.

There is no legal requirement in Brazil which compels to implement any other alternatives or which will make them unlawful.

There are no regulations governing flaring and/or combustion of landfill gas and no regulation is expected over the next decade.

Step 2: Investment analysis

Sub-step 2a. : Determine appropriate analysis method
No commercial use of landfill gas will be made. An active LFG collection and flaring system is only implemented for environmental purposes. As the project activity does not generate any financial or economical benefits other than CDM related income, option I (sub-step2b) will be used.

Sub-step 2b. : Apply simple cost analysis

In order to implement the CDM project activity, Proactiva will have to invest into additional gas wells and collection system. An abstraction and flaring facility will also be purchased. All the equipments, described in section A.4.3 are dedicated to the CDM project. The table below shows the nature and the level of the main investment and operation that Proactiva expects to invest into the CDM project.

INVESTMENT	
Gas collection system	1 540 300 US$
Landfill gas abstraction and flaring system	643 000 US$
OPERATION AND MAINTENANCE	
10% of the investment + Monitoring and verification costs	258 330 US$/an

The project only goal is the destruction of the methane contained within the LFG for environmental purposes. The only revenue generated by the project will be from the sale of CER's.

The installation of the enhanced extraction system will maximize LFG capture.

The result of the cost analysis clearly shows that the implementation of the project activity is not the economically most attractive course of action.

Sub-step 2c and sub-step 2d

Not applicable

Step 3: Barrier analysis

For the purpose of demonstration of the additionality, step 2 of the '*Tool for the demonstration and assessment of additionality*' has been used.

Step 4: Common practice analysis

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

Landfill gas emission is very particular situation that cannot be compared with other activities.

The main reasons of such specificities are:

- Production of a significant volume of GHG's
- Emissions are not concentrated in a stack, but are surface emissions from the area of the landfill.

- Emissions are not directly linked with the economical activity of the site, i.e. even if the activity stops, emissions continue, as organic matter degradation occurs over 10 to 20 years

As a consequence, there is no activity similar to landfill gas capture and flaring.

Sub-step 4b. Discuss any similar options that are occurring.
As explained in section B.4, 96% of the waste in Brazil are landfilled with at best passive venting and flaring as it is the case actually at Tijuquinhas landfill site. Some others project activities of the same nature are under development in Brazil, but all of them are linked to CDM.

The registration of the project activity will allow to finance the enhancement of the gas collection system. As demonstrated previously, the project does not generate any revenue. Consequently, the sale of the CER's will allow to finance the implementation of the project activity.
The registration of the project will contribute to reduce greenhouse gas emission from the landfill site by capturing and burning the fatal methane produced by the anaerobic fermentation of biomass contained within the waste.

Consequently, the project is additional.

B.6. Emission reductions:

B.6.1. Explanation of methodological choices:

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The project will not produce electricity for commercial purpose nor for internal use. Consequently, only the emission reductions due to the destruction of methane are claimed for. The paragraph below describes how the methodology ACM0001 / version 5 and its equations will be applied to the project activity:

According the ACM0001 / version 5, emission reductions should be calculated from the following equations:

$$\mathrm{ER}_{\mathrm{Y}} = (MD_{project,y} - MD_{reg,y}) * \mathrm{GWP}_{\mathrm{CH4}} + EL_y * CEF_{electricity,y} - ET_y * CEF_{thermal,y}$$

Eq: 1

Where:

ER_y	is emission reductions, in tonnes of CO_2 equivalents (tCO_2e).
$MD_{project,y}$	the amount of methane that will be destroyed/combusted during the year by the project activity, in tonnes of methane (tCH_4)
$MD_{reg,y}$	the amount of methane that would have been destroyed/combusted during the year in the absence of the project, in tonnes of methane (tCH_4)

GWP_{CH4}	Global Warming Potential value for methane for the is 21 tCO_2e/tCH_4
EL_y	net quantity of electricity exported during year y, in megawatt hours (MWh).
$CEF_{electricity,y}$	CO_2 emissions intensity of the electricity displaced, in tCO_2e/MWh. 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.
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

Since no electricity is exported, the equation (1a) of ACM0001 / version 5 is equivalent to

$$EL_y = -EL_{IMP}$$

Where:

EL_{IMP}	Net incremental electricity imported, defined as difference of project imports less any imports of electricity in the baseline, to meet the project requirements, in MWh

Since no fossil fuel will be used or saved, the parameter ET_y, is null.

As $MD_{reg,y}$ is not given or defined, this parameter will be calculated as explained within the methodology ACM0001 / version 5, using the equation below:

$$MD_{reg,y} = MD_{project,y} * AF \qquad \textbf{Eq: 2}$$

Where,

AF	Adjustment factor

According to the equation (3) and (4) of the ACM0001 / version 5 and considering the project will not generate any electricity, $MD_{project,y}$ can be calculated as follows:

$$\mathrm{MD}_{\mathrm{project,y}} = (LFG_{flare,y} * w_{CH4,y} * D_{CH4}) - (\frac{PE_{flare,y}}{GWP_{CH4}}) \qquad \textbf{Eq: 3}$$

$LFG_{flare,y}$	Quantity of landfill gas flared during the year measured in cubic meters (m^3)
$W_{CH4,y}$	Average methane fraction of the landfill gas

D_{CH4}	Methane density expressed in t_{CH4}/m^3_{CH4}
$PE_{flare,y}$	Emissions from flaring of the residual gas stream in year y
GWP_{CH4}	Global Warming potential of CH_4

$PE_{flare,y}$ is calculated according to "the tool to determine project emissions from flaring gases containing methane".

$$PE_{flare,y} = \sum TM_{RG,h} * (1 - \eta_{flare,h}) * \frac{GWP_{CH4}}{1000}$$

Where

PEflare,y	tCO_{2e}	Project emissions from flaring of the residual gas stream in year y
$TM_{RG,h}$	Kg/h	Mass flow rate of methane in the residual gas in the hour h
GWP_{CH4}	tCO_{2e}/tCH_4	Global Warming Potential

$\eta_{flare,h}$ is the hourly efficiency of the flare. Since the project activity will use an enclosed flare and continuous monitoring the flare efficiency will be monitored as follows :

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

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

Where:

Variable	**SI Unit**	**Description**
$\eta_{flare,h}$	-	Flare efficiency in the hour *h*
$TM_{FG,h}$	kg/h	Methane mass flow rate in exhaust gas averaged in a period of time t (hour, two months or year)
$TM_{RG,h}$	kg/h	Mass flow rate of methane in the residual gas in the hour *h*

In case of the continuous system is unavailable for maintenance, or failure, the following methods will be used:

- 0% if the temperature in the exhaust gas of the flare (T_{flare}) is below 500 °C for more than 20 minutes during the hour *h* .
- 50%, if the temperature in the exhaust gas of the flare (T_{flare}) is above 500 °C for more than 40 minutes during the hour *h*, but the manufacturer's specifications on proper operation of the flare are not met at any point in time during the hour *h*.
- 90%, if the temperature in the exhaust gas of the flare (T_{flare}) is above 500 °C for more than 40 minutes during the hour *h* and the manufacturer's specifications on proper operation of the flare are met continuously during the hour *h*.

$TM_{FG,h}$ and $TM_{RG,h}$ will be calculated applying the equations below:

$$TM_{FG,h} = \frac{TV_{n,FG,h} * fv_{CH_4,FG,h}}{1000000}$$

$$TM_{RG,h} = FV_{RG,h} * fv_{CH_4,RG,h} * \rho_{CH_4,n}$$

$TM_{FG,h}$	kg/h	Mass flow rate of methane in the exhaust gas of the flare in dry basis at normal conditions in the hour *h*
$TV_{n,FG,h}$	m^3/h exhaust gas	Volumetric flow rate of the exhaust gas in dry basis at normal conditions in hour *h*
$fv_{CH4,FG,h}$	mg/m^3	Concentration of methane in the exhaust gas of the flare in dry basis at normal conditions in the hour *h*
$TM_{RG,h}$	kg/h	Mass flow rate of methane in the residual gas in the hour *h*
$FV_{RG,h}$	m^3/h	Volumetric flow rate of the residual gas in dry basis at normal conditions in the hour *h*
$fv_{CH4,RG,h}$	-	Volumetric fraction of methane in the residual gas on dry basis in hour *h* (NB: this corresponds to fvi,RG,h where *i* refers to methane).
$\rho_{CH4,n}$	kg/m^3	Density of methane at normal conditions (0.716)

Considering that the mass fraction of carbon, hydrogen, oxygen and nitrogen of the residual gas ($fm_{j,h}$) can be calculated as follows:

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

Where:

Variable	**SI Unit**	**Description**
$fm_{j,h}$	-	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	kg/kmol	Atomic mass of element *j*
$NA_{j,i}$	-	Number of atoms of element *j* in component *i*
$MM_{RG,h}$	kg/kmol	Molecular mass of the residual gas in hour *h*
j	The elements carbon, hydrogen, oxygen and nitrogen	
i	The components CH_4, CO_2, O_2, N_2	

$TV_{n,FG,h}$ is calculated as follows:

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

Where:

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

$$V_{n,FG,h} = V_{n,CO_2,h} + V_{n,O_2,h} + V_{n,N_2,h}$$

Where:

Variable	SI Unit	Description
$V_{n,FG,h}$	m^3/kg residual gas	Volume of the exhaust gas of the flare in dry basis at normal conditions per kg of residual gas in the hour *h*
$V_{n,CO2,h}$	m^3/kg residual gas	Quantity of CO_2 volume free in the exhaust gas of the flare at normal conditions per kg of residual gas in the hour *h*
$V_{n,N2,h}$	m^3/kg residual gas	Quantity of N_2 volume free in the exhaust gas of the flare at normal conditions per kg of residual gas in the hour *h*
$V_{n,O2,h}$	m^3/kg residual gas	Quantity of O_2 volume free in the exhaust gas of the flare at normal conditions per kg of residual gas in the hour h

$$V_{n,0_2,h} = n_{0_2,h} * MV_n$$

Where:

Variable	SI Unit	Description
$V_{n,O2,h}$	m^3/kg residual gas	Quantity of O_2 volume free in the exhaust gas of the flare at normal conditions per kg of residual gas in the hour *h*
$n_{O2,h}$	kmol/kg residual gas	Quantity of moles of O_2 in the exhaust gas of the flare per kg of residual gas flared in hour *h*

MV_n	m^3/kmol	Volume of one mole of any ideal gas at normal temperature and pressure (22.4 L/mol)

$$V_{n,N2,h} = MV_n * \left\{ \frac{fm_{N,h}}{200 AM_N} + \left(\frac{1 - MF_{O_2}}{MF_{O_2}} \right) * \left[F_h + n_{O_2,h} \right] \right\}$$

Where:

Variable	**SI Unit**	**Description**
$V_{n,N2,h}$	m^3/kg residual gas	Quantity of N_2 volume free in the exhaust gas of the flare at normal conditions per kg of residual gas in the hour *h*
MV_n	m^3/kmol	Volume of one mole of any ideal gas at normal temperature and pressure (22.4 m^3/Kmol)
$fm_{N,h}$	-	Mass fraction of nitrogen in the residual gas in the hour *h*
AM_n	kg/kmol	Atomic mass of nitrogen
MF_{O2}	-	O_2 volumetric fraction of air
Fh	kmol/kg residual gas	Stoichiometric quantity of moles of O_2 required for a complete oxidation of one kg residual gas in hour *h*
$n_{O2,h}$	kmol/kg residual gas	Quantity of moles O_2 in the exhaust gas of the flare per kg residual gas flared in hour *h*

$$V_{nCO2,h} = \frac{fm_{C,h}}{AM_c} * MV$$

Where:

Variable	**SI Unit**	**Description**
$V_{n,CO2,h}$	m^3/kg residual gas	Quantity of CO_2 volume free in the exhaust gas of the flare at normal conditions per kg of residual gas in the hour *h*
$fm_{C,h}$	-	Mass fraction of carbon in the residual gas in the hour *h*
AM_C	kg/kmol	Atomic mass of carbon
MV_n	m^3/kmol	Volume of one mole of any ideal gas at normal temperature and pressure (22.4 m^3/Kmol)

$$n_{0_2,h} = \frac{t_{O_2}, h}{\left(1 - (t_{O_2} / MF_{O_2})\right)} * \left[\frac{fm_{C,h}}{AM_C} + \frac{fm_{N,h}}{2AM_N} + \left(\frac{1 - MF_{O_2}}{MF_{O_2}} \right) * F_h \right]$$

Where :

Variable	**SI Unit**	**Description**
$n_{O2,h}$	kmol/kg residual gas	Quantity of moles of O_2 in the exhaust gas of the flare per kg of residual gas flared in hour *h*
$t_{O2,h}$	-	Volumetric fraction of O_2 in the exhaust gas in the hour *h*

MF_{O2}	-	Volumetric fraction of O_2 in the air (0.21)
Fh	kmol/kg residual gas	Stochiometric quantity of moles of O_2 required for a complete oxidation of one kg of residual gas in hour *h*
$fm_{j,h}$	-	Mass fraction of element *j* in the residual gas in hour *h*
AM_j	kg/kmol	Atomic mass of element *j*
j		The elements carbon (index C) and nitrogen (index N)

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

Where:

Variable	SI Unit	Description
F_h	kmol O_2/kg residual gas	Stoichiometric quantity of moles of O_2 required for a complete oxidation of one kg residual gas in hour *h*
$fm_{j,h}$	-	Mass fraction of element *j* in the residual gas in hour *h*
AM_j	kg/kmol	Atomic mass of element *j*
i		The elements carbon (index C), hydrogen (index H) and oxygen (index O)

And $FM_{RG,h}$ will be calculated as follows:

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

Where:

Variable	SI Unit	Description
$FM_{RG,h}$	kg/h	Mass flow rate of the residual gas in hour *h*
$\rho_{RG,n,h}$	kg/m^3	Density of the residual gas at normal conditions in hour *h*
$FV_{RG,h}$	m^3/h	Volumetric flow rate of the residual gas in dry basis at normal conditions in the hour *h*

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

Where:

Variable	SI Unit	Description
$\rho_{RG,n,h}$	kg/m^3	Density of the residual gas at normal conditions in hour *h*
P_n	Pa	Atmospheric pressure at normal conditions (101 325)
R_u	$Pa.m^3/kmol.K$	Universal ideal gas constant (8 314)
$MM_{RG,h}$	kg/kmol	Molecular mass of the residual gas in hour *h*
T_n	K	Temperature at normal conditions (273.15)

$$MM_{RG,h} = \sum \left(fv_{i,h} * MM_i \right)$$

Where:

Variable	SI Unit	Description
$MM_{RG,h}$	kg/kmol	Molecular mass of the residual gas in hour *h*
$fv_{i,h}$	-	Volumetric fraction of component *i* in the residual gas in the hour *h*
MM_i	kg/kmol	Molecular mass of residual gas component *i*
i	The components CH_4, CO_2, O_2, N_2	

Applying the above to the equation 1, the ex ante estimate of emissions reductions can be calculated following the below equation:

$$\mathrm{ER_Y} = \left[LFG_{flare,y} * w_{CH4,y} * D_{CH4} \right] * \left[(1 - AF) * \mathrm{GWP_{CH4}} \right] - EL_{IMP} * CEF_{electricity,y} - PE_{flare,y} * (1 - AF)$$

Eq: 4

$CEF_{electricity,y}$ has been calculated according to the methodology for small-scale project AMS.I.D.

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

Data / Parameter:	Factor Used for Converting Methane to Carbon Dioxide Equivalents
Data unit:	tCO_{2e}/tCH_4
Description:	Regulatory requirements relating to landfill gas projects.
Source of data used:	Revised 1996 IPCC Guideline for National Greenhouse Gas Inventories
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 5.
Any comment:	

Data / Parameter:	Methane density
Data unit:	tCH_4/m^3CH_4
Description:	Conversion factor
Source of data used:	ACM0001 / version 5
Value applied:	0.0007168
Justification of the	Parameter defined within the methodology ACM0001 / version 5.

choice of data or description of measurement methods and procedures actually applied:	This factor will be adjusted depending the on-site pressure and temperature conditions.
Any comment:	At standard temperature and pressure (0 degree Celsius and 1.013 bar).

Data / Parameter:	CO_2 emissions intensity if electricity imported
Data unit:	tCO_{2eq}/MWh
Description:	Conversion factor
Source of data used:	Mine and Energy Ministry
Value applied:	0.2677 tCO_{2eq}/MWh
Justification of the choice of data or description of measurement methods and procedures actually applied:	The small scale methodology I.D, version 10 has been used to estimate the CEF. Referring to section 10 b, of this methodology, the weighted average emissions of the current generation mixed has been used. The emission factors from dispatch centres are not publicly available. Data on fuel type, fuel emission factor are sensitive data and consequently not available to us for each of the 1599 power stations referenced by ANEEL (National Agency of Electric Energy : http://www.aneel.gov.br/aplicacoes/capacidadebrasil/capacidadebrasil.asp). Consequently, the 2006 IPPC Guidelines for National Greenhouse Gas Inventories has been used in conjunction with the latest data, provided by the Ministry of Mine and Energy (2005 figures, 2004 and 2003), for the consumption of primary and secondary energy sources consumed for electricity production (http://www.mme.gov.br). Calculation are explained in Annexe 3. The value obtained is 0.0751 tCO2/MWh. However, in order to be conservative, the highest value of the CEF used within the registered PDDs in Brazil, applying the methodology ACM0001, has been applied. This conservative value of 0.2677 tCO_{2eq}/MWh, defined ex-ante, will be used through the crediting period.
Any comment:	

Data / Parameter:	Pn: Atmospheric pressure at normal conditions
Data unit:	Pa
Description:	Atmospheric pressure at normal conditions
Source of data used:	"tool to determine project emissions from flaring gases containing methane"
Value applied:	101325 Pa
Justification of the choice of data or description of measurement methods	Physical constant

and procedures actually applied:	
Any comment:	

Data / Parameter:	Ru: Universal ideal gas constant
Data unit:	$Pa.m^3/kmol.K$
Description:	Universal ideal gas constant
Source of data used:	"tool to determine project emissions from flaring gases containing methane"
Value applied:	8314.472 $Pa.m^3/kmol.K$
Justification of the choice of data or description of measurement methods and procedures actually applied:	Physical constant
Any comment:	

Data / Parameter:	T_n: Temperature at normal conditions
Data unit:	K
Description:	Temperature at normal conditions
Source of data used:	"tool to determine project emissions from flaring gases containing methane"
Value applied:	273.15 K
Justification of the choice of data or description of measurement methods and procedures actually applied:	Physical constant
Any comment:	

Data / Parameter:	AM_j: Atomic Mass of element j
Data unit:	kg/mol
Description:	Atomic mass of element j (j= Carbon or hydrogen, oxygen and nitrogen)
Source of data used:	Mendeleïev table
Value applied:	AM_C = 12.00 kg/mol AM_O = 16.00 kg/mol AM_H = 1.01 kg/mol AM_N = 14.01 kg/mol
Justification of the choice of data or description of measurement methods and procedures actually applied:	Physical constant
Any comment:	

Data / Parameter:	MV_n: Volume of one mol of any ideal gas at normal conditions
Data unit:	m^3/kmol
Description:	Volume of one mol of any ideal gas at normal conditions
Source of data used:	"tool to determine project emissions from flaring gases containing methane"
Value applied:	22.414 m^3/kmol
Justification of the choice of data or description of measurement methods and procedures actually applied:	Physical constant
Any comment:	

Data / Parameter:	MM_i: Molecular mass of component i
Data unit:	Kg/kmol
Description:	Molecular mass of component i (i = methane, carbon dioxide, oxygen, hydrogen or nitrogen)
Source of data used:	"tool to determine project emissions from flaring gases containing methane"
Value applied:	MM_{CH4} = 16.04 kg/kmol MM_{CO2} = 44.01 kg/kmol MM_{O2} = 32 kg/kmol MM_{N2} = 28.02 kg/kmol
Justification of the choice of data or description of measurement methods and procedures actually applied:	Physical constant
Any comment:	

Data / Parameter:	MF_{O2}: Oxygen volumetric fraction of air
Data unit:	Dimensionless
Description:	Oxygen volumetric fraction of air
Source of data used:	"tool to determine project emissions from flaring gases containing methane"
Value applied:	MF_{O2} = 0.21
Justification of the choice of data or description of measurement methods and procedures actually applied:	Physical constant
Any comment:	

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

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As described in section B.6.1, the emission reductions of the project correspond to the amount of methane actually destroyed by a flare. The quantity of methane that can be produced by a tonne of deposited waste can be estimated using a first order decay model. This fraction is depending on the waste quality and also on the way the site has been engineered and operated.

At the Tijuquinhas site, it has been estimated that 30% of the methane is recoverable from Zone 1 and 2 whereas, the newly engineered Zone 3 shall reach a collection rate of 70%.

The paragraph below explains how the ex-ante emission reductions are estimated.

Estimation of Methane Generated From Landfill

The first order decay model defined within the *IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories issued in 2000* was used to estimate methane emissions from Tijuquinhas landfill. The model is as follows:

$$CH4_{\Pr ojected,t} = \left(\frac{(1-e^{-k})}{k}\right)k * L_0 * \sum_{y=0,t} WASTE_{contract,y} * e^{-k(t-y)} \qquad \textbf{Eq: 5}$$

Where:

$CH4_{projected,t}$ is the quantity of methane estimated to be generated during the year t (m^3)

k is the methane generation rate constant (1/yr)

L_o is the methane generation potential (m^3 CH_4 / t Waste)

$Waste_{contract,y}$ is the waste input at year y

t is the year where methane production is calculated

y is the year where the waste was input to the landfill

Assumption of k

The estimation of methane generated from the landfill at a given year is highly sensitive to the assumption of the methane generation rate constant value, k. The k value depends on the overall moisture content in the landfill, temperature in the anaerobic zone, pH, and nutrient availability. According to the *IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories issued in 2000*, values of k should be assumed to be between 0.2 and 0.03. Due to high level of precipitation, around 1500 mm, the degradation is accelerated. The k value has then been estimated to be 0.1.

Estimation of Methane Generation Potential (L_o)

According to IPCC guidelines, methane generation potential is estimated from the following equation:

$Lo = MCF*DOC_{CH4}*F*(16/12)$ **Eq: 6**

Where:
Lo is the methane generation potential of the waste (t CH_4 / t Waste)

MCF is the methane correction factor

DOC_{CH4} is the degradable organic carbon in the waste (t CH_4 / t Waste)

F is the fraction of CH_4 in the landfill gas

16 is the molar weigh of methane (CH_4)

12 is the molar weight of carbon (C)

Estimating MCF

According to IPCC, MCF is assumed according to the types of sites shown in table 4.

Type of Site	Methane Correction Factor (MCF)
Managed Landfill	1
Unmanaged – deep (≥ 5m waste)	0.8
Unmanaged – shallow (< 5m waste)	0.4
Default value – uncategorized SWDSs	0.6

Table 4: Methane Correction Factor

MCF was assumed to have a value of 1 since the landfill is a well-managed landfill. According to IPCC guidelines, well-managed landfills should have controlled placement of waste and a degree of control of scavenging activities and control of fires should be in place. Tijuquinhas landfill satisfies these criteria for the following reasons:

- Placement of waste is well planned in specifically designed cells. The cells are lined with compacted clay.
- The landfill access is controlled; no scavenging activities are allowed inside the landfill.
- After the placement of each layer of waste (5 m), the waste is covered by a 30 to 40 cm of soil which prevents any possible self-ignition of the waste and rainwater to penetrate the cell.

Estimating DOC_{CH4}

Degradable organic fraction (DOC) is based on the composition of the waste. DOC is estimated from a weighted average of the carbon content of various components of the waste stream. This value depends on the waste type and also humidity. A waste characterisation was carried out for the municipality of Florianopolis which included moisture content for various waste types. These results are presented in table 5, shown below:

Waste Stream	Percent DOC_{CH4} by Weight
A. Paper and textiles	17%
B. Garden and park waste, and other (non-food) organic and Food waste	15%

Table 5: Degradable Organic Carbon into methane for Major Waste Streams

If the composition of the percentage of each type of waste is known, the weighted average of the degradable organic carbon can be estimated as follows:

% DOC_{CH4} (by weight) = 0.17(A) + 0.15(B) **Eq: 7**

Where:
A is the percent paper and textiles in the waste
B is the percent garden and park waste, and other organic waste such as food waste

Table 6, shown below, presents the composition of waste in the county of Florianopolis. This composition was used to estimate the degradable organic fraction of the waste.

	Composition (%humid waste)	
	Urban Waste	Rural and semi-Urban waste
A: Paper, cardboard, textile	26.8%	32.4%
B: Food and green waste and wood	45.9%	34.5%
Inerts	27.3%	33.1%
Total	100%	100%

Table 6: Composition of Brazilian waste

The weighted average for the degradable organic carbon was estimated as follows:

% DOC_{CH4} = 0.17*A + 0.15*B

Applying this equation, the %DOC_{CH4} value for the urban waste is 0.1136
Applying this equation, the % DOC_{CH4} value for the rural and semi-urban waste is 0.107

In order to assess the baseline scenario, the most conservative assumption of %DOC_{CH4} value is the one for urban waste. This value will then be used to establish the baseline scenario.

Estimating F

F was assumed at 55%.

Estimating L_o

Based on the estimation of different parameters needed, methane generation potential was estimated as follows:

Lo = MCF*DOC_{CH4}*F*(16/12) **Eq: 8**

Lo = 1*0.1136*0.55*(16/12) = 0.0832 Mg CH_4 / Mg Waste

This value can be converted in a volume using the density of methane in the normal conditions of pressure and temperature :

Lo = 0.0832/0.0007168 = 116 m^3 CH_4 / t Waste

IPCC guidelines states that the value of Lo may range from less than 100 to over 200 m^3 CH_4 / t Waste. This shows that the estimated values are within acceptable range.

Estimation of Waste Quantities

As previously mentioned, Tijuquinhas landfill has received waste since 1991. The quantity of waste already landfilled has been measured by a weighbridge. Projected waste inputs have been estimated based on those received in the previous year with an assumed growth of 2%. Table 7 presents the amount of solid waste that is projected to be disposed within the site. It has been estimated that the site cease accepting waste on 31st December 2013.

Year	Waste Quantity (Tonnes)
1991	16 179
1992	64 085
1993	69 525
1994	72 336
1995	82 731
1996	93 690
1997	103 529
1998	121 115
1999	126 466
2000	141 175
2001	141 093
2002	181 949
2003	190 430
2004	188 980
2005	236 212
2006	240 936
2007	245 755
2008	250 670
2009	255 683
2010	260 797
2011	266 013
2012	271 333
2013	276 760

Table 7: Projected Municipal Solid Waste Disposed in Tijuquinhas landfill during Project Lifetime

Total Quantity of Methane Recoverable

Applying the approved model using the estimated parameters, the total quantity of methane generated from Tijuquinhas landfill can be assessed as described below.

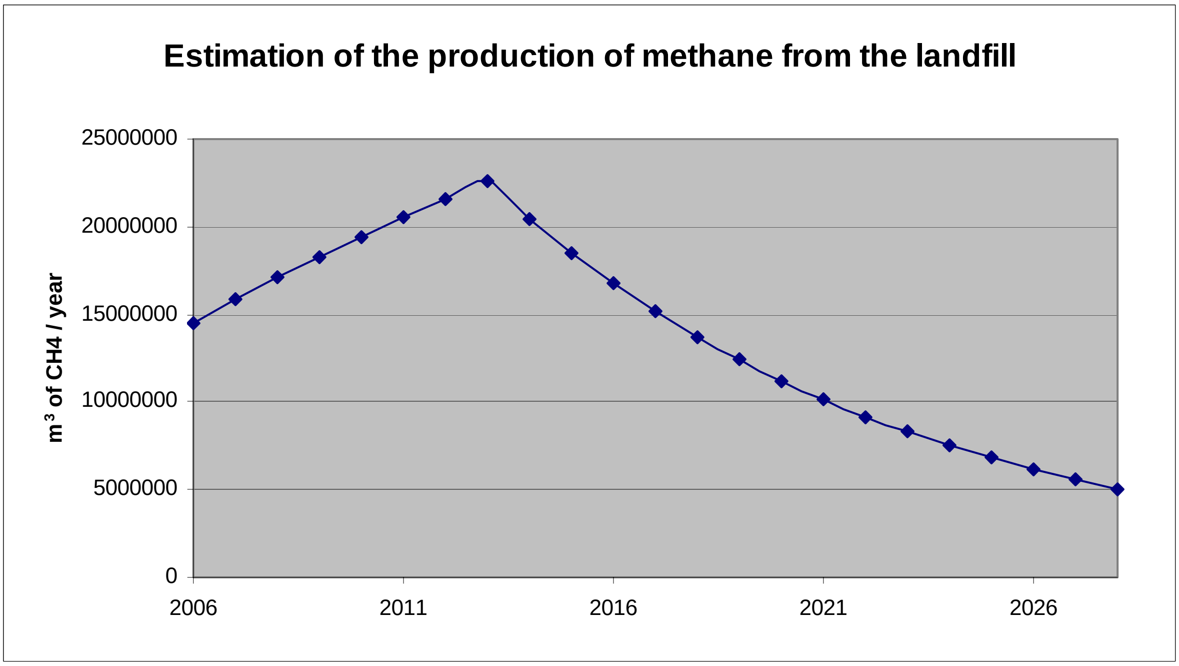

Figure 6 : estimation of the production of methane from the landfill

The total amount of methane recoverable has been adjusted in accordance with the operation planning. Landfilled waste will be connected to the network after a necessary delay. Landfill gas can only be collected in a safe manner when a minimum quantity of waste has been deposited and when truck movements on the landfill will not interfere with landfill gas collection.

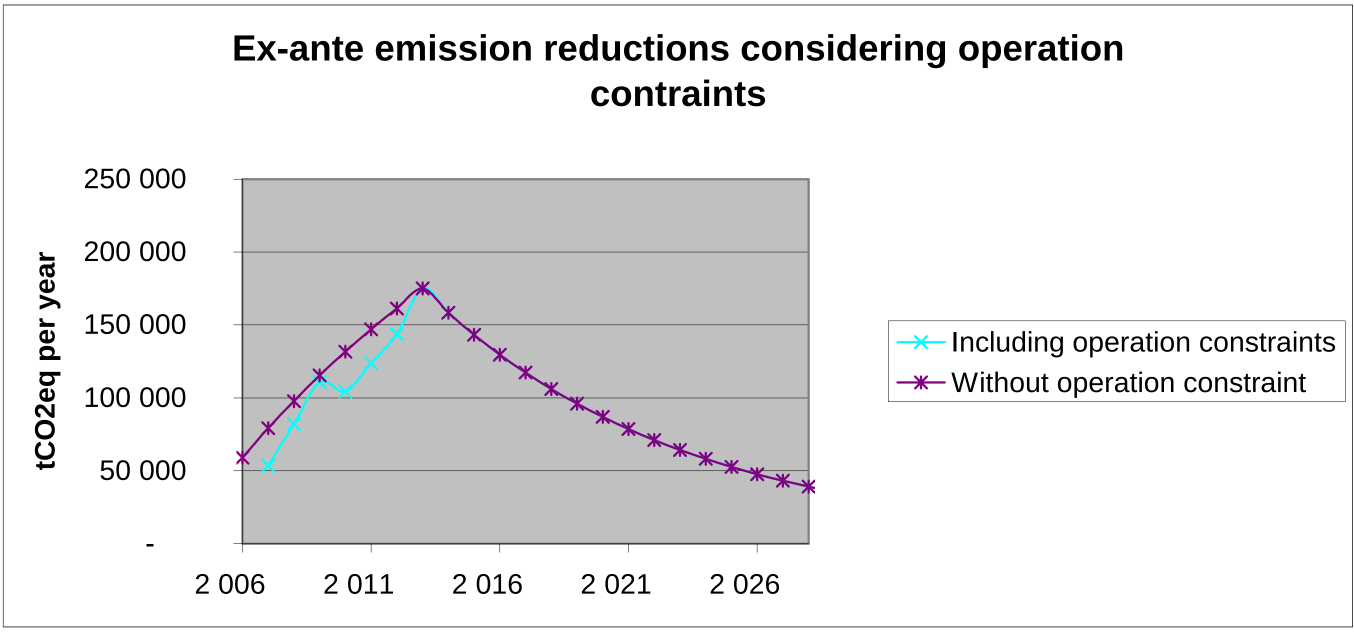

Figure 7: Integration of the operation constraints into the ex-ante emission reductions from the project

Ex –ante estimation of Emission reductions

As described in section B.6.1, the amount of methane that would be destroyed by the project activity (ER_y) should be calculated from the following equation:

$$\mathrm{ER}_{\mathrm{Y}} = \left[LFG_{flare,y} * w_{CH4,y} * D_{CH4}\right] * \left[(1 - AF) * \mathrm{GWP}_{\mathrm{CH4}}\right] - EL_{IMP} * CEF_{electricity,y} - PE_{flare,y}(1 - AF)$$

Where,

$LFG_{flare,y}$	Quantity of landfill gas flared during the year measured in cubic meters (m^3)
$W_{CH4,y}$	Average methane fraction of the landfill gas
D_{CH4}	Methane density expressed in t_{CH4}/m^3_{CH4}
EL_{IMP}	Net incremental electricity imported, defined as difference of project imports less any imports of electricity in the baseline, to meet the project requirements, in MWh
$CEF_{electricity,y}$	CO_2 emissions intensity of the electricity displaced, in tCO_2e/MWh. 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.
GWP_{CH4}	Global Warming Potential value for methane 21 tCO_2e/tCH_4
AF	Adjustment factor
$PE_{flare,y}$	Emissions from flaring of the residual gas stream in year y in tCO_{2e}

For the purpose of the ex-ante estimation of the emission reductions of the project, the value of the parameters have been set as described below:

$LFG_{flare,y}$	Refer to figure 7	
$W_{CH4,y}$	50%	Value in accordance with the model
D_{CH4}	0.0007168 tCH_4/m^3CH_4	Value in accordance with the model
$PE_{flare,y}$	0	Expected greenhouse gas emissions after the combustion of landfill gas
EL_{IMP}	7Wh/m^3_{LFG}	Expected electricity consumption of the blower.
$CEF_{electricity,y}$	267.7 $kgCO_{2e}$/MWh	Refer section B.6.2
GWP_{CH4}	21	
AF	10%	

Electricity will be imported to run the blower which will create the vacuum within the landfill. The electricity consumption has been estimated to be 7Wh/ m^3 of landfill gas treated.

The estimated emissions of CO_2 linked to the electricity consumption of the gas abstraction system are described in the table below:

Year		Ex-ante CO_2 emission link to the electricity consumption of the project (tCO2/year)
2008	8 months	15
2009	12 months	31
2010	12 months	29
2011	12 months	34
2012	12 months	40
2013	12 months	48
2014	12 months	43
2015	12 months	39
2016	12 months	36
2017	12 months	33
2018	12 months	29
2019	12 months	26
2020	12 months	24
2021	12 months	21
2022	12 months	19
2023	12 months	18
2024	12 months	16
2025	12 months	15
2026	12 months	13
2027	12 months	12
2028	12 months	11
2029	4 months	3
Total	**21 years**	**555**

Table 8: CO_2 emissions associated with the electricity consumption of the project

Leakage:

As part of the methodology no leakage shall be accounted for.

<u>Ex-ante emission reductions</u>

Using the data, the ex-ante emission reductions can be estimated as follows:

Year		Ex-ante emission reductions of the project (tCO2/year)
2008	8 months	54 656
2009	12 months	110 830
2010	12 months	104 338
2011	12 months	123 830
2012	12 months	143 670
2013	12 months	174 969
2014	12 months	158 318
2015	12 months	143 251
2016	12 months	129 619
2017	12 months	117 284
2018	12 months	106 124
2019	12 months	96 024
2020	12 months	86 886
2021	12 months	78 618
2022	12 months	71 139
2023	12 months	64 367
2024	12 months	58 241
2025	12 months	52 698
2026	12 months	47 685
2027	12 months	43 146
2028	12 months	39 041
2029	4 months	11 775
Total	**21 years**	**2 016 509**

Table 9: Ex-ante emission reductions of the project

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

>>

Year		Estimation of project activity emissions (tonnes of CO_2 e)	Estimation of baseline emission (tonnes of CO_2 e)	Estimation of Leakage (tonnes of CO_2 e)	Estimation of Emission Reductions (tonnes of CO_2 e)
2008	8 months	94 303	148 959	-	54 656
2009	12 months	145 460	256 290	-	110 830
2010	12 months	133 550	237 888	-	104 338
2011	12 months	134 861	258 691	-	123 830
2012	12 months	137 100	280 770	-	143 670
2013	12 months	145 485	320 454	-	174 969
2014	12 months	131 641	289 959	-	158 318
2015	4 months	39 705	87 455	-	47 750
Total (tonnes of CO_2 e)		962 105	1 880 466	-	918 361

Table 10: Summary of the ex-ante estimation of emission reductions for the first crediting period

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

B.7.1 Data and parameters monitored:

Data / Parameter:	2. $LFG_{flare,y}$
Data unit:	m^3
Description:	Total amount of landfill gas captured
Source of data used:	Measured by a flow meter. Data to be aggregated monthly and yearly.
Value of data applied for the purposed of calculating expected emission reductions in B.6	Refer to figure 7
Description of measurements methods and procedures to be applied:	A Flowmeter will be used. Data will automatically and continuously be monitored and recorded. Data will be checked each business day by the landfill gas manager.
QA/QC procedures to be applied:	Flowmeter will be calibrated as per manufacturer recommendations, at least annually per an officially accredited entity. Flowmeters will be subject to a regular maintenance, testing and calibration regime in accordance with manufacturer specifications to ensure accuracy.
Any comment:	

Data / Parameter:	5. $PE_{flare,y}$
Data unit:	tCO2
Description:	Project emissions from flaring of the residual gas stream in year y
Source of data used:	Calculated
Value of data applied for the purposed of calculating expected emission reductions in B.6	0 tCO_2
Description of measurements methods and procedures to be applied:	The parameters used for determining the project emissions from flaring of the residual gas stream in year y ($PE_{flare,y}$) will be calculated as per the “Tool to determine project emissions from flaring gases containing Methane”. The parameters used for the determination of $PE_{flare,y}$ are $LFG_{flare,y}$, $W_{CH4,y}$, $fv_{i,h}$, $fv_{CH4,FG,h}$ and $t_{O2,h}$.
QA/QC procedures to be applied:	Regular maintenance will ensure optimal operation of the flare. Analysers will be calibrated annually according to manufacturer’s recommendations.
Any comment:	The flare will be designed to provide an internal combustion

	temperature above 700°C .

Data / Parameter:	6. $W_{CH4,y}$
Data unit:	m^3 CH_4 / m^3 LFG
Description:	Methane fraction in the landfill gas
Source of data used:	Preferably measured by continuous gas quality analyser.
Value of data applied for the purposed of calculating expected emission reductions in B.6	50%
Description of measurements methods and procedures to be applied:	An infrared gas analyser will be used. The gas quality will be continuously recorded through the data logger. Measurement will be made on wet gas and corrected to a dry basis.
QA/QC procedures to be applied:	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.
Any comment:	

Data / Parameter:	7. T
Data unit:	° C
Description:	Temperature of the landfill gas
Source of data used:	Measured to determine the density of methane D_{CH4}. No separate monitoring of temperature is necessary when using flow meters that automatically measure temperature and pressure, expressing LFG volumes in normalized cubic meters.
Value of data applied for the purposed of calculating expected emission reductions in B.6	0°C (suitable with the landfill gas model)
Description of measurements methods and procedures to be applied:	Data will continuously be registered through a data logger.
QA/QC procedures to be applied:	The temperature 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:	8. P
Data unit:	Pa
Description:	Pressure of the landfill gas.
Source of data used:	Measured to determine the density of methane D_{CH4}. No separate monitoring of pressure is necessary when using flow meters that automatically measure temperature and pressure, expressing LFG volumes in normalized cubic meters.
Value of data applied for the	1.013bar

purposed of calculating expected emission reductions in B.6	
Description of measurements methods and procedures to be applied:	Data will be registered through a data logger.
QA/QC procedures to be applied:	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:	10. EL_{IMP}
Data unit:	MWh
Description:	Total amount of electricity imported to meet project requirement
Source of data used:	Required to determine CO_2 emissions from use of electricity or other energy carriers to operate the project activity.
Value of data applied for the purposed of calculating expected emission reductions in B.6	7 Wh/m^3
Description of measurements methods and procedures to be applied:	Electricity consumption will be monitored continuously and archived electronically.
QA/QC procedures to be applied:	The meter will be subject to a regular maintenance, testing and calibration regime in accordance with manufacturer specifications to ensure accuracy.
Any comment:	

Data / Parameter:	13. Regulatory requirements relating to landfill gas projects
Data unit:	Test
Description:	Regulatory requirements relating to landfill gas projects.
Source of data used:	
Value of data applied for the purposed of calculating expected emission reductions in B.6	Not applicable
Description of measurements 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 be applied:	All support documentation and assumptions will be made available for review by a verifier.
Any comment:	

Data / Parameter:	$fv_{i,h}$
Data unit:	-

Description:	Volumetric fraction of component *i* in the residual dry gas in the hour *h* where *i* = CO_2, O_2
Source of data used:	Gas analyser
Value of data applied for the purposed of calculating expected emission reductions in B.6	Since $PE_{flare,y}$ has been estimated to be 0, the values are not used in the calculation of the expected emissions reductions in B.6.
Description of measurements methods and procedures to be applied:	A gas sample will be taken into the exhaust, will go through a condensate trap before being analysed. Value will be logged through a datalogger at least hourly. Measurement will be made on dry gas.
QA/QC procedures to be applied:	Analysers will be calibrated according to the manufacturer's recommendation at least annually. A zero check and a typical value check should be performed by comparison with a standard certified gas.
Any comment:	As defined within the tool to determine project emissions from flaring gases containing methane, N_2 will be determined from the CH_4, CO_2 and O_2 concentration.

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 used:	Continuous gas analyser.
Value of data applied for the purposed of calculating expected emission reductions in B.6	$fv_{CH4,FG,h} = 0$ Following campaign test realised on similar flares, it has been shown that no significant residue of methane is measured at the exhaust of high efficiency flare.
Description of measurements methods and procedures to be applied:	Continuously. Values to be averaged at least hourly. 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.
QA/QC procedures to be applied:	Analysers will be calibrated according to manufacturer's recommendation at least annually. A zero check and a typical value check will 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/m^3 , the value shall be multiplied by 0.716. 1%

	equals 10 000 ppmv.

Data / Parameter:	$t_{O2,h}$
Data unit:	-
Description:	Volumetric fraction of O_2 in the exhaust gas of the flare in the hour *h*
Source of data used:	Continuous gas analyser
Value of data applied for the purposed of calculating expected emission reductions in B.6	Since $PE_{flare,y}$ has been estimated to be 0, the values are not used in the calculation of the expected emissions reductions in B.6.
Description of measurements methods and procedures to be applied:	Continuously. Values to be averaged at least hourly. Extractive sampling analysers with water and particulates removal devices will be used. The point of measurement (sampling point) will be in the upper section of the flare (80% of total flare height). Sampling will be conducted with appropriate sampling probes adequate to high temperature level.
QA/QC procedures to be applied:	Analysers will be calibrated according to the manufacturer's recommendation and at least annually. A zero check and a typical value check will be performed by comparison with a standard gas.
Any comment:	

Data / Parameter:	T_{flare}
Data unit:	° C
Description:	Temperature in the exhaust gas of the flare
Source of data used:	A thermocouple type N will be used.
Value of data applied for the purposed of calculating expected emission reductions in B.6	N/A
Description of measurements methods and procedures to be applied:	Data will continuously be registered through a data logger.
QA/QC procedures to be applied:	Thermocouples will be replaced or calibrated as per the manufacturer recommendations every year.
Any comment:	A UV sensor will also provide another indication that the flare burn landfill gas.

B.7.2 Description of the monitoring plan:

>>

The monitoring equipments, described herein, may be modified to meet operational requirements or system upgrades. Any modifications will take into account the monitoring requirements specified in the applied methodology and will be subject to review in the verification process.

Applied methodology

ACM0001 Approved Monitoring Methodology "Consolidated monitoring methodology for landfill gas project activities" – Version 5.

1. Brief description of how the methodology will be applied

As part of the Approved monitoring methodology, it is acceptable to assume that the volume of LFG actually recovered is an indication of the volume of gas that would have been emitted without the project. This will be monitored.

As recommended within the "tool to determine project emissions from flaring gases containing methane" all concentration and gas flow will refer to in dry conditions (moisture will be removed from the sample or discounted from the flow rate and composition).

The emission reductions are defined as the difference of emissions in the baseline situation and in the project situation as per the equation number 1. The data will be analysed on a monthly basis and then aggregated to obtain the yearly emission reductions. Since the instrumentation will provide series of finite figures, the data will be analysed as follows:

$$MD_{project,y} = \sum_{m=1}^{12}\left(\sum_{h=1}^{Hm}\left(\frac{\frac{0.016}{22.4}\sum_{t=1}^{N_h}(LFG_{flare_{t,h}} * W_{CH4_{t,h}})}{N_h} * \eta_{flare,h}\right)\right)$$

Where,

$$\eta_{flare,h} = \begin{cases} 0 \rightarrow if.\dfrac{\sum_{t=1}^{N_h} N_{>500°C,t}}{N_h} * 60 \leq 40mn \\ (1-\dfrac{TM_{fg,h}}{TM_{rg,h}}) \rightarrow if.\dfrac{\sum_{t=1}^{Nh} N_{>500°C,t}}{N_h} * 60 > 40mn \end{cases}$$

Where,

$MD_{project,y}$ is the methane actually destroyed/combusted during the year y in tCH_4
$LFG_{flare,\,t,\,m}$ is the amount of landfill gas captured in m^3/hr and flared at the time t.
$W_{CH4t,m}$ is the concentration of methane in the landfill gas at the time t of the month m
N_h is the number of data available during the given hour.
Hm is the number of hours within the considered month

0.016 = molecular weight methane (t/kmol)
22.4 = molecular volume at 0 °C and 1013 hPa (m^3/kmol)
$\eta_{flare,h}$ is the flare efficiency during the hour h.
$N_{>500°C,t}$ is 1 if the flare temperature is above 500°C; and 0 if the flare temperature is below 500°C.

The molecular weight of methane will be adjusted according to the pressure and temperature of landfill gas.

2. Data to be collected or used in order to monitor emissions from the project activity and how this data will be archived

Instrumentation

ID number	Data variable	Source of data	Data Unit	Recording frequency	Calibration method and frequency	Default Value to use in case of failure	Comment
2. LFG flare..y	Total amount of landfill gas captured	Flowmeter	m^3	Continuously[6]	Annually or according to the manufacturer requirements if more stringent. The calibration will be made by an officially accredited entity.	Daily average of the volume in the previous month	Measured by a flow meter. Data to be aggregated monthly and yearly. A pitot tube or orifice plate Flowmeter will be used or an equivalent providing the same level of accuracy and robustness.
6. W_i.y	Fraction of the component i in measured gas	Gas analyser	m^3 i/m^3 of gas	Continuously	Weekly Automatic calibration or manually by an Proactiva technician following the manufacturer recommendations Bi-annually by a manufacturer representative or an independent laboratory.	In case of failure on the residual landfill gas stream, manual measurements will be taken daily using an infrared portable device	Fixed Gas analyser to be used or equivalent model providing the same level of accuracy and robustness. On the residual gas stream, i = CH_4, O_2, CO_2 On the exhaust gas stream i = CH_4, O_2

[6] The measurement will be continuous, the data will be recorded every 6 min.

7 **T**	Temperature of the landfill gas	Temperature gauge	°C	Continuously	Annually, by Proactiva technician	Daily average of the temperature in the previous month	Analogical devices Measured to determine the density of methane D_{CH4}; *These devices may be replaced by a Flowmeter that integrates the measurement of the pressure and temperature in order to provide a direct reading of the normalized gas flow.*
8 **P.**	Pressure of the landfill gas	Pressure gauge	Pa	Continuously	Annually, by Proactiva technician	Daily average of the pressure in the previous month	
10. **EL_{Imp}**	Total amount of electricity and/or other energy carriers used in the project for gas pumping and heat transport (not derived from gas)	Electricity import meter	kWh	Continuously monitored	According to the specification of the manufacturer and electricity supplier agreement	Daily average of the electricity consumed in the previous month	Only electricity from the grid will be used to feed the blowers and to ignite the flare.
13.	Regulatory requirements relating to landfill gas projects	Official publication	Test	At the renewal of crediting period	N/A	N/A	Required for any changes to the adjustment factor (AF) or directly $MD_{reg..y}$

The abstraction and flaring unit can be represented as shown below.

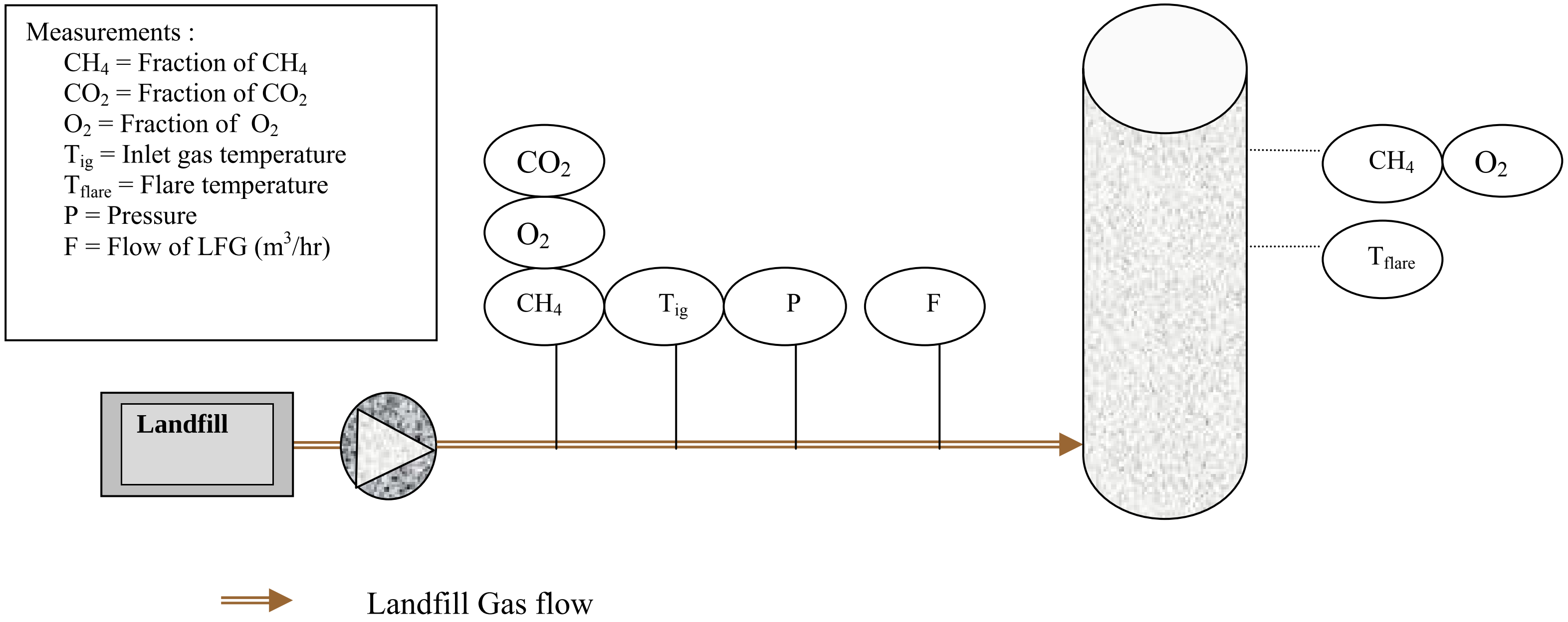

Figure 8 : P&I Diagram to be implemented at Proactiva Tijuquinhas Landfill site

Calibration Procedures:

Instrumentation will be calibrated as recommended by manufacturers or by the methodology ACM0001. The most stringent procedures will be used. Calibration frequency and procedures are detailed in the table above.

Procedures for record handling:

Most data will be recorded through a data logger. The file will be converted into a spreadsheet using a pre-defined format. The file will then be directly used for the verification report.
Data not automatically recorded will be registered daily from Monday to Saturday onto a dedicated monitoring form by the landfill Technician.

The paper forms will be aggregated and kept on site. Electronic data will be stored onsite on a computer hard drive.

Monthly, data from the data logger will be downloaded in an office based computer and data will be transferred on a dedicated spreadsheet. Computer will be located in a separate office than the datalogger.

Procedures for dealing with monitoring data adjustments and uncertainties

As described in the table above, in some cases alternative methods could be used to monitor the performance of the project activity. In case adjustment shall be carried out, it will be done manually. All changes will be marked.

The verification report will assess the uncertainty associated with each category of adjustments.

All data will be kept on site for the duration of the crediting period + 2 years.

Procedures for internal audits, performance reviews and corrective actions to be taken

On a monthly basis, the Site Managing Director will review the performance of the project activity and take the necessary action.

The annual renewal of the operation licenses require the site to check and to comply with the latest regulation. No additional audit is considered to be necessary.

Data collection:

Some data are collected automatically through a data logger such as information on flare temperature, gas flow.

Daily visual inspection will be carried out by a Landfill Gas Technician. During this visit the Landfill Gas Technician checks the instrumentation and monitoring data such as gas quality, gas flow, vacuum, and flare temperature.

During this daily visit, the Landfill Gas Technician analyses the data and balances the landfill gas collection system to the adequate suction of the landfill to maintain a steady gas quality. Periodically, gas quality and vacuum level are checked at each individual gas well, using a portable meter. This monitoring plan allows maximising gas collection and maintaining the infrastructure.

During this daily visit, the Technician analyses the data and adjusts the applied vacuum within the landfill to maintain a steady gas quality and flow.

Gas quality and vacuum levels are also checked directly at each gas well, using a portable meter. This routine monitoring allows to identify underperforming gas wells and to take necessary corrective actions. The combination of these two inspections optimises the landfill gas collection efficiency.

Data Analysis:

The data are analysed on a daily basis by the operator. In case of a drift of one parameter, the operator can react quickly and fix any potential problems.

All data required for the emission reductions calculations will be kept in the onsite-monitoring database. This information will be reported on a monthly basis.

Data Storage:

Data will be monitored and archived as described in the ACM0001 monitoring methodology.
As recommended, data will be kept for two years after the end of the crediting period or the last issuance of CER's for this project activity, whatever occurs the latest.

Project Management Responsibility

The project implementation and operation will be under the direct Supervision of the Landfill Manager, who reports to the Treatment Facilities Manager and/or Proactiva Brasil Director.

Project management organization

The registration of the project is managed by the Environment and Quality Department of Veolia Propreté, based in France, in close collaboration with the Proactiva Managing Director and the Proactiva Treatment Director.

The monitoring, measurement, and reporting will be realized following the below procedure. This procedure allows for numerous crosschecks of the validity of the data.

Normal Operation	**Contingencies**
Proactiva Landfill Gas Technician: • Daily monitoring of key parameters (paper) • Monthly transmission of the data to the Landfill Manager • Perform preventive maintenance and necessary calibration	In case of unforeseen problems • Alert the Landfill Manager • Used troubleshooting procedure defined by manufacturers
Proactiva Landfill Manager: • Verify the quality of the data • Monthly report the number of ER • Carry out the scheduled investment in order to enhance the landfill gas collection and its combustion.	In case of unforeseen problems • Analyze the nature of the problem • Act accordingly in order to limit its impact on the CDM project • In case of major failure inform directly the Treatment Facility Manager
Report to Proactiva **Treatment Director** and Proactiva **Managing Director of Proactiva Brasil**	

Figure 9: Monitoring and reporting organization.

Training of monitoring personnel

Once a year the monitoring personnel will be trained internally or externally.

Training will include:
- Landfill gas collection system balancing
- Calibration of monitoring equipment
- Impact of the monitoring on the CDM activity

Procedure in case of failure

If there is an equipment (flow meter, gas analyser, gauge, etc.) failure, the equipment supplier will be immediately notified. If possible, repairs will be carried out. If the damaged equipment cannot be repaired, it will be replaced by the same or an equivalent unit as soon as possible. In some cases, portable tools will be used in order to carry out daily monitoring of the missing parameter(s). These data will be recorded on paper.

The previous table specifies the alternative measurement procedures that would be used in case of failure of a measuring device.

Flare will be equipped with a telemetry system allowing to notify the landfill gas technician in case the flare is stopped.

If the flare is stopped, no landfill gas will be burned and no credits will be claimed during this period. The running hours of the flare will be monitored as part of the monitoring procedures.

In case of failure of one of the monitoring devices, portable tools will be used in order to carry out periodic daily monitoring of the missing parameter(s). These data will be recorded on paper.

A set of data registered manually and daily will be taken. The data will be used for cross checking the operation of the data logger as backup information, which could be used for the verification in case of failure of the data logger.

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)

>>

Monitoring methodology and baseline study have been completed on the 11/09/2006.

Gary Crawford and Lionel Bondois of Veolia Propreté have applied the baseline and monitoring methodology to the project activity. Veolia Propreté is a project participant listed in Annex 1.

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:

>>
21/09/2006

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:

>>
01/05/2008, or on the date of registration of the CDM project activity, whichever is the latest.

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:

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The project activity consists of the collection and combustion of LFG, thereby avoiding its diffuse and uncontrolled emissions. The project activity will enhance the overall landfill management and will reduce adverse global and local environmental effects of uncontrolled releases of landfill gas.

The main environmental concern over emissions of landfill gas is that it contains an average of 50% methane, a potent greenhouse gas that contributes significantly to global warming.

In addition, emissions of LFG can have health and safety implications at the local level:

- 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.
- Another potential threat of concentrated emissions of LFG in confined space is asphyxiation and/or toxic effects on humans.
- Landfill gas also contains over 150 trace components that can cause other local and global environmental effects such as odour nuisances, stratospheric ozone layer depletion, and ground-level ozone creation.

The project activity will contribute to the mitigation of the potential negative environmental impacts of landfill gas emissions. The project will:

- Reduce the greenhouse gas emission by optimising the collection and by combusting the methane in order to only emit CO_2.
- Minimize the accumulation of LFG by creating a dynamic and control collection system and so decrease the risk of explosion or potential threat for human health.

In addition, by installing a high temperature flare (>700°C) with a retention time above 0.3 seconds, the methane, volatile organic compound and ammonia will be destroyed with an expected combustion efficiency exceeding 99%.

To obtain the operation license, new landfills or site expansions need an Environmental Impact Assessment (EIA-RIMA by Brazilian law). The EIA was conducted in 2003 by a specialized engineering company and focused on impacts associated with the landfill expansion. For the implementation of the landfill gas collecting and flaring system no further EIA is necessary.

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:

>>

As noted above, there are no significant environmental impacts expected from the project activity.

SECTION E. Stakeholders' comments

>>

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

>>

Proactiva has invited local stakeholders for a meeting which was held on 7th of November 2006 in the Municipal library of Biguaçu, State of Santa Catarina.

A document describing the project entitled, 'Proactiva Tijuquinhas landfill gas capture and flaring project, version 0' which can be considered as a first version of the PDD was sent in advance to the Stakeholders on the 21st of October by email and then by post. Each stakeholder received a version in Portuguese and in English. It describes the project activity, the baseline scenario, the additionality, the emission reduction calculation and the monitoring plan.

Below is the list of Stakeholders invited to comment on the project. The first part of the list corresponds to the stakeholders required by the Brazilian Designated National Authority.

- City Hall
    - Prefeitura Municipal de Biguaçu
- City Council
    - Câmara dos Vereadores de Biguaçu
- State environmental Agencies
    - Fatma – Fundação do meio Ambiente
- Municipal Environmental Agency
    - Secretaria de Agricultura de Biguaçu
- Brazilian Forum of NGO's
    - Fórum Brasileiro de ONGs e Movimentos Sociais para o Meio Ambiente e o Desenvolvimento (FBOMS)
- Community associations
    - Associação de moradores Bairro Tijuquinhas
    - Associação de moradores Jardim São Miguel
    - Associação de moradores Amigos de São Miguel
    - Associação de moradores de Cachoeiras
    - Associação de moradores de localidade da Estiva do Inferninho
    - Associação de moradores Irene e Carandaí
    - Associação de moradores Praia João Rosa
- Public Prosecution Office
    - Promotora de Justiça da Comarca de Biguaçu
    - Procurador de Justiça

Additional stakeholders invited to participate in the meeting and to comment on the project:

- Brazilian Institute for Environmental and Natural Renewable Development - IBAMA
- Public Library of Biguaçu (Biblioteca Pública Municipal)
- ONG Ambiental Acqua Bios

- Fórum Catarinense de Produção + Limpa

In addition, a copy of the above mentioned document, was made publicly available at the Public Library of Biguaçu for public comments.

Comments were received by emails or during the stakeholder meeting.

The stakeholder meeting started by an introduction of the Director of Proactiva followed by a presentation describing the project:

- General description of Greenhouse Gases and Climate Change
- Description of the Kyoto Protocol and the flexible mechanism
- Description of the waste cycle and its impact on greenhouse gases
- The experience of the project developer in developing such program
- A description of the project activity

The comments were received during a one and half hour discussion period where the stakeholders were free to ask questions and comment on the project. This period was followed by a site visit.

E.2. Summary of the comments received:

>>

The main comments received so far from the stakeholders are described below:

1. Has Proactiva explored or will explore alternative for the utilization of landfill gas ?
2. Will other fossil fuel be used to ignite or to assist the combustion of the landfill gas ?
3. Why has a 7-year crediting period, renewable twice, been selected instead of a 10-year crediting period ?
4. What are the social or community benefit of the project ?

Other remarks were made by stakeholders on the landfill operation which were not linked or impacted by the project activity, such as leachate treatment.

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

>>

Proactiva, in response to the comments, provided the following answers:

1) As part of the CDM project, the alternatives of the project activity have been evaluated. Proactiva has carried out initial study to evaluate the feasibility of a landfill gas engine facility in order to produce and sell electricity. The main barrier to energy generation is the lack of market

options. The normal electricity price is much lower than the required price for electricity production from LFG.

Thermal energy of landfill gas can, in some cases, be used by final users or to treat leachate via a leachate evaporator. At the Tijuquinhas landfill site, Proactiva is already implementing a mechanical and biological leachate treatment facility. It requires minimal thermal energy to be operated. Consequently, there is no sufficient need of landfill gas energy on site.

As the site of Biguaçu is located in a remote area, no end-user available to use the landfill gas within a reasonable proximity, was identified.

Consequently, there is currently no economical landfill gas to energy project for the site.

2) Several flare types exist on the market. Some use small amount of fossil fuel in order to ignite the landfill gas, others are ignited via an electronic ignition system. In any case, the methodology defined by the Executive Board of the UNFCCC and used as part of this project clearly defined that all fuel or electricity used as part of the project activity will be monitored and discounted from the claimed emission reductions.

3) The degradation of waste within a landfill is a long process which can take up to 30 years. By selecting the 7-year crediting period, renewable twice, Proactiva will invest on a long term basis to mitigate greenhouse gas emission.

4) The project will bring additional activities in the area of Biguaçu during the construction and operation of the project by contracting with local subcontractors. The project will require qualified personnel in order to operate and maintain the flare as well as to balance the landfill gas collection system.
Since this technology is not a common practice in the state of Santa Catarina, Proactiva will have to train employees on the operation of the system.
In addition, the existing environmental education programmes, organised by Proactiva, within the community, will be enhanced.
This will provide social benefit and contribute to sustainable development in the State of Santa Catarina.

Annex 1

CONTACT INFORMATION ON PARTICIPANTS IN THE PROJECT ACTIVITY

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Annex 2

INFORMATION REGARDING PUBLIC FUNDING

No public funding is involved.

Annex 3

BASELINE INFORMATION

Hypothesis on landfill gas modelling

k	0,1	
Lo	116	m^3 CH_4/ tWaste
Flare electricity consumption	0,000007	MWh/m^3 collected
CF m^3CH_4 in tCH_4	0,0007168	m^3CH_4 in tCH_4
Baseline gas collection efficiency rate	10%	
Electricity emission factor	0,2677	tCO_2/MWh
Maximum capture rate Phase 1	30%	
Maximum capture rate Phase 2	30%	
Maximum capture rate Phase 3	70%	

Calculation of the Electricity Emission Factor

Fuel consumption of power plants in Brazil

Fuel source	Brazilian fuel consumption 2005 1E3*TOE	2005 TJ	2004 1E3*TOE	2004 TJ	2003 1E3*TOE	2003 TJ	Biogenic carbon (Yes=0; No=1)	Net GhG emissions 2005 kgCO2/MWh	2004 kgCO2/MWh	2003 kgCO2/MWh
Natural gaz	4 022	168 401	4 107	171 949	2 638	110 458	1	28,1389	29,9288	20,3595
Coal & Other Bituminous coal	1 890	79 134	1 771	74 141	1 577	66 045	1	22,4271	12,9047	12,1734
Wood	127	5 317	128	5 347	126	5 268	0	0,0225	0,0009	0,0009
Sugar cannes	1 528	63 977	1 406	58 886	1 371	57 403	0	0,2711	0,0096	0,0099
Other primary fuel	19	796	1 843	77 154	1 747	73 140	1	0,2685	13,4291	13,4811
Gasoil	1 896	79 386	1 837	76 922	1 511	63 266	1	17,5889	13,3887	11,6610
Domestic fuel	697	29 183	602	25 226	840	35 174	1	6,4659	4,3907	6,4833
Town gas or gas coke	139	5 813	141	5 916	132	5 507	1	1,8620	1,0296	1,0151
Tar	13	544	26	1 097	21	859	1	0,1317	0,1909	0,1583
other secundary fuel	269	11 263	346	14 480	290	12 134	1	2,7261	2,5203	2,2366
						Total (kg CO2e/MWh)		79,9	77,8	67,6

Consumed electricity in Brazil

	1000*TOE	TJ	kWh
2005	28 895	1 209 843	336 051 316 593
2004	27 740	1 161 455	322 611 059 540
2003	26 195	1 096 785	304 647 940 761

Conversion factor

	kWh	cal	GJ	TOE
kWh	1	860 000	0,0036	0,00008598
cal	0,000001163	1	0,0000000042	0,0000000001
J	0,0000002777	0,23884	0,000000001	0,000000000024
TOE	11 630	10 000 000 000	42	1

Emission factor kgCO2/MWh	
2005	79,9
2004	77,8
2003	67,6
Average	75,1

TOE = Tonne Oil Equivalent

TOE = Tonne Oil Equivalent

Assumptions:

- The calulation have been made considering the less favorable situation for the calculation of a CEF for electricity importation.
- CO_2 due to biomass combustion has not been taken into account as per the IPCC guideline (Chapter 12 of volume)
- When a category includes several fuels, the largest emission factor of these fuels has been selected.
- The emissions of CO_2 of the Auto-producer have been taken into account whereas their energy production has not been integrated: Their production is not available onto the grid.

	Emission factor (Source: 2006 IPCC guidelines for National Greenhouse Gas Inventories)		
Fuel source	**kgCO2/TJ**	**kgCH4/TJ**	**kgN2O/TJ**
Natural gaz	56 100	1	0
Coal & Other Bituminous coal	94 600	1	2
Wood	112 000	32	4
Sugar cannes	100 000	30	4
Other primary fuel	112 000	32	4
Gasoil	74 100	3	1
Domestic fuel	74 100	3	1
Town gas or gas coke	107 000	1	2
Tar	80 700	1	2
other secundary fuel	80 700	3	2

However, in order to be conservative, the highest value of the CEF used within the registered PDDs in Brazil, applying the methodology ACM0001, has been applied. This conservative value of 0.2677 tCO2/MWh, defined ex-ante, will be used through the crediting period.

Annex 4

MONITORING INFORMATION

Please refer to section B.7.2

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