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

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#### SECTION A. General description of project activity

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

Itaoca Landfill Gas Project Version 4 01/10/2010

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

The objective of the Itaoca Landfill Gas Project is to develop the landfill gas (LFG) collection and flaring potential of the Itaoca Dumpsite, which is located in São Gonçalo – Rio de Janeiro, to avoid emissions of methane to the atmosphere.

The Itaoca dumpsite opened in 1980 and has operated as an uncontrolled dumpsite without appropriate design or construction as well as poor oversight of disposal. On August 10, 2004, Novagerar Ecoenergia LTDA (Novagerar) was granted a 15-year concessional licence by the São Gonçalo's municipality to manage the Itaoca dumpsite and explore its landfill gas potential. Since Novagerar took over operations, waste has been deposited under control, cover has been applied daily and it has been improved the leachate collection and treatment system. On July 01, 2009, NovaGerar merged with Haztec Tecnologia e Planejamento Ambiental S.A. (Haztec) and Haztec has thereby assumed all its rights and obligations. Haztec is planning to stop receiving waste and close the dumpsite at the end of 2010. As part of this concessional agreement, Haztec is contractually obliged to decommission and rehabilitate the Itaoca dumpsite and will open the new Waste Treatment Centre – Alcantara, São Gonçalo - Rio de Janeiro which will provide complete waste treatment and waste disposal.

With an area of 270,250 m<sup>2</sup>, the Itaoca dumpsite received on average around 800 tons of household waste per day from the city of São Gonçalo. During the period 1980-2010, approximately 7 million tons of waste will be disposed. Currently, the Itaoca dumpsite does not collect and treat the greenhouse gases which are emitted naturally into the atmosphere. By investing in a gas collection and flare system much of the methane produced in the landfill gas will be flared.

Technical analysis was conducted in order to quantify the potential volume of emissions reductions that the project can generate. The analysis was based on the projections of carbon emissions for the project and its baseline. The results found that the project has the capacity to generate 258, 869 tonnes of emission reduction credits over 10 years.

The main social and environmental impacts of this project will be positive effects on the health for the local community and surroundings. Contaminated leachate and uncontrolled surface run-off from the dumpsite can affect down-gradient ground and surface water quality, which consequently could affect the local environment. The uncontrolled release of landfill gas can also impact negatively on the health of the local environment and lead to risks of explosions in the local surroundings. By managing the Itaoca dumpsite properly, the environmental health risks and the potential for explosions will be greatly reduced. The project will also have a small, but positive impact on employment in the local area as a number of staff will need to be recruited and trained to manage the landfill gas operations, and to monitor the equipment so that it functions properly according to the manufacturers specifications.



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### A.3. Project participants:

Table 1 Project participants				
Name of Party involved (*) ((host) indicates a host Party)	Private and/or public entity (ies) project participants (*) (as applicable)	Kindly indicate if the Party involved wishes to be considered as project participant (Yes/No)		
Brazil (host)	Haztec Tecnologia e Planejamento Ambiental S.A.	No		
		Yes		
Kingdom of Spain	International Bank for Reconstruction and			
	Development (IBRD) as Trustee of the			
	Spanish Carbon Fund (SCF)			
(*) 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 registrat	time of requesting registration, the approval by the Party (ies) involved is required.			

#### A.4. Technical description of the <u>project activity</u>:

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

The Itaoca dumpsite is located in the city of São Gonçalo, in the Metropolitan Region of Rio de Janeiro.

A.4	4.1.1.	Host Party(ies):

Brazil

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

Rio de Janeiro

A.4.1.3. City/Town/Community etc:

Community: Salgueiro; City: São Gonçalo

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

Itaoca dumpsite is located adjacent to a densely populated section of the municipality of São Gonçalo, Rio de Janeiro, with more than 800,000 inhabitants. This site is located 8 Kilometres (km) from the centre of São Gonçalo city. The coordinates of the project are: 22°46'30" S and 43°22'25" W.



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Figure 1– Localization of the Itaoca Landfill Gas Project<sup>1</sup>

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

Itaoca Landfill Gas Project is designed as a sectoral scope 13 - waste handling and disposal - project.

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

Itaoca site has opened in 1980 and operated as an uncontrolled dumpsite without appropriate design or construction, as well as poor oversight of disposal. Since 2004, Novagerar took over and since then, waste is being dumped in a controlled manner and the leachate collecting system has been improved. However, nothing has been done about venting of gases being produced and much less flaring or collecting them. The waste composition is 46.5% organic matter, paper 12.8%, textiles 4.1%, wood 0.9% and 35.7% inert matter<sup>2</sup> (see Annex 3 for more details). Waste is being disposed since 1980 and will stop at the end of 2010. During this period approximately 7 million tons of waste will be disposed.

The scenario existing prior to the start of the implementation of the project activity (same as baseline scenario), much like many other dumpsites in Brazil, is that there are no organized passive vents, or equipment installed for flaring of the landfill gas. Thus:

#### Under the current situation and baseline conditions:

- The site has no organized passive vents.
- There is no equipment for flaring landfill gas.

<sup>&</sup>lt;sup>1</sup> Source: IBGE. Adapted from <http://mapas.ibge.gov.br>

<sup>&</sup>lt;sup>2</sup> Source: Caracterização de residuos, GETRES. September 2010



The baseline scenario, as identified later in section B.4 and B.5, is therefore the continuation of the current operation where waste is being land-filled until the closure of the site without any gas recovery, and gas produced is being emitted into the atmosphere.

#### Under the proposed project activity:

The activities/measures that will be implemented within the project activity consist of a LFG collecting system, pre-treatment system, and flaring system, consisting of the installation of one enclosed flare.

First, the landfill gas will be collected with the use of blowers, and then through a pipe system, the landfill gas will reach a pre-treatment system, in which the moisture and impurities of the landfill gas will be removed. The landfill is covered by clay to prevent the biogas to come out through the landfill surface. Consequently, the conservative value for the LFG collection efficiency has been estimated to be 40%<sup>3</sup>. This value considers the physical conditions of this landfill (partially managed) as well as the covering material (clay) used to cover the waste. This efficiency is not monitored, but estimated for evaluating the amount of the landfill gas capturing for blowers. Finally the landfill gas will be transported with the use of a blower, to the enclosed flare for its combustion. The flare will be under continuous monitoring of compliance with its manufacturer's specifications in order to ensure methane destruction.

#### Landfill gas collection System:

The equipment that will be installed by the project activity for the landfill gas collection system includes:

- Vertical wells used to extract gas and leachate;
- Horizontal wells used to extract gas;
- Optimal well spacing for maximum gas collection whilst minimizing costs;
- Wellheads designed as a looping system in order to allow for partial or total loss of header function in one direction without losing gas system functionality; and
- Condensate extraction and storage systems designed at strategic low points throughout the gas system.
- Pipeline collection system to connect the LFG collected with the flare system

Figure 2– Example of Transmission Pipeline – Adrianópolis Landfill/Brazil



<sup>&</sup>lt;sup>3</sup> Pre-Feasibility Study for the preparation of landfill gas projects in Latin America and the Caribbean. Itaoca landfill site São Gonçalo, Rio de Janeiro, Brazil. April 2008



Under the project activity, vertical wells will be dig (between 10 to 30 meters depth), using HDPE pipes to extract the gas. Each well will have an individual wellhead, incorporating a built-in LFG flow measuring device, gas temperature port, quick-connect gas sample ports and a flow control gate valve to monitor the quantity and quality of the LFG collected.

The wellhead will be connected with the pipeline collection system through a flex hose, which is designed to withstand the vacuum forces of a landfill gas extraction system and the constant contact with landfill gas, condensate, leachate and ultraviolet (UV) light (if installed above ground) that cause other flexible interconnects commonly available to deteriorate rapidly or fall under vacuum service.

The Knock Out (K-O) system, used for condensate removal, is designed to be installed in-line with the LFG pipelines, with its inlet and outlet attached to a straight or sloping pipeline segment.

All wells will be connected to a pipeline system that will make a "ring" around of the landfill and will direct the LFG, at pipeline pressure between 40 at 60 mm Bar, to the blower and Flare system.

#### Landfill gas flaring system:

The equipment that will be installed by the project activity for the landfill gas flaring system includes:

- One enclosed flare with burning controlled system; all burners will be anti-flashback type, with an internal stainless steel flame arresting seal, a stainless steel diverter plate, and no adjustable, or moving parts;
- Blower system used to direct the landfill gas for flaring;
- Equipment to continuously monitor the landfill gas methane composition, gas flow, and flare temperature;
- Security restart system in case the system is turned off; and
- Flare efficiency continuous monitoring.

All landfill gas flaring system equipment will be purchased from Annex-I countries

The enclosed flare selected is designed to operate continuously with automatic temperature control to safely destroy the biogas generated by solid waste. Also, the flaring system will be controlled by a programmable logic controller (PLC) which will receive and transmit signals associated to the operating conditions of the flare.

The flare system, with a capacity to process 3,000Nm<sup>3</sup>/h of LFG, is expected to achieve destruction efficiency greater than 99% of total organic compounds and greater than 98% of total non-methane volatile organic compounds (NMVOC) throughout the entire flare operating range, without any burner adjustments or flare modification<sup>4</sup>. For the ex-ante estimates of the Emission reductions, and for conservative reasons, a 90% flare efficiency has been considered. The average lifetime of the equipments of the system is between 15 to 20 years<sup>5</sup>.

The landfill gas flaring system will be maintained in accordance with manufacturer's recommended specifications on schedule and procedures in order to ensure the safety and environmental soundness of

<sup>&</sup>lt;sup>4</sup> Source: Manufacturer (John Zinc) technical specifications

<sup>&</sup>lt;sup>5</sup> Ibid



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the operations. The project personnel involved in the operations and monitoring will receive a comprehensive training on equipment, maintenance and monitoring from the equipment supplier.

Figure 3– Example of Flare System – Adrianópolis Landfill/Brazil



Project emissions from the project activity will be derived from the consumption of electricity from the grid for the blowers and from the fossil fuel consumption for the ignition system of the flare. These parameters will be monitored as indicated in section B.7.1.

Estimated amount of emission reductions over the chosen crediting period:

Table 2: Estimated emission	on reductions
Year	Annual estimation of emission reductions in tons of Carbon Dioxide equivalent (tCO <sub>2</sub> e)
01/01/2011-31/12/2011	52,633
01/01/2012-31/12/2012	41,243
01/01/2013-31/12/2013	33,213
01/01/2014-31/12/2014	27,462
01/01/2015-31/12/2015	23,264
01/01/2016-31/12/2016	20,129
01/01/2017-31/12/2017	17,728
01/01/2018-31/12/2018	15,839
01/01/2019-31/12/2019	14,312
01/01/2020-31/12/2020	13,045
Total estimated reductions (tCO <sub>2</sub> e)	258,869
Total number of crediting years	10
Annual average over the crediting period of estimated reductions (tCO <sub>2</sub> e)	25,887

A.4.5. Public funding of the project activity:



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There is no public funding involved in Itaoca Landfill Gas Project.

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

## **B.1.** Title and reference of the <u>approved baseline and monitoring methodology</u> applied to the <u>project activity</u>:

The baseline methodology applied to Itaoca Landfill Gas Project is:

- ACM0001 version 11: "Consolidated baseline and monitoring methodology for landfill gas project activities."
- Version 05.2 "Tool for demonstration and assessment of additonality"
- Version 01 "Tool to determine project emissions from flaring gases containing methane".
- Version 01- "Tool to calculate baseline, project and/or leakage emissions from electricity consumption";
- Version 02- "Tool to calculate project or leakage CO<sub>2</sub> emissions from fossil fuel combustion";
- Version 05 "Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site".
- Version 02 "Tool to calculate the emission factor for an electricity system".

## **B.2** Justification of the choice of the methodology and why it is applicable to the <u>project</u> activity:

ACM0001 "Consolidated baseline and monitoring methodology for landfill gas project activities" ---Version 11 is applicable to landfill gas capture project activities, where the baseline scenario is the partial or total atmospheric release of the gas and the project activities include situations such as: (a) The captured gas is flared; and/or

(b) The captured gas is used to produce energy (e.g. electricity/thermal energy). Emission reductions can be claimed for thermal energy generation, only if the LFG displaces use of fossil fuel either in a boiler or in an air heater. For claiming emission reductions for other thermal energy equipment (e.g. kiln), project proponents may submit a revision to this methodology;

(c) The captured gas is used to supply consumers through natural gas distribution network.

Thus, ACM0001 methodology is applicable to the Itaoca Landfill Gas Project because the baseline scenario is the partial or total atmospheric release of the landfill gas and the project activity as listed in option a) of the methodology, involves the capture of the gas through a blower and the installation of a collection system to flare the landfill gas.

The "*Tool to determine project emissions from flaring gases containing methane*"-*Version 1* is applicable to projects where the residual gas stream contains no other combustible gases than methane, carbon monoxide and hydrogen; and the residual gas stream to be flared shall be obtained from decomposition of organic material (through landfills, bio-digesters or anaerobic lagoons, among others) or from gases vented in coal mines (coal mine methane and coal bed methane). The project flares the residual gas obtained from decomposition of municipal organic waste and thus the tool is applicable to the project.

The "Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site" version 05 is applicable in cases where the solid waste disposal site where the waste would be



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dumped can be clearly identified; in this case it is clearly identified at the project site. The second applicability condition states that the tool is not applicable to hazardous wastes, and at the project site there are no hazardous wastes, it receives municipal solid waste from the populated section of the municipality of São Gonçalo, Rio de Janeiro; thus the project activity also meets the tool's applicability conditions.

The "*Tool to calculate the emission factor for an electricity system*" *version 02* is applicable for the purpose of calculating project and leakage emissions in case where a project activity consumes electricity from the grid or results in increase of consumption of electricity from the grid outside the project boundary. For the current project activity, since electricity will be sourced from the grid, then the tool is applicable.

The "Tool to calculate project or leakage  $CO_2$  emissions from fossil fuel combustion" version 2 is applicable for the purpose of calculating the project  $CO_2$  emissions from the combustion of fossil fuels in cases where  $CO_2$  emissions from fossil fuel combustion are calculated based on the quantity of fuel combusted and its properties. For the current project activity, since the quantity of fuel combusted and its properties are monitored, then the tool is applicable.

The "*Tool to calculate baseline, project and/or leakage emissions from electricity consumption version 1* is applicable for the purpose of calculating project emissions in case where a project activity consumes electricity from the grid (Scenario A of Section I of the Tool). For the current project activity, since electricity will be sourced from the grid, then the tool is applicable

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

The table below shows the gases involved in the transformation of the methane within the project boundary. Emissions in the baseline from electricity consumption and thermal energy generation were not applicable. This is also indicated in the subsequent figure on the project boundary below the table.

	Source	Gas	Included	Justification/Explanation
Baseline	Emissions from decomposition of waste at the landfill site	CO <sub>2</sub>	No	$CO_2$ emissions from the decomposition of organic waste are not accounted because it is part of the natural carbon cycle.
		CH <sub>4</sub>	Yes	The major source of emissions in the baseline.
		N <sub>2</sub> O	No	$N_2O$ emissions are small compared to $CH_4$ emissions from landfills. Exclusion of this gas is conservative.
	Emissions from	CO <sub>2</sub>	No	Excluded because there is no EC related to gas extraction in the baseline
	electricity consumption	CH <sub>4</sub>	No	Excluded for simplification. This is conservative.
		N <sub>2</sub> O	No	Excluded for simplification. This is conservative.
	Emission from	CO <sub>2</sub>	No	No thermal energy generation taking place.

#### Table 3: Sources and gases included in the project boundary



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	thermal energy generation	$CH_4$	No	Excluded for simplification. This is conservative.
		N <sub>2</sub> O	No	Excluded for simplification. This is conservative.
		CO <sub>2</sub>	Yes	May be an important emission source.
t activity	Emissions from on- site electricity use	CH <sub>4</sub>	No	Excluded for simplification. This emission source is assumed to be very small.
		N <sub>2</sub> O	No	Excluded for simplification. This emission source is assumed to be very small.
ject	On-site fossil fuel	CO <sub>2</sub>	Yes	May be an important emission source.
Pro	consumption due to the project activity other than for	CH <sub>4</sub>	No	Excluded for simplification. This emission source is assumed to be very small.
	electricity generation	N <sub>2</sub> O	No	Excluded for simplification. This emission source is assumed to be very small.

#### Figure 4- Project Boundary





The project boundary is the site of the project activity where the gas is captured and destroyed; in this case this is the Itaoca landfill site. As shown in the figure above, the project boundary at Itaoca includes the landfill, where the gas capture system will be installed along with the gas treatment (condensate removal) and flare system. In addition the project boundary covers the power plants that supply power to the grid. The project will use electricity generated by these power plants for operation of the blowers (vacuum pumps), the flare and ancillary equipment. Thus, as indicated by the methodology since electricity is sourced from the grid, the project boundary includes all the power generation sources connected to the grid to which the project activity is connected. In addition, the project boundary covers the LPG consumed to ignite the flare.

## **B.4**. Description of how the <u>baseline scenario</u> is identified and description of the identified baseline scenario:

As per ACM0001, Step 1 of the *"Tool for the demonstration and assessment of additionality"* version 5.2 has been used to identify all realistic and credible baseline alternatives, as follows:

#### Step 1: Identification of alternative scenarios

According to ACM0001, Step 1 of the latest version of the "Tool for demonstration and assessment of additionality" (version 5.2) was used to identify all realistic and credible baseline alternatives.

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

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

Alternatives for the disposal/treatment of the waste in the absence of the relevant for estimating baseline methane emissions, to be analyzed should include, inter alia:

- LFG1: The project activity (i.e. capture of landfill gas and its flaring and/or its use) undertaken without being registered as a CDM project activity. The landfill operator would invest in LFG capture and flaring not undertaken as a CDM project activity. Due to absence of legislation mandating capture and flaring of landfill this scenario is not an economically attractive course of action for the landowner nor for the landfill operator since there is no revenue to cover the high costs of LFG equipment, operation and maintenance (refer to Section B.5 for details).
- LFG2: Atmospheric release of the landfill gas or partial capture of landfill gas and destruction to comply with regulations or contractual requirements, or to address safety and odour concerns. This is the business as usual scenario, the landfill gas would continue to be released to the atmosphere as there are no requirements in place that would mandate landfill gas capture and flaring. This is the most plausible course of action and is a common practice.
- LFG3: LFG collection and utilization for power generation or gas supply off-site. Most of the waste, since 1980 until 2004, have been mostly disposed in an uncontrolled dump that will close at the end of 2010, not receiving additional waste, the low and declining volume of LFG would not satisfy the requirements of either power generation or gas supply off-site and thus making this alternative not plausible.



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Outcome of sub-step 1a: As described above, plausible alternative scenarios for the Project are LFG1 and LFG2.

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

Currently in Brazil there are no laws or regulations mandating capture and flaring of the landfill gas. In the state of Rio de Janeiro, the environmental agency, has been acting towards closing rubbish dumps and forcing municipalities to give proper destination to the generated waste. That may be done through concessions to private entities either to build and operate sanitary landfills or to be responsible for the whole municipality's waste management. In all cases, however, active collection and flaring of the landfill gas has never been required. Thus all alternative scenarios identified are consistent with mandatory laws and regulations in Brazil.

Outcome of sub-step 1b: Scenarios LFG1 and LFG2 are compliant with mandatory legislation and regulations.

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

In the baseline scenario there is no energy use, as waste is just being deposited at the landfill, thus this step does not apply.

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

Step 2 (investment analysis) of the latest approved Tool for demonstration and assessment of additionality is used in undertaken in B.5 of this PDD. The outcome of this analysis shows that scenario LFG1 does not beneficiated of any revenues and thus is not financially attractive compared to the alternative LFG2, the common practices in Brazil.

# Step 4: Where more than one credible and plausible alternative remains, project participants shall, as a conservative assumption, use the alternative baseline scenario that results in the lowest baseline emissions as the most likely scenario.

As demonstrated in section B.5., the outcome of the analysis is that the most plausible baseline scenario for the current project activity is LFG2 "*Atmospheric release of the landfill gas*", there is only one remaining scenario and thus Step 4 does not apply.

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

The determination of additionality is done using the "Tool for demonstration and assessment of additionality"-Version 5.2.

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

UNFCCC



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

The three scenarios considered were described in the previous section.

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

Outcome of sub-step 1a: As described above, plausible alternative scenarios for the Project are LFG1 and LFG2.

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

All above scenarios are in line with applicable laws and regulations.

Outcome of sub-step 1b: Scenarios LFG1 and LFG2 are all compliant with mandatory legislation and regulations.

#### **Step 2. Investment Analysis**

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

As the Itaoca Landfill Gas Project generates no financial or economic benefits other than CDM related income, a simple cost analysis scenario is applied.

Outcome of sub-step 2a:

The appropriate analysis method is simple cost analysis.

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

As the project activity will not receive any other income apart from CER revenues, simple cost analysis is applied.

The total costs for the construction of the system are estimated to be €1,453,346.58 euro (2010 constant price), as indicated by the assessment for the Landfill:

Table 4. Estimated costs for EFO concerton	and Maring	g systems
Pipelines and wellheads	€	354,895.19
Biogas plant (blowers, chillers, flares, manifolds		
and others)	€	958,228.56
Engineering expenses	€	125,222.82
Total estimated costs	€	1,438,346.58

**Table 4:** Estimated costs for LFG Collection and Flaring systems<sup>6</sup>

<sup>&</sup>lt;sup>6</sup> Based on evidences provided to the DOE during validation All the values have been converted into constant 2010 prices using Inflation rates for USD and R\$. There is an additional estimated cost of  $\leq$ 15,000 for the facility building, which for conservative reasons has been excluded from the analysis. For complete details please refer to background financial cost spreadsheet.



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And added to the cost of capital, the cost estimate for the operation of the LFG collection system is estimated at 5% of total investment cost (about  $\notin$ 72,000/year), with insurance and other fixed costs it amounts to slightly more than  $\notin$ 100,000.

Given such a high investment cost, LFG1 (undertaking the project activity without being registered as CDM project) is not possible. Thus, the only plausible scenario is the continuation of the actual scenario LFG2 "*Atmospheric release of the landfill gas*".

Outcome of sub-step 2b: LFG2 is the only plausible baseline scenario.

#### Step 3. Barrier analysis

Since the additionality is demonstrated using financial analysis, the barrier analysis is not undertaken.

#### Step 4. Common practice analysis

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

The Figure 1 below illustrates the latest official statistics on urban solid waste in Brazil – *Pesquisa Nacional de Saneamento Básico 2000* (PNSB 2000).



**Figure 5**. Waste Final Destination per Municipality in Brazil<sup>7</sup>

According to the PNSB study from 2000, the country produces 228,413 tons of waste per day, which corresponds to 1.35 kg/inhabitant/day. Most of the waste produced in the country is sent to open dumps which are, in most of the cases, areas without any sort of proper infrastructure to avoid environmental hazards.

<sup>&</sup>lt;sup>7</sup> Source: Table 109. PNSB, 2000. Web site:

http://www.ibge.gov.br/home/estatistica/populacao/condicaodevida/pnsb/pnsb.pdf



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Outcome of sub-step 4a:

Only a few existing Brazilian landfills have installed methane collection and flaring systems, electric generation systems, or evaporator leachate treatment systems. The majority of landfills operate with natural emissions of methane to the atmosphere through concrete wells.

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

All of the project activities implemented in Brazil with forced methane extraction and destruction, blowers, and collection and flaring systems do so because of the incentive provided by the CDM.

As for the percentage of cities that do use sanitary landfills, as per the Brazil Country Profile published by Methane to Markets, very few have gas recovery systems, much less energy generation or distribution to consumers through a natural gas distribution network; the ones that do have gas recovery and energy generation are projects under the CDM. This can also be corroborated by analyzing the *Diagnóstico do Manejo de Resíduos Sólidos Urbanos* elaborated by the Brazilian Ministry of the Cities in 2007<sup>8</sup>.

According to this report, which considers a sample of the major municipalities of the country, we have that:

- Only 37.1% of the final waste disposal units in the sample corresponded to sanitary landfills (Diagnóstico do Manejo de Resíduos Sólidos Urbanos, table 6.14, page 130), which is approximately - Among all the units used to dispose urban solid residues analyzed by this research which includes beyond the sanitary landfills, open dumps and controlled landfills, only 45.3% of the landfills of the country have a system to collect the landfill gas which not necessarily consist of a forced capture system (Diagnóstico do Manejo de Resíduos Sólidos Urbanos, table 6.16, page 131);

- The landfill gas is used/flared in only 6.4% of units of final waste disposal sites (Diagnóstico do Manejo de Resíduos Sólidos Urbanos, table 6.16, page 131).

At present, forced methane extraction and destruction, using blowers, collection systems and flaring systems are presented at the following landfill sites in Brazil:

	Plant	CDM Registration N	umber
•	Bandeirantes Landfill	0164	
•	Novagerar Landfill	0008	
•	Onyx Landfill	0027	
•	Marca Landfill	0137	
•	Caieiras Landfill	0171	
•	Anaconda Landfill	0226	
•	São João Landfill	0373	
•	Canabrava Landfill	0893	
•	Aurá Landfill	0888	
•	Embralixo.Arauna - Braga	nça Landfill. 1247	
•	ESTRE Itapevi Landfill	0911	
•	Quintaúna Landfill	0912	
•	ESTRE Pedreira Landfill	1134	
•	Salvador da Bahia Landfill	0052	
•	ESTRE Paulínia Landfill	0165	

<sup>&</sup>lt;sup>8</sup> Sistema Nacional de Informações sobre Saneamento: diagnóstico do manejo de resíduos sólidos urbanos – 2007. Brasília: MCIDADES.SNSA, 2009. Available at <u>http://www.snis.gov.br/</u>



Lara Landfill 0091 • Recreio Landfill 0648 URBAM/ARAUNA Landfill 1247 Joao Pessoa Landfill 1165 Terrestre Ambiental Landfill (Santos) 1133 CTRW Landfill (Vila Velha) 1491 Alto-Tiete Landfill 1636 Feira de Santana Landfill 1626 Tijuquinhas Landfill (Santa Catarina) 1506

Andread Catalina (Santa Catalina) 1500
 SANDTEC Landfill 1908

Outcome of sub-step 4b:

In Brazil, there is no LFG capture and power generation projects developed without CDM incentives.

#### Outcome of the analysis:

The project activity is additional given that there is no other incentive to install a landfill gas collection and flaring system, other than CDM revenue. The baseline scenario is compliant with all regulatory requirements, thus the project implementer without CDM has no incentive to implement such project activity, which will generate no revenue.

#### **B.6**. Emission reductions:

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

The following methodology and tools are applied to the proposed project activity. Details are provided below.

- ACM0001 Version 11: "Consolidated baseline and monitoring methodology for landfill gas project activities."
- Version 05.2 "Tool for demonstration and assessment of additonality"
- Version 01 "Tool to determine project emissions from flaring gases containing methane".
- Version 01- "Tool to calculate baseline, project and/or leakage emissions from electricity consumption";
- Version 02- "Tool to calculate project or leakage CO<sub>2</sub> emissions from fossil fuel combustion";
- Version 05 "Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site".
- Version 02 "Tool to calculate the emission factor for an electricity system".

#### **Baseline Emissions**

$$BE_{y} = (MD_{project,y} - MD_{BL,y}) * GWP_{CH4} + EL_{LFG,y} \cdot CEF_{elec,BL,y} + ET_{LFG,y} * CEF_{ther,BL,y}$$
(1)

Where:

 $BE_{y} = Baseline emissions in year y (tCO_{2}e).$   $MD_{project,y} = The amount of methane would have been destroyed during the year, in tons of methane (tCH_{4}) in project scenario.$ 



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$MD_{BL,y} =$	The amount of methane that would have been destroyed/combusted during the year in the absence of the project due to regulatory and/or contractual requirement, in tons of methane (tCH <sub>4</sub> ).
$GWP_{CH4} =$	Global Warming Potential value for methane for the first commitment period is 21 $tCO_2e/tCH_4$ .
$EL_{LFG,y} =$	Net quantity of electricity produced using LFG, which in the absence of the project activity would have been produced by power plants connected to the grid or by an on- site/off-site fossil fuel based captive power generation, during year y, in megawatt hours (MWh).
$CEF_{elecy,BL,y} =$	CO <sub>2</sub> emissions intensity of the baseline source of electricity displaced, in tCO2e/MWh.
$ET_{LFG,y} =$	The quantity of thermal energy produced utilizing the landfill gas, which in the absence of the project activity would have been produced from onsite/offsite fossil fuel fired boiler/air heater during the year y in TL
CEFther,BLy =	CO <sub>2</sub> emissions intensity of the fuel used by boiler/air heater to generate thermal energy which is displaced by LFG based thermal energy generation, in tCO <sub>2</sub> e/TJ.

Given the context of the project activity, we therefore have:

$MD_{BL,y} =$	Assumed to be zero since there are no regulations or contractual agreements requiring
	capture and flaring of methane.
$EL_{LFG,y} =$	Assumed to be zero since there is no electricity generation.
$ET_{LFG,y} =$	Assumed to be zero since there is no thermal heat generation.
MD <sub>project,y</sub> =	Will be determined ex-post by metering the actual quantity of methane captured and
	destroyed once the project activity is operational. The methane destroyed by the project
	activity (MD <sub>project,y</sub> ) during a year is determined by monitoring the quantity of methane
	actually flared.

Thus for the project activity, the baseline emissions are streamlined to:

$$BE_{y} = (MD_{project, y} - MD_{BL, y}) * GWP_{CH4}$$
<sup>(2)</sup>

#### Ex-ante estimation of the amount of methane that would have been destroyed in project scenario during the year y, in tones of methane (MD<sub>project,y</sub>)

Ex-ante estimation of baseline emissions is estimated as per "Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site" version 5, where BECH4,SWDS,y is methane emissions generated during the year y from the disposal of waste at the solid waste disposal site during the period from the start of the project activity to the end of the year y (tCO2e). As per the tool, we have that:

$$MD_{project,y} = BE_{CH4,SWDS,y}/GWP_{CH4}$$
(3)

Where:

$$BE_{CH4,SWDS,y} = \varphi \cdot (1-f) \cdot GWP_{CH4} \cdot (1-OX) \cdot \frac{16}{12} \cdot F \cdot DOC_{f} \cdot MCF \cdot \sum_{x=1}^{y} \sum_{j} W_{j,x} \cdot DOC_{j} \cdot e^{-k_{j}(y-x)} \cdot (1-e^{-k_{j}})$$
(4)

Where:



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$BE_{CH4,SWDS,y} =$	Methane emissions avoided during the year y from preventing waste disposal at the solid waste disposal site (SWDS) during the period from the start of the project activity to the end of the year y (tCO <sub>2</sub> e).
=	Model correction factor to account for model uncertainties (0.9).
f =	Fraction of methane captured at the SWDS and flared, combusted or used in another manner (0).
$GWP_{CH4} =$	Global Warming Potential (GWP) of methane, valid for the relevant commitment period (21).
OX =	Oxidation factor (reflecting the amount of methane from SWDS that is oxidized in the soil or other material covering the waste) $(0.1)$ .
F =	Fraction of methane in the SWDS gas (volume fraction) (0.5).
$DOC_f =$	Fraction of degradable organic carbon (DOC) that can decompose (0.5)
MCF =	Methane correction factor (0.8).
$W_{j,x} =$	Amount of organic waste type $j$ disposed in the SWDS in the year $x$ (tons) (AVE: 224,000/year).
$DOC_j =$	Fraction of degradable organic carbon (by weight) in the waste type <i>j</i> .
$k_{\rm i} =$	Decay rate for the waste type <i>j</i> .
j =	Waste type category (index).
x =	Year during the crediting period: x runs from the first year of the first crediting period $(x = 1)$ to the year y for which avoided emissions are calculated $(x = y)$ .
$v \equiv$	Year for which methane emissions are calculated.

The LFG collection efficiency  $(40\%)^9$ , as well as the flare efficiency (90%) have both been taken into account while estimating the *ex ante* emission reductions.

## Ex-post estimation of the amount of methane destroyed in the project scenario during the year y, in tones of methane $(MD_{project,y})$

According to the Methodology, *ex post* MD<sub>project,y</sub> is determined by:

$$MD_{project,y} = MD_{flared,y} + MD_{electricity,y} + MD_{thermal,y} + MD_{PL,y}$$
(5)

Where:

$MD_{flared,y} =$	Quantity of methane destroyed by flaring (tCH <sub>4</sub> )
$MD_{electricity,y} =$	Quantity of methane destroyed by generation of electricity (tCH <sub>4</sub> )
$MD_{thermal,y} =$	Quantity of methane destroyed for the generation of thermal energy (tCH <sub>4</sub> )
$MD_{PL,y} =$	Quantity of methane sent to the pipeline for feeding to the natural gas
	distribution network (tCH <sub>4</sub> )

For the current project activity, since methane is only being destroyed by flaring, we have that  $MD_{project,y}$  is determined by:

$$MD_{project, y} = MD_{flared, y} \tag{6}$$

Where:

<sup>&</sup>lt;sup>9</sup> Prefeasibility Study. Itaoca. April 2008

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(7)

MD<sub>flared,y</sub> is determined by:

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

Where:

LFG <sub>flare,y</sub> =-	Quantity of landfill gas fed to the flare(s) during the year measured in cubic meters $(m^3)$
$W_{CH4,y} =$	Average methane fraction of the landfill gas as measured during the year and expressed as a fraction (in $m^{3}CH_{4}/m^{3}LFG$ )
D <sub>CH4</sub> - =	Methane density expressed in tons of methane per cubic meter of methane $tCH_4/m^3CH_4$ )
$PE_{flare,y} =$	Project emissions from flaring of the residual gas stream in year y (tCO2e) determined following the procedure described in the <i>"Tool to determine project emissions from</i> "
	flaring gases Containing Methane" Version 1. The project uses an enclosed flaring system and monitoring will be done continuously.

According to the tool. PE<sub>flare,y</sub> is determined as follows:

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

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

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

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

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

STEP 6: Determination of the hourly flare efficiency

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

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

As per the tool, using the simplified approach, the project developer will only measure the volumetric fraction of methane and consider the difference to 100% as being nitrogen ( $N_2$ ).

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

Determine the mass fractions of carbon, hydrogen, oxygen and nitrogen in the residual gas, calculated from the volumetric fraction of each component *i* in the residual gas, as follows:

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

Where:

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Variable	SI Unit	Description
fm <sub>j,h</sub>	-	Mass fraction of element $j$ in the residual gas in hour $h$
fvih	-	Volumetric fraction of component <i>i</i> in the residual gas in the
-		hour h
AMj	kg/kmol	Atomic mass of element j
NA <sub>j,i</sub>	-	Number of atoms of element <i>j</i> in component <i>i</i>
MM <sub>RG,h</sub>	kg/kmol	Molecular mass of the residual gas in hour $h$
j		The elements carbon, hydrogen, oxygen and nitrogen
i		The components CH <sub>4</sub> , CO, CO <sub>2</sub> , O <sub>2</sub> , H <sub>2</sub> , N <sub>2</sub>

As per the tool, using the simplified approach, the project developer will only measure the volumetric fraction of methane. Therefore, only elements  $CH_4$  and  $N_2$  are included in the calculation of STEP 2.

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

This step is applied because the flare is continuously monitored. Determine the average volumetric flow rate of the exhaust gas in each hour h based on a stoichiometric calculation of the combustion process, which depends on the chemical composition of the residual gas, the amount of air supplied to combust it and the composition of the exhaust gas, as follows:

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

Where:

#### SEE REFERENCES TO DRY BASIS BELOW

Variable	SI Unit	Description
TV <sub>n,FG,h</sub>	m <sup>3</sup> /h	Volumetric flow rate of the exhaust gas in dry basis at normal
		conditions in hour h
V <sub>n,FG,h</sub>	m <sup>3</sup> /kg residual	Volume of the exhaust gas of the flare in dry basis at normal
	gas	conditions per kg of residual gas in hour $h$
FM <sub>RG,h</sub>	kg residual	Mass flow rate of the residual gas in the hour $h$
	gas/h	-

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

Where:

(10)

(9)



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Variable	SI Unit	Description
V <sub>n,FG,h</sub>	m <sup>3</sup> /kg residual	Volume of the exhaust gas of the flare in dry basis at normal
	gas	conditions per kg of residual gas in the hour $h$
V <sub>n,CO2,h</sub>	m <sup>3</sup> /kg residual	Quantity of CO <sub>2</sub> volume free in the exhaust gas of the flare at
	gas	normal conditions per kg of residual gas in the hour $h$
V <sub>n,N2,h</sub>	m <sup>3</sup> /kg residual	Quantity of N <sub>2</sub> volume free in the exhaust gas of the flare at
	gas	normal conditions per kg of residual gas in the hour $h$
V <sub>n,O2,h</sub>	m <sup>3</sup> /kg residual	Quantity of O <sub>2</sub> volume free in the exhaust gas of the flare at
	gas	normal conditions per kg of residual gas in the hour h

$$V_{n,O_2,h} = n_{O_2,h} \times MV_n$$

Where:

Variable	SI Unit	Description
V <sub>n,O2,h</sub>	m <sup>3</sup> /kg residual	Quantity of O <sub>2</sub> volume free in the exhaust gas of the flare at
	gas	normal conditions per kg of residual gas in the hour $h$
n <sub>O2,h</sub>	kmol/kg	Quantity of moles O2 in the exhaust gas of the flare per kg
	residual gas	residual gas flared in hour h
MVn	m <sup>3</sup> /kmol	Volume of one mole of any ideal gas at normal temperature and
		pressure (22.4 L/mol)

$$V_{n,N_{2},h} = MV_{n} * \left\{ \frac{fm_{N,h}}{200AM_{N}} + \left( \frac{1 - MF_{O_{2}}}{MF_{O_{2}}} \right) * \left[ F_{h} + n_{O_{2},h} \right] \right\}$$

(12)

Where:	
--------	--

Variable	SI Unit	Description
V <sub>n,N2,h</sub>	m <sup>3</sup> /kg	Quantity of N <sub>2</sub> volume free in the exhaust gas of the flare at
	residual gas	normal conditions per kg of residual gas in the hour $h$
MVn	m <sup>3</sup> /kmol	Volume of one mole of any ideal gas at normal temperature and
		pressure (22.4 m <sup>3</sup> /Kmol)
fm <sub>N,h</sub>	-	Mass fraction of nitrogen in the residual gas in the hour $h$
AM <sub>n</sub>	kg/kmol	Atomic mass of nitrogen
MF <sub>02</sub>	-	O <sub>2</sub> volumetric fraction of air
F <sub>h</sub>	kmol/kg	Stochiometric quantity of moles of O2 required for a complete
	residual gas	oxidation of one kg residual gas in hour $h$
n <sub>O2,h</sub>	kmol/kg	Quantity of moles O2 in the exhaust gas of the flare per kg
	residual gas	residual gas flared in hour h

(11)



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(13)

$$V_{n,CO_2,h} = \frac{fm_{C,h}}{AM_C} * MV_n$$

Where:

Variable	SI Unit	Description
V <sub>n,CO2,h</sub>	m <sup>3</sup> /kg residual	Quantity of CO <sub>2</sub> volume free in the exhaust gas of the flare at
	gas	normal conditions per kg of residual gas in the hour $h$
fm <sub>C,h</sub>	-	Mass fraction of carbon in the residual gas in the hour $h$
AM <sub>C</sub>	kg/kmol	Atomic mass of carbon
MV <sub>n</sub>	m <sup>3</sup> /kmol	Volume of one mole of any ideal gas at normal temperature and
		pressure (22.4 m <sup>3</sup> /Kmol)

$$m_{O_2,h} = \frac{t_{O_2,h}}{\left(1 - (t_{O_2,h} / MF_{O_2})\right)} \times \left[\frac{fm_{C,h}}{AM_C} + \frac{fm_{N,h}}{2AM_N} + \left(\frac{1 - MF_{O_2}}{MF_{O_2}}\right) \times F_h\right]$$
(14)

Where:

Variable	SI Unit	Description
n <sub>O2,h</sub>	kmol/kg	Quantity of moles O <sub>2</sub> in the exhaust gas of the flare per kg
-	residual gas	residual gas flared in hour h
t <sub>O2,h</sub>	-	Volumetric fraction of $O_2$ in the exhaust gas in the hour $h$
MF <sub>02</sub>	-	Volumetric fraction of $O_2$ in the air (0.21)
F <sub>h</sub>	kmol/kg	Stochiometric quantity of moles of O2 required for a complete
	residual gas	oxidation of one kg residual gas in hour $h$
fm <sub>j, h</sub>	-	Mass fraction of element $j$ in the residual gas in hour $h$ (from
		Equation 8 )
AMi	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:

(15)



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(16)

(17)

Variable	SI Unit	Description
F <sub>h</sub>	kmol O <sub>2</sub> /kg	Stoichiometric quantity of moles of O2 required for a complete
	residual gas	oxidation of one kg residual gas in hour $h$
fm <sub>j,h</sub>	-	Mass fraction of element $j$ in the residual gas in hour $h$ (from
		Equation 8 )
AMi	kg/kmol	Atomic mass of element j
j		The elements carbon (index C), hydrogen (index H) and oxygen
		(index O)

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

This step is applied because the efficiency of the flare is continuously monitored. The mass flow of methane in the exhaust gas is based on the volumetric flow of the exhaust gas and the measured concentration of methane in the exhaust gas, as follows:

$$TM_{FG,h} = \frac{TV_{n,FG,h} * f_{V_{CH4,FG,h}}}{1000000}$$

Where:

Variable SI Unit Description Mass flow rate of methane in the exhaust gas of the flare in dry TM<sub>FG,h</sub> kg/h basis at normal conditions in the hour hTV<sub>n.FG.h</sub> m<sup>3</sup>/h exhaust Volumetric flow rate of the exhaust gas in dry basis at normal gas conditions in hour h Concentration of methane in the exhaust gas of the flare in dry mg/m<sup>3</sup> fv<sub>CH4,FG,h</sub> basis at normal conditions in hour h

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

The quantity of methane in the residual gas flowing into the flare is the product of the volumetric flow rate of the residual gas (FVRG,h), the volumetric fraction of methane in the residual gas (fvCH4,RG,h) and the density of methane (CH4,n,h) in the same reference conditions (normal conditions and dry or wet basis).

It is necessary to refer both measurements (flow rate of the residual gas and volumetric fraction of methane in the residual gas) to the same reference condition that may be dry or wet basis. If the residual gas moisture is significant (temperature greater than 60°C), the measured flow rate of the residual gas that is usually referred to wet basis should be corrected to dry basis due to the fact that the measurement of methane is usually undertaken on a dry basis (i.e. water is removed before sample analysis).

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

Where:



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Variable	SI Unit	Description
TM <sub>RG,h</sub>	kg/h	Mass flow rate of methane in the residual gas in the hour $h$
$\mathrm{FV}_{\mathrm{RG},\mathrm{h}}$	m <sup>3</sup> /h	Volumetric flow rate of the residual gas in dry basis at normal conditions in hour $h$
fv <sub>CH4,RG,h</sub>	-	Volumetric fraction of methane in the residual gas on dry basis in hour $h$ (NB: this corresponds to $fv_{i,RG,h}$ where $i$ refers to methane).
PCH4 n	kg/m <sup>3</sup>	Density of methane at normal conditions (0.716)

#### STEP 6. Determination of the hourly flare efficiency

The approach used in the project is enclosed flare with continuous monitoring.

In this case the flare efficiency in the hour  $h(\eta flare, h)$  is

- 0% if the temperature of the exhaust gas of the flare (Tflare) 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* :

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

(18)

(19)

Variable	SI Unit	Description
η <sub>flare, h</sub>	-	Flare efficiency in the hour h
TM <sub>FG,h</sub>	kg/h	Methane mass flow rate in exhaust gas averaged in a
		period of time t (hour, two months or year)
TM <sub>RG,h</sub>	kg/h	Mass flow rate of methane in the residual gas in the hour
, í		h

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

Project emissions from flaring are calculated as the sum of emissions from each hour h, based on the methane flow rate in the residual gas (*TMRG*,h) and the flare efficiency during each hour h (*flare*,h), as follows:

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

Where:



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Variable	SI Unit	Description		
PE <sub>flare,y</sub>	tCO <sub>2</sub> e	Project emissions from flaring of the residual gas stream in year		
-		у		
TM <sub>RG,h</sub>	kg/h	Mass flow rate of methane in the residual gas in the hour h		
η <sub>flare, h</sub>	-	Flare efficiency in hour h		
GWP <sub>CH4</sub>	tCO2e/tCH4	Global Warming Potential of methane valid for the commitment		
		period		

#### **Project Emissions:**

According to the methodology, project emissions are determined by the following:

$$PEy = PE_{ECy} + PE_{FCjy}, (20)$$

Where:

$PE_{EC,y} =$	Emissions from consumption of electricity in the project case (tCO2e)
$PE_{FC,j,y} =$	Project emissions from fossil fuel combustion (tCO2e)

Project emissions from electricity consumption (PEEC,y) are calculated following version 01 of "*Tool to calculate baseline, project and/or leakage emissions from electricity consumption*", scenario A "Electricity consumption from the grid" has been applied for this project activity; PE<sub>EC,y</sub> is calculated as follows:

$$PE_{EC,y} = EC_{PJ,y} * EF_{CP,y} * (1+TDL_y)$$

$$(21)$$

Where:

$EC_{PJ,y}$	Quantity of electricity consumed by the project activity during the year (MWh)
$EF_{CP,y}$	Brazilian grid emission factor (tCO <sub>2</sub> /MWh)
TDLy	Average technical transmission and distribution losses in the grid in year y for the
	voltage level at which electricity is obtained from the grid at the project site

Project emissions from fossil fuel combustion ( $PE_{FC,j,y}$ ) are calculated following version 02 of "*Tool to calculate project or leakage CO2 emissions from fossil fuel combustion*". For this project, LPG (Liquefied Petroleum Gas) is used for the ignition of the flare system, thus these emissions are calculated as follows:

$$PE_{FC,y} = FCy, * COEF_y \tag{22}$$

Where	·// ·
$FC_{v}$	is the fossil fuel (LPG) combusted $(m^3)$
$OOEF_y$	is the CO <sub>2</sub> emission coefficient of the LPG (tCO2/ $m^3$ fuel)

The amount of LPG combusted (FC<sub>y</sub>) is estimated for the ex-ante calculation by determining the volume used for only one ignition in the flare system, as per the instructions extracted from the 2006 IPCC Guidelines for national Greenhouse Gas Inventories: Reference Manual - Energy<sup>10</sup>, and then multiplying this by the number of ignitions during the year (ex-ante these are estimated by the project



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developer, but these will be monitored ex-post). The LFG consumed in the project will be measured as per the "Tool to calculate project or leakage  $CO_2$  emissions from fossil fuel combustion"-version 2.

 $COEF_y$  is calculated by following option B of the tool:

$$COEF_{y} = NCV_{y} * EF_{CO2y}$$
<sup>(23)</sup>

WhereIs the weighted average net calorific value of the fuel type  $(0.106 \text{ GJ/ m}^3)$  $EF_{CO2y}$ Is the weighted average CO2 emission factor of fuel type  $(0.0656 \text{ tCO}_2/\text{GJ})$ 

Project emissions from flaring have not been shown in this section since they are already taken into account in the  $MD_{project}$  parameter.

#### <u>Leakage</u>

No leakage effects need to be accounted under this methodology.

#### **Emission Reductions**

Emission reductions are calculated as follows:

$$\mathbf{ER}_{\mathbf{y}} = \mathbf{BE}_{\mathbf{y}} - \mathbf{PE}_{\mathbf{y}} \tag{24}$$

Where:

$ER_y =$	Emission reductions in year $y$ (tCO <sub>2</sub> e/yr)
$BE_y =$	Baseline emissions in year $y$ (tCO <sub>2</sub> e/yr).
$PE_v =$	Project emissions in year $y$ (tCO <sub>2</sub> /yr).

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

Data / Parameter:	Regulatory requirements relating to landfill gas
Data unit:	Norms
Description:	Regulatory requirements relating to landfill gas from ABNT NBR (Associação Brasileira de Normas Tecnicas / Brazilian Association of Technical Norms ) and (Norma Brasileira / Brazilian Norm), including: ABNT NBR 8419:1992 Versão Corrigida: 1996. Apresentação de projetos de aterros sanitários de resíduos sólidos urbanos. (Introduction of Projects for Sanitary Landfills of Municipal Solid Waste.)
Source of data used:	Publicly available information
Value applied:	Will be reflected in the AF. Further information can be found in section B.6.3.
Justification of the choice of data or description of measurement methods and procedures actually applied :	The information will be recorded, to use it for changes in the adjustment factor (AF) or directly to $MD_{BL, y}$ at renewal of the credit period.
Any comment:	Further information in Section B.6.3.



Data / Parameter:	GWP <sub>CH4</sub>
Data unit:	tCO <sub>2</sub> e/tCH <sub>4</sub>
Description:	Global warming potential of CH <sub>4</sub>
Source of data used:	IPCC
Value applied:	21
Justification of the	Shall be updated accordingly to any future COP/MOP decisions
choice of data or	
description of	
measurement methods	
and procedures actually	
applied :	
Any comment:	N/A

D <sub>CH4</sub>
tCH <sub>4</sub> /m <sup>3</sup> CH <sub>4</sub>
Methane density
IPCC
0.0007168
At standard T and P (0 degrees C and 1,013 bar)
N/A

Data / Parameter:	BE <sub>CH4, SWDS,y</sub>		
Data unit:	tCO <sub>2</sub> e		
Description:	Methane generation from the landfill in the absence of the project activity at		
	year y		
Source of data used:	Calculated as per the "Tool	l to determine methane emissions avoided	from
	disposal of waste at a solid w	aste disposal site" –Version 5	
Value applied:		$\mathbf{PE} \qquad (\mathbf{f} \mathbf{CO} \mathbf{a})$	
	Year	$\mathbf{DE}_{CH4,SWDS,y}$ ( $\mathbf{U},\mathbf{U},\mathbf{U},\mathbf{U},\mathbf{U},\mathbf{U},\mathbf{U},\mathbf{U},$	
	2011	146,351	
	2012	114,711	
	2013	92,407	
	2014	76,432	
	2015	64,770	
	2016	56,061	
	2017	49,392	
	2018	44,146	
	2019	39,905	
	2020	36,386	



		Total	7	20.562	
Justification of the choice of data or description of measurement methods and procedures actually applied :	A w	s per the "Tool to determ aste at a solid waste dispose	ine methane emissi Il site" –Version 5	ons avoided from dispo	sal of
Any comment:	U de	sed for ex-ante estimation estroyed/combusted during t	of the amount of r he year	nethane that would have	been

Data / Parameter:	φ
Data unit:	-
Description:	Model correction factor to account for model uncertainties
Source of data used:	As per the "Tool to determine methane emissions avoided from disposal of
	waste at a solid waste disposal site" –Version 5
Value applied:	0.9
Justification of the	Oonk et el. (1994) have validated several landfill gas models based on 17
choice of data or	realized landfill gas projects. The mean relative error of multi-phase models
description of	was assessed to be 18%. Given the uncertainties associated with the model and
measurement methods	in order to estimate emission reductions in a conservative manner, a discount of
and procedures actually	10% is applied to the model results.
applied :	
Any comment:	

Data / Parameter:	F
Data unit:	-
Description:	Fraction of methane in the SWDS gas (volume fraction)
Source of data used:	IPCC 2006 Guidelines for National Greenhouse Gas Inventories
Value applied:	0.5
Justification of the	According to the "Tool to determine methane emissions avoided from disposal
choice of data or	of waste at a solid waste disposal site". –Version 5
description of	
measurement methods	
and procedures actually	
applied :	
Any comment:	This factor reflects the fact that some degradable organic carbon does not
	degrade, or degrades very slowly, under anaerobic conditions in the SWDS. A
	default value of 0.5 is recommended by IPCC.

Data / Parameter:	f
Data unit:	-
Description:	Fraction of methane captured at the SWDS and flared, combusted or used in
	another manner
Source of data used:	According to the "Tool to determine methane emissions avoided from disposal
	of waste at a solid waste disposal site". –Version 5
Value applied:	0
Justification of the	All the methane generated was directly vented to the atmosphere prior to



choice of data or	the project activity. Upon the implementation of the project activity,
description of	methane captured will only be flared.
measurement methods	
and procedures actually	
applied :	
Any comment:	

Data / Parameter:	OX
Data unit:	-
Description:	Oxidation factor (reflecting the amount of methane from SWDS that is oxidized
	in the soil or other material covering the waste)
Source of data used:	As per the "Tool to determine methane emissions avoided from disposal of
	waste at a solid waste disposal site" version 5.
Value applied:	0.1
Justification of the	According to the "Tool to determine methane emissions avoided from disposal
choice of data or	of waste at a solid waste disposal site" version 5. for managed solid waste
description of	disposal sites" this value has been used for conservative reasons since the
measurement methods	landfill has been using soil as cover.
and procedures actually	
applied :	
Any comment:	

Data / Parameter:	MCF
Data unit:	-
Description:	Methane correction factor
Source of data used:	IPCC 2006 Guidelines for National Greenhouse Gas Inventories
Value applied:	0.8
Justification of the	According to the "Tool to determine methane emissions avoided from disposal
choice of data or	of waste at a solid waste disposal site" version 5. for managed solid waste
description of	disposal sites" this value is to be applied to Itaoca Landfill as it is "for
measurement methods	unmanaged solid waste disposal sites - deep and/or with high water table. This
and procedures actually	comprises all SWDS not meeting the criteria of managed SWDS and which
applied :	have depths of greater than or equal to 5 meters and/or high water table at near
	ground level.
Any comment:	

Data / Parameter:	DOC
Data unit:	-
Description:	Fraction of degradable organic carbon (by weight) in the waste type <i>j</i> .
Source of data used:	IPCC 2006 Guidelines for National Greenhouse Gas Inventories (adapted from Volume 5, Tables 2.4 and 2.5)
Value applied:	The following values for the different waste types <i>j</i> are applied:



	Waste type j	DOC <sub>j</sub> (% wet waste)
	Wood and wood products	43
	Pulp, paper and cardboard (other than sludge)	40
	Food, food waste, beverages and tobacco (other than sludge)	15
	Textiles	24
	Garden, yard and park waste	20
	Glass, plastic, metal, other inert waste	0
Justification of the	In accordance with "Tool to determine methan	ne emissions avo
choice of data or	disposal of waste at a solid waste disposal site	e", version 05
description of		
measurement methods		
and procedures actually		
applied :		
Any comment:	The values applied are for wet waste.	

Data / Parameter:	DOC <sub>f</sub>
Data unit:	-
Description:	Fraction of degradable organic carbon (DOC) that can decompose
Source of data used:	IPCC 2006 Guidelines for National Greenhouse Gas Inventories
Value applied:	0.5
Justification of the	According to the "Tool to determine methane emissions avoided from disposal
choice of data or	of waste at a solid waste disposal site" version 05.
description of	
measurement methods	
and procedures actually	
applied :	
Any comment:	

Data / Parameter:	kj			
Data unit:	-			
Description:	Decay rate	for the waste type j	•	
Source of data used:	IPCC 2006	Guidelines for Nati	ional Greenhouse Gas Inve	entories (adapted from
	Volume 5,	Table 3.3)		_
Value applied:	The follow	ing values for the di	ifferent waste types <i>j</i> are ap	oplied:
		-		_
			Tropical (MAT > 20°C)	
	Waste type j		Wet (MAP > 1000 mm)	
	ading	Pulp, paper,	0.07	
		cardboard (other		
	Jegr	than sludge),		
	∠	textiles		-
	Slow	Wood,wood	0.035	
05	0,	products and straw		-
	ely ng	Other (non-food)	0.17	
	erat adii	organic putrescible		
	lod(	garden and park		
	$\geq \Box$	waste		



	D	Food, food waste,		
	idly	sewage sludge.		
	api gra	beverages and	0.40	
	ЧЧ	beverages and		
		tobacco		
T I C I	<b>x</b> 1			
Justification of the	In accordan	ice with "Tool to de	etermine methane emission	s avoided from
choice of data or	disposal of	waste at a solid wa	ste disposal site", version	05.
description of				
measurement methods				
and procedures actually				
applied :				
Any comment:	The values	applied are for trop	ical (MAT>20°C) and we	t (MAP > 1000m)
	conditions.			

Data / Parameter:	E <sub>DS</sub>
Data unit:	%
Description:	Efficiency of the degassing system which will be installed in the Project
	activity
Source of data used:	Itaoca Landfill Feasibility Study April 2008
Value applied:	40
Justification of the	The collection efficiency value considers the physical conditions of this landfill
choice of data or	(partially managed) as well as the capping material (soil cover) used to cover
description of	the waste. According to the feasibility study, 40% is a reasonable conservative
measurement methods	factor for unmanaged site and in terms of the nature of the cover materials and
and procedures actually	leachate levels, and the resultant effect on LFG collection.
applied :	
Any comment:	

Data / Parameter:	$W_x$
Data unit:	tons
Description:	Total amount of organic waste prevented from disposal in year x (tons)
Source of data used:	Project Developer
Value applied:	224,000 (average)
Justification of the	Based on Project Developer operations, receiving an average of 800 tpd and
choice of data or	operating 280 days per year.
description of	
measurement methods	
and procedures actually	
applied :	
Any comment:	

Data / Parameter:	p <sub>n,j,x</sub>
Data unit:	%
Description:	Weight fraction of the waste type <i>j</i> in the sample <i>n</i> collected during the year <i>x</i>
Source of data used:	Sample measurements done by GETRES/University of Rio de Janeiro
	(Caracterização de resíduos GETRES. September 2010)
Value applied:	



		Waste Composition			
		Pulp, paper,			
		Cardboard (other	% of Wet MSW	12 70	
		than Sludge)		12.19	
		Textiles	% of Wet MSW	4.05	
		Food and Food			
		Waste, beverages			
		and tobacco (other	9/ of Mot MSM	16 51	
		than sludge)	% OF WELIVISV	40.04	
		Garden, Yard and			
		Park Waste	% of Wet MSW	0	
		Wood & Wood			
		Products	% of Wet MSW	0.9	
Justification of the	Based on	specific waste comp	position study do	ne for I	taoca dumpsite
choice of data or					
description of					
measurement methods					
and procedures actually					
applied :					
Any comment:					

Data / Parameter:	Ζ
Data unit:	
Description:	Number of samples collected during the year x
Source of data used:	Sample measurements done by GETRES/University of Rio de Janeiro
	(Caracterização de resíduos GETRES. September 2010)
Value applied:	3
Justification of the	The research was conducted by Grupo de Estudos em Tratamento de Resíduos
choice of data or	(GETRES) / University of Rio de Janeiro for Haztec in year 2010.
description of	
measurement methods	
and procedures actually	
applied :	
Any comment:	

Data / Parameter:	MM <sub>CH4</sub>
Data unit:	kg/kmol
Description:	Molecular mass of methane
Source of data used:	Constant
Value applied:	16.04
Justification of the	As per "Tool to determine project emissions from flaring gases containing
choice of data or	methane" version1.
description of	
measurement methods	
and procedures actually	
applied :	
Any comment:	

Data / Parameter:	MM <sub>co</sub>
Data unit:	kg/kmol



Description:	Molecular mass of carbon monoxide
Source of data used:	Constant
Value applied:	28.01
Justification of the	As per "Tool to determine project emissions from flaring gases containing
choice of data or	methane" version1.
description of	
measurement methods	
and procedures actually	
applied :	
Any comment:	

Data / Parameter:	MM <sub>CO2</sub>
Data unit:	kg/kmol
Description:	Molecular mass of carbon dioxide
Source of data used:	Constant
Value applied:	44.01
Justification of the	As per "Tool to determine project emissions from flaring gases containing
choice of data or	methane" version1.
description of	
measurement methods	
and procedures actually	
applied :	
Any comment:	

Data / Parameter:	MM <sub>02</sub>
Data unit:	kg/kmol
Description:	Molecular mass of oxygen
Source of data used:	Constant
Value applied:	32.00
Justification of the	As per "Tool to determine project emissions from flaring gases containing
choice of data or	methane" version1.
description of	
measurement methods	
and procedures actually	
applied :	
Any comment:	

Data / Parameter:	MM <sub>H2</sub>
Data unit:	kg/kmol
Description:	Molecular mass of hydrogen
Source of data used:	Constant
Value applied:	2.02
Justification of the	As per "Tool to determine project emissions from flaring gases containing
choice of data or	methane" version1.
description of	
measurement methods	
and procedures actually	



applied :	
Any comment:	

Data / Parameter:	MM <sub>N2</sub>
Data unit:	kg/kmol
Description:	Molecular mass of nitrogen
Source of data used:	Constant
Value applied:	28.02
Justification of the	As per "Tool to determine project emissions from flaring gases containing
choice of data or	methane" version1.
description of	
measurement methods	
and procedures actually	
applied :	
Any comment:	

Data / Parameter:	AM <sub>c</sub>
Data unit:	kg/kmol
Description:	Atomic mass of carbon
Source of data used:	Constant
Value applied:	12.00
Justification of the	As per "Tool to determine project emissions from flaring gases containing
choice of data or	methane" version1.
description of	
measurement methods	
and procedures actually	
applied :	
Any comment:	

Data / Parameter:	AM <sub>H</sub>
Data unit:	kg/kmol
Description:	Atomic mass of hydrogen
Source of data used:	Constant
Value applied:	1.01
Justification of the	As per "Tool to determine project emissions from flaring gases containing
choice of data or	methane" version1.
description of	
measurement methods	
and procedures actually	
applied :	
Any comment:	

Data / Parameter:	AM <sub>o</sub>
Data unit:	kg/kmol
Description:	Atomic mass of oxygen
Source of data used:	Constant
Value applied:	16.00



Justification of the	As per "Tool to determine project emissions from flaring gases containing
choice of data or	methane" version1.
description of	
measurement methods	
and procedures actually	
applied :	
Any comment:	

Data / Parameter:	AM <sub>N</sub>
Data unit:	kg/kmol
Description:	Molecular mass of nitrogen
Source of data used:	Constant
Value applied:	14.01
Justification of the	As per "Tool to determine project emissions from flaring gases containing
choice of data or	methane" version1.
description of	
measurement methods	
and procedures actually	
applied :	
Any comment:	

Data / Parameter:	P <sub>n</sub>
Data unit:	Pa
Description:	Atmospheric pressure at normal conditions
Source of data used:	Constant
Value applied:	101,325
Justification of the	As per "Tool to determine project emissions from flaring gases containing
choice of data or	methane" version1.
description of	
measurement methods	
and procedures actually	
applied :	
Any comment:	

Data / Parameter:	R <sub>u</sub>
Data unit:	Pa.m <sup>3</sup> /kmol.K
Description:	Universal ideal gas constant
Source of data used:	Constant
Value applied:	8,314.472
Justification of the	As per "Tool to determine project emissions from flaring gases containing
choice of data or	methane" version1.
description of	
measurement methods	
and procedures actually	
applied :	
Any comment:	
Data / Parameter:	T <sub>n</sub>



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Data unit:	Κ
Description:	Temperature at normal conditions
Source of data used:	Constant
Value applied:	273.15
Justification of the	As per "Tool to determine project emissions from flaring gases containing
choice of data or	methane" version1.
description of	
measurement methods	
and procedures actually	
applied :	
Any comment:	

Data / Parameter:	MF <sub>02</sub>
Data unit:	Dimensionless
Description:	O <sub>2</sub> volumetric fraction of air
Source of data used:	Constant
Value applied:	0.21
Justification of the	As per "Tool to determine project emissions from flaring gases containing
choice of data or	methane" version1.
description of	
measurement methods	
and procedures actually	
applied :	
Any comment:	

Data / Parameter:	MV <sub>n</sub>
Data unit:	m <sup>3</sup> /Kmol
Description:	Volume of one mole of any ideal gas at normal
Source of data used:	Constant
Value applied:	22.414
Justification of the	As per "Tool to determine project emissions from flaring gases containing
choice of data or	methane" version1
description of	
measurement methods	
and procedures actually	
applied :	
Any comment:	

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

Ex ante calculation of emission reductions was done using the "Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site" –Version 5. The actual emission reductions will be monitored ex-post.

#### **Baseline Emissions**

Ex-ante estimation of baseline emissions



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 $BE_y = MD_{project,y} * GWP_{CH4}$ 

Calculation of MD<sub>Project,y</sub>

a) Ex-ante estimation of the amount of methane generated by the disposal of waste at a solid waste disposal site during the year (MD<sub>Project,y</sub>) are calculated by:

 $MD_{project,y} = BE_{CH4,SWDS,y}/GWP_{CH4}$ 

Note: The efficiency of the degassing system (40%) and the flare efficiency (90%) have both been taken into account in the calculation of ex-ante baseline emissions. (For details please refer to ER calculation spreadsheet).

		oject,y
Year	BE <sub>CH4,SWDS,y</sub> (t CO <sub>2</sub> e)	MD <sub>project,y</sub> (t CH <sub>4</sub> )
2011	146,351	2,509
2012	114,711	1,966
2013	92,407	1,584
2014	76,432	1,310
2015	64,770	1,110
2016	56,061	961
2017	49,392	847
2018	44,146	757
2019	39,905	684
2020	36,386	624
Total	720,562	12,352

Table 5.	Annual	colculation	for	$MD_{n}$ .
Table 5:	Annuar	calculation	IOU	<b>WID</b> Project

#### **Table 6: Baseline Emissions**

	MD <sub>project</sub> *GWP <sub>CH4</sub>	BE <sub>y</sub> (t C02)
2011	52,687	52,687
2012	41,296	41,296
2013	33,266	33,266
2014	27,516	27,516
2015	23,317	23,317
2016	20,182	20,182
2017	17,781	17,781
2018	15,893	15,893
2019	14,366	14,366
2020	13,099	13,099
Total	259,402	259,402



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#### **Project Emissions**

For Project emissions from electricity consumption, we have that according to the "*Tool to calculate baseline, project and/or leakage emissions from electricity consumption*" version 1, under scenario A "Electricity consumption from the grid" PE<sub>EC,y</sub> is calculated as follows:

 $PE_{EC,y} = EC_{PJ,y} * EF_{CP,y} * (1+TDL_y)$ 

Thus since the grid emission factor for  $Brazil^{11}$  is 0.1635 tCO<sub>2</sub>/MWh, the electricity consumption per year by the equipment amounts to 9.28MWh and according to the tool TDLy is 20%, then we have that yearly project emissions amount to:

 $PE_{EC,y} = 272.0 \text{ MWh} * 0.1635 \text{ tCO2/MWh} * (1+0.2) = 53.37 \text{tCO}_2 \text{e}$ 

On the other hand, for Project emissions from fossil fuel combustion we have that annual emissions are:

 $PE_{FC,y} = 1.9E-06* 0.0069 = 1.326e-08tCO_2e$ 

Where

1.9E-06	has been calculated by the consumption of LFG by the number of expected ignitions in the year $(m^3)$ and
0.0069	has been calculated by multiplying NCV <sub>y</sub> * $EF_{CO2y}(tCO_2/m^3)$
Where	
NCVy	Is the weighted average net calorific value of the fuel type $(0.106 \text{ GJ/m}^3)$
EF <sub>CO2y</sub> `	Is the weighted average $CO_2$ emission factor of fuel type (0.0656 tCO <sub>2</sub> /GJ)

Thus in summary we have that:

#### **Project emissions**

Year	PE <sub>ECy</sub> (tCO <sub>2</sub> e)	PE <sub>FCy</sub> (tCO <sub>2</sub> e)	Cumulative Project emissions (tCO <sub>2</sub> e)
2011	53.37	0.00000013	53.37
2012	53.37	0.00000013	53.37
2013	53.37	0.00000013	53.37
2014	53.37	0.00000013	53.37
2015	53.37	0.00000013	53.37
2016	53.37	0.000000013	53.37

<sup>11</sup> For complete details please refer to Annex 3



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2017	53.37	0.00000013	53.37
2018	53.37	0.00000013	53.37
2019	53.37	0.00000013	53.37
2020	53.37	0.00000013	53.37
Cumulative Total	533.7	0.000000013	533.7

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

Year	Estimation of project activity emissions (tCO <sub>2</sub> e)	Estimation of baseline emissions (tCO <sub>2</sub> e)	Estimation of emission reductions (tCO <sub>2</sub> e)
2011	53.37	52,687	52,633
2012	53.37	41,296	41,243
2013	53.37	33,266	33,213
2014	53.37	27,516	27,462
2015	53.37	23,317	23,264
2016	53.37	20,182	20,129
2017	53.37	17,781	17,728
2018	53.37	15,893	15,839
2019	53.37	14,366	14,312
2020	53.37	13,099	13,045
Total	533.7	259,402	258,869

#### Table 8: Summary of ex-ante estimation of Emission Reductions

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

#### **B.7.1** Data and parameters monitored:

Data / Damana Aana	
Data / Parameter:	LFG <sub>total,y</sub>
Data unit:	Nm <sup>3</sup>
Description:	Total amount of landfill gas captured at normal Temperature and Pressure on a
	wet basis
Source of data to be	Project developer
used:	
Value of data applied	3,829,515 (Annual average over the crediting period)
for the purpose of	
calculating expected	
emission reductions in	
section B.5	
Description of	As per the methodology on page 15 "In the case where LFG is just flared, one flow
measurement methods	meter for each flare can be used provided that these meters used are calibrated
and procedures to be	periodically by an officially accredited entity;" Thus LFG <sub>total</sub> will be the same as
applied:	LFG <sub>flare</sub> , and will be measured by one flow meter.



	Data will be measured with a flow meter and monitored continuously (average value in a time interval not greater than an hour) by the Project Developer. Data to be aggregated monthly and yearly.
QA/QC procedures to	The flow meter will be calibrated as per manufacturer specifications.
be applied:	It will be subject to a regular maintenance, testing and calibration regime in accordance with manufacturer specifications to ensure its accuracy, which is assumed to be above 95%.
Any comment:	Data will be kept for 2 years after end of crediting period or last issuance of CERs for the project activity

Data / Parameter:	LFG <sub>flare,y</sub>
Data unit:	Nm <sup>3</sup>
Description:	Amount of landfill gas flared at normal Temperature and Pressure on a wet basis
Source of data to be used:	Project developer
Value of data applied for the purpose of	3,829,515(Annual average over the crediting period)
calculating expected	
emission reductions in	
section B.5	
Description of	Measured with a flow meter continuously (average value in a time interval not
measurement methods	greater than an hour), data to be aggregated monthly and yearly
and procedures to be	
applied:	
QA/QC procedures to	The flow meter will be calibrated as per manufacturer recommendations. It will
be applied:	be subject to a regular maintenance, testing and calibration regime in accordance
	above 95%.
Any comment:	There will be only one flare; LFG <sub>flare,y</sub> is considered to be equivalent to the
	variable $FV_{RG,h}$ (volumetric flow rate of the residual gas) as described in the
	"Tool to determine Project emissions from flaring gases containing methane"
	<i>Version 01</i> used to determine project emissions from flaring.
	Data will be kept for 2 years after end of crediting period or last issuance of
	CERs for the project activity

Data / Parameter:	PE <sub>flare,y</sub>
Data unit:	tCO <sub>2</sub> e
Description:	Project emissions from flaring of the residual gas stream in year y
Source of data to be	Project Developer
used:	
Value of data applied	2,882 (Annual average over the crediting period)
for the purpose of	
calculating expected	
emission reductions in	
section B.5	
Description of	Calculated as per the "Tool to determine Project emissions from flaring
measurement methods	gases containing Methane". Version 01



and procedures to be	
applied:	
QA/QC procedures to	As per the "Tool to determine Project emissions from flaring gases
be applied:	containing Methane" Version 01.
Any comment:	Data will be kept for 2 years after end of crediting period or last issuance of
-	CERs for the project activity

Data / Parameter:	W <sub>CH4,y</sub>
Data unit:	m <sup>3</sup> CH <sub>4</sub> / m <sup>3</sup> LFG
Description:	Methane fraction in the landfill gas on a wet basis
Source of data to be	Project Developer
used:	
Value of data applied	50%
for the purpose of	
calculating expected	
emission reductions in	
section B.5	
Description of	A LANDTEC gas analyzer will be adopted. It will sample and analyze the
measurement methods	Methane, Carbon Dioxide and Oxygen content of LFG, providing continuous
and procedures to be	monitoring of the readings that will be connected to a monitoring system for
applied:	storage of the information analyzed. The Methane is analyzed using laser and
	infra-red light technology.
QA/QC procedures to	The gas analyzer will be calibrated bi-annually and subject to regular
be used:	maintenance, according to manufacturer's recommendation.
Any comment:	$w_{CH4}$ is considered to be equivalent to the variable $fv_{CH4,h}$ (Volumetric fraction of
	the component CH <sub>4</sub> in the landfill gas in the hour h) as described in the "Tool to
	determine Project emissions from flaring gases containing methane" Version 01.
	Data will be kept for 2 years after end of crediting period or last issuance of
	CERs for the project activity

Data / Parameter:	Т
Data unit:	°C
Description:	Temperature of the landfill gas
Source of data to be	Project Developer
used:	
Value of data applied	
for the purpose of	
calculating expected	
emission reductions in	
section B.5	
Description of	Measured continuously to determine the density of methane $D_{CH4}$ .
measurement methods	
and procedures to be	
applied:	
QA/QC procedures to	The temperature gauge will be calibrated as per manufacturer recommendations.
be used:	It will be subject to a regular maintenance, testing and calibration regime in
	accordance with manufacturer specifications to ensure its accuracy, which is
	assumed to be above 95%.



Any comment:	No separate monitoring of temperature is necessary when using flow meters that
	automatically measure temperature and pressure, expressing LFG volumes in
	normalized cubic meters
	Data will be kept for 2 years after end of crediting period or last issuance of
	CERs for the project activity

Data / Parameter:	Р
Data unit:	Pa
Description:	Pressure of the landfill gas
Source of data to be	Project developer
used:	
Value of data applied	
for the purpose of	
calculating expected	
emission reductions in	
section B.5	
Description of	Measured continuously to determine the density of methane D <sub>CH4</sub>
measurement methods	
and procedures to be	
applied:	
QA/QC procedures to	Measuring instruments shall be subject to a regular maintenance and testing
be used:	regime, based on the manufacturer s recommended schedule and procedures and
	in accordance with appropriate national/international standards.
Any comment:	No separate monitoring of pressure is necessary when using flow meters that
	automatically measure temperature and pressure, expressing LFG volumes in
	normalized cubic meters
	Data will be kept for 2 years after end of crediting period or last issuance of
	CERs for the project activity

Data / Parameter:	Tflare
Data unit:	°C
Description:	Temperature in the exhaust gas of the flare
Source of data to be	Project Developer
used:	
Value of data applied	
for the purpose of	
calculating expected	
emission reductions in	
section B.5	
Description of	The temperature in the exhaust gas will be measured continuously with a type N
measurement methods	thermocouple and continuously monitored as described in the "Tool to determine
and procedures to be	project emissions from flaring gases containing methane" Version 01.
applied:	
QA/QC procedures to	The thermocouple will be replaced or calibrated every year.
be used:	
Any comment:	Required to determine adequate operation and operating hours of the flare.
	Data will be kept for 2 years after end of crediting period or last issuance of
	CERs for the project activity



Data / Parameter:	t <sub>O2,h</sub>
Data unit:	
Description:	Volumetric fraction of $O_2$ in the exhaust gas of the flare in the hour <i>h</i>
Source of data to be	Project Developer
used:	
Value of data applied	
for the purpose of	
calculating expected	
emission reductions in	
section B.5	
Description of	An in situ LANDTEC Gas analyzer will be adopted. The gas analyzer will: 1)
measurement methods	sample and analyze the methane, carbon dioxide and oxygen content of LEG 2)
and procedures to be	provide continuous monitoring of the parameter and 3) transfer data to
applied.	monitoring system for storage of the information. The Oxygen is analyzed using
approx	Cell Absorption technology.
QA/QC procedures to	Analyzers will be calibrated bi-annually according to the manufacturer's
be used:	recommendation A zero check and a typical value check will be performed by
	comparison with a standard certified gas.
Any comment:	Monitoring of this parameter is due to continuous monitoring of the flare
	efficiency. Data will be kept for 2 years after end of crediting period or last
	issuance of CERs for the project activity.

Data / Parameter:	NCV <sub>iv</sub>
Data unit:	GJ/m3
Description:	Weighted average net calorific value of fuel type I (LPG) in year y
Source of data to be	Fuel supplier
used:	
Value of data applied	0.1059
for the purpose of	
calculating expected	
emission reductions in	
section B.5	
Description of	Values provided by the fuel supplier.
measurement methods	Undertaken in line with national or international fuel standards
and procedures to be	The NCV will be obtained for each fuel delivery, from which weighted average
applied:	annual values should be calculated
QA/QC procedures to	Values will be verified to check that they are within the uncertainty range of the
be used:	IPCC default values as provided in Table 1.2, Vol. 2 of the 2006 IPCC
	Guidelines.
Any comment:	

Data / Parameter:	EF <sub>CO2,i,y</sub>
Data unit:	tCO <sub>2</sub> /GJ
Description:	Weighted average $CO_2$ emission factor of fuel type i in year y
Source of data to be	IPCC default values at the upper limit of the uncertainty at a 95% confidence



used:	interval as provided in table 1.4 of chapter 1 of Vol 2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories (there is no available data from the fuel supplier).
Value of data applied	0.0656
for the purpose of	
calculating expected	
emission reductions in	
section B.5	
Description of	-
measurement methods	
and procedures to be	
applied:	
QA/QC procedures to	Will be checked against any future revision of IPCC Guidelines
be used:	
Any comment:	-

Data / Parameter:	TDL <sub>y</sub>
Data unit:	%
Description:	Average technical transmission and distribution losses in the grid in year y for the voltage level at which electricity is obtained from the grid at the project site.
Source of data to be used:	Use as default values of 20% for project or leakage electricity consumption sources as per "Tool to calculate project emissions from electricity consumption" version 01.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	20
Description of measurement methods and procedures to be applied:	Annually monitored. In the absence of data from the relevant year, most recent figures should be used, but not older than 5 years. TDL should be estimated for the distribution and transmission networks of the electricity grid of the same voltage as the connection where the proposed CDM project activity is connected to. The technical distribution losses should not contain other types of grid losses (e.g. commercial losses/theft).
QA/QC procedures to be used:	
Any comment:	

Data / Parameter:	fv <sub>CH4,h</sub>
Data unit:	
Description:	Volumetric fraction of methane in the residual gas in the hour h
Source of data to be	Project developer
used:	
Value of data applied	-



for the purpose of	
calculating expected	
emission reductions in	
section B.5	
Description of	Continuously measured on wet basis when the residual gas temperature exceeds
measurement methods	60 °C
and procedures to be	
applied:	
QA/QC procedures to	Gas chromatograph. Analyzers will be periodically calibrated according to the
be used:	manufacturer's recommendation. A zero check and a typical value check will be
	performed by comparison with a standard certified gas.
Any comment:	Data will be kept for 2 years after end of crediting period or last issuance of
	CERs for the project activity

Data / Parameter:	<b>FV</b> <sub>RG,h</sub>
Data unit:	m <sup>3</sup> /h
Description:	Volumetric flow rate of the residual gas in wet basis at normal conditions in the
	hour h
Source of data to be	Project developer
used:	
Value of data applied	-
for the purpose of	
calculating expected	
emission reductions in	
section B.5	
Description of	Continuously measured on wet basis.
measurement methods	
and procedures to be	
applied:	
QA/QC procedures to	Flow meters are to be periodically calibrated according to the manufacturer.s
be used:	recommendation.
Any comment:	Monitoring of this parameter is due to continuous monitoring of the flare
	efficiency.
	Data will be kept for 2 years after end of crediting period or last issuance of
	CERs for the project activity

Data / Parameter:	fv <sub>CH4,FG,h</sub>
Data unit:	Mg/m <sup>3</sup>
Description:	Concentration of methane in the exhaust gas of the flare in dry basis at normal
	conditions in the hour h
Source of data to be	Project developer
used:	
Value of data applied	-
for the purpose of	
calculating expected	
emission reductions in	
section B.5	
Description of	Continuously measured. Values to be averaged hourly or at a shorter time



measurement methods	interval.
applied:	
QA/QC procedures to	Gas chromatograph. Analysers will be periodically calibrated according to
be used:	manufacturer's recommendation. Zero check and typical value check will be
	performed by comparison with a standard gas.
Any comment:	Data will be kept for 2 years after end of crediting period or last issuance of
	CERs for the project activity
Data / Parameter	ECPLy
Data unit:	MWh
Description:	Onsite consumption of electricity provided by the grid attributable to the project activity during the year y
Source of data to be used:	Project Developer
Value of data applied	272.0
for the purpose of	(ex-ante estimate from Project Developer, based on electricity capacity to be
calculating expected	installed in the landfill and a number of operating hours per day)
emission reductions in	
Description of	Electricity will be measured continuously using an electricity meter. Data will be
measurement methods	aggregated at least annually as stated in the "Tool to calculate Project emissions"
and procedures to be	from electricity consumption" version 01.
applied:	
QA/QC procedures to	Electricity meter will be subject to regular maintenance and testing in accordance
be used:	with stipulation of the meter supplier to ensure accuracy. The calibration will be
	conducted strictly as per the manufacturer specifications. The measurement
	results will be cross-checked with invoices for purchased electricity if relevant.
Any comment:	Required to calculate project emissions
	Data will be kept for 2 years after end of crediting period or last issuance of CEPs for the project activity.
	CERS for the project activity

Data / Parameter:	FCy
Data unit:	m <sup>3</sup> /yr
Description:	Onsite combustion of fossil fuels attributable to the project activity during the
	year y
Source of data to be	Project Developer
used:	
Value of data applied	1.908E-06
for the purpose of	(ex-ante estimate from Project Developer, based on monitored consumption by
calculating expected	same equipment installed at a project site run by the same project developer)
emission reductions in	
section B.5	
Description of	Gas Flow Meter will be employed as per the "Tool to calculate project or leakage
measurement methods	CO2 emissions from fossil fuel combustion" version 02. There will be a book of
and procedures to be	control for recording the measurements.
applied:	
QA/QC procedures to	The flow meter will be calibrated as per manufacturer specifications.



be used:	The metered fuel consumption quantities will be cross-checked with available purchase invoices from the financial records.
Any comment:	Required to calculate project emissions
	Data will be kept for 2 years after end of crediting period or last issuance of
	CERs for the project activity

Data / Parameter:	PE <sub>EC,y</sub>
Data unit:	t <sub>CO2</sub>
Description:	Project emissions from electricity consumption by the project activity during the
	year y
Source of data to be	Calculated as per the "Tool to calculate project emissions from electricity
used:	consumption" version 01.
Value of data applied	53.37
for the purpose of	
calculating expected	
emission reductions in	
section B.5	
Description of	As per the "Tool to calculate Project emissions from electricity consumption"
measurement methods	version 01.
and procedures to be	
applied:	
QA/QC procedures to	As per the "Tool to calculate Project emissions from electricity consumption"
be used:	version 01.
Any comment:	Data will be kept for 2 years after end of crediting period or last issuance of
	CERs for the project activity

Data / Parameter:	PE <sub>FC,y</sub>
Data unit:	tCO <sub>2</sub> e
Description:	Project emissions from fossil fuel combustion
Source of data to be	Calculated as per the "Tool to calculate project or leakage CO2 emissions from
used:	fossil fuel combustion" version 02.
Value of data applied	1.326E-08
for the purpose of	
calculating expected	
emission reductions in	
section B.5	
Description of	Calculated as per the "Tool to calculate project or leakage CO2 emissions from
measurement methods	fossil fuel combustion" version 02.
and procedures to be	
applied:	
QA/QC procedures to	Cross check measurement results with invoices for purchased fuel
be used:	
Any comment:	Data will be kept for 2 years after end of crediting period or last issuance of
	CERs for the project activity

Data / Parameter:	EF <sub>grid</sub> , BM, y
Data unit:	tCO <sub>2</sub> /MWh



Description:	Build Margin for Brazil
Source of data to be	Published available data for the year 2009
used:	
Value of data applied	0.0794
for the purpose of	
calculating expected	
emission reductions in	
section B.5	
Description of	Calculated as per the "Tool to calculate the emission factor for an electricity
measurement methods	system" version 02.
and procedures to be	
applied:	
QA/QC procedures to	
be used:	
Any comment:	For details on the calculations please refer to Annex 3. This value will be
	monitored ex-post.
	Data will be kept for 2 years after end of crediting period or last issuance of
	CERs for the project activity

Data / Parameter:	EF <sub>grid,OM,y</sub>
Data unit:	tCO <sub>2</sub> /MWh
Description:	Operating Margin for Brazil
Source of data to be	Published available data for 2009
used:	
Value of data applied	0.2476
for the purpose of	
calculating expected	
emission reductions in	
section B.5	
Description of	Calculated as per the "Tool to calculate the emission factor for an electricity
measurement methods	system" version 02.
and procedures to be	
applied:	
QA/QC procedures to	
be used:	
Any comment:	For details on the calculations please refer to Annex 3. This value will be
	monitored ex-post.
	Data will be kept for 2 years after end of crediting period or last issuance of
	CERs for the project activity

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

The following variables need to be measured to determine and account for emission reductions due to Itaoca Landfill Gas Project.

- The amount of landfill gas being sent to flares.
- The amount of methane in the landfill gas.



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- The flare's efficiency.
- The pressure of the LFG.
- The temperature of the LFG.
- The electric consumption of all the systems, in MWh.
- The volume/mass of fossil fuel used to flare system.

**Figure 6**– Monitoring Plan (For complete details on required equipment for the measurement of each parameter, please see section B.7.1 above)



Measurements:

 $W_{CH4} = Fraction of CH_4$ 

T = Temperature

P = Pressure

 $LFG_{Total}$  = Total amount of landfill gas captured =  $LFG_{Flare}$  = Amount of landfill gas flared (as per the methodology, since gas is just flared)

 $T_{\text{flare}}$  = Temperature in the exhaust gas of the flare

EC = Electricity consumption by the project activity

FC = Fossil fuel consumption for the ignition of the flare

 $\mathbf{t}_{\mathbf{O2,h}}$  = Content of the exhaust gas

For specific details on measuring equipment please refer to section B.7.1.

According as ACM0001, the parameters below have to be monitored

- Amount of landfill gas generated (in Nm<sup>3</sup>, using flow meter), where as per the methodology "In the case where LFG is just flared, one flow meter for each flare can be used" for the total quantity (LFG<sub>total,y</sub>) since they will be the same as the quantities fed to the flare (LFG<sub>flare,y</sub>). LFG<sub>flare,y</sub> will be measured continuously.
- The fraction of methane in the landfill gas  $(w_{CH4,y})$  should be measured with a continuous analyzer. Methane fraction of the landfill gas to be measured on wet basis.
- Temperature and Pressure of the Landfill gas (T, P) are measured continuously to determine the density of methane  $D_{CH4}$
- The temperature of the exhaust gas will be measured continuously with a type N thermocouple and continuously monitored as required by the methodology to determine adequate operation and operating hours of the flare.
- The volumetric fraction of  $O_2$  in the exhaust gas will be monitored for the flare efficiency
- The quantity of fossil fuel required to operate the landfill gas project (ignite the flare)
- The quantity of electricity used on site for the project activity
- The project emissions derived from the combustion of fossil fuels required to operate the landfill gas project

- The project emissions derived from the consumption of electricity for the project activity.
- The gird emission factor, as published by the Brazilian DNA

Data will be kept for 2 years after end of crediting period or last issuance of CERs for the project activity.

**Project management responsibility.** Information on the Monitoring Manager, the project team, and internal inspection of the LFG capture and flare program are addressed below.

- Monitoring Manager. A competent manager will be assigned responsibility for the monitoring plan and supervision on the collected data. The manager will report monthly about project performance and data. Additionally, the manager will report immediately to senior company management if nonconformance in the performance is detected such as flow meters not working. The Monitoring Manager will be the main contact person for the verifiers, Brazilian DNA, World Bank, and any other designated entity, during the crediting period.
- Project Team. The LFG project team will gather, at least monthly, to discuss the performance of the LFG capture and flaring project. Members of the project team will include the Monitoring Manager and the General Manager of the Itaoca landfill. Meetings of the project team can be part of regular meetings, but meeting minutes will be recorded as required. In case of non-conformance, each members of the team will be called in for a project team meeting.
- Internal inspection. The monitoring plan including all defined procedures, reports, data, and personnel will be inspected internally to ensure the monitoring activities are in-compliance. Especially in the beginning of the crediting period, these internal inspections should take place, to guarantee the monitoring procedures.

**Training.** A training program will be developed for all employees involved in the landfill gas capture and flaring project. The program will define the type and frequency of training. The site's General Manager will ensure that only trained and skilled staff will work in the project. The training program's content will depend on the trainees' background and the function to which each will be assigned. Depending on each staff member's assignment, they will receive comprehensive information on the general and technical aspects of the gas capture and flaring project.

The technology suppliers will be requested to provide instructions and training to the project staff on the instalment, operation, maintenance and calibration of monitoring equipment. Over time, as staff members change, new employees will be trained by existing staff on these topics.

**Data management - Quality control and quality assurance procedures.** The project will establish a quality management system that will ensure the quality and accuracy of the measured data, including corrective measures in case of non-conformity. The quality management system will include:

- Gas field monitoring records
  - Daily readings of all field meters will be filled out on paper worksheets or electronically and filed consecutively. All data collected will also be entered on electronic worksheets and stored on a computer system immediately and on discs periodically.



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- Periodic controls of the LFG field monitoring records will be carried out to check any deviations from the estimated ERs following the guidelines for the LFG flare operation and monitoring for correction or future references.
- Periodic reports to evaluate performance and assist with performance management will be elaborated.
- Monitoring data evaluation
  - Following the main criteria such as use and strict adherence to standard methods, use of nonstandard methods only after approved validation, use of standard reporting forms including process measures as well as emission data, etc. to guarantee the data reliable and accurate.
  - A procedure will be developed to define the responsibility of how critical data parameters and possible adjustments or uncertainties will be evaluated and performed.
- Equipment calibration and maintenance.
  - Flow meters, gas analyzers, other critical CDM project equipment will be subject to regular maintenance and testing according to the technical specifications from the manufactures to ensure accuracy and good performance.
  - Calibration of equipment will be conducted periodically according to manufacturer's technical specifications.
- Corrective actions
  - Actions to correct deviations from the Monitoring Plan and the guidelines for LFG capture and flare operation and monitoring will be implemented as these deviations are observed either by the operator or during internal audits.
  - Corrective actions also will be set down in case of equipment or systems malfunction or breakdown.
- Site audits
  - The company's management team for this project will make regular site audits to ensure that monitoring and operational procedures are being observed in accordance with the monitoring plan and the guideline for LFG capture and flare operation and monitoring activities.
- Documents storage
  - List of monitoring equipment (flow meters, gas analyzers, thermometers, etc.), including their numbers, names, manufacturers, specifications, use requirements, etc.
  - Calibration lists and reports, including equipment or parts calibrated, date, method and procedures of calibration, their precision after these procedures, personnel, devices needed, etc.
  - Maintenance lists and reports, including equipment or parts maintained, date, method and procedures of maintenance, their performance after these procedures, personnel, devices needed, etc.
  - Operational manual of the proposed project
  - Meeting minutes of CDM project team meeting
  - Non-conformance reports
  - Worksheets, monthly and yearly
  - Training plan
  - Internal audit/inspection reports, including personnel, time, findings, corrective actions, followup inspections
  - Annual monitoring review



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- Emergency preparedness for unintended emissions
  - In case of equipment malfunction or breakdown, the timely corrective actions will be carried out to minimize the unintended consequences.
  - Project staff will be trained to appropriately cope with the emergent situations. They will be able to effectively judge an abnormal situation and make a prompt response such as fixing malfunctioned equipment, recording and reporting to the management team in a timely manner.
  - The plant operator will inspect the gas capture and flare system, at least once per week, including all methane-containing parts of the plant (on the surface). All findings will be documented. In case a leakage is found, the leakage will be repaired according to the manufacturer's recommendations.

**Verification.** Verification is the focal point of a CDM project and all relevant documents will be in place, archived and accumulated in a Monitoring Report or on-site review by the DOE (verifier), who is verifying the project. The project management team will work closely with the verifier and answer all questions raised by the DOE for the emission reduction verification.

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

The baseline study and monitoring methodology was updated, in 05/03/2009, to reflect the conditions in ACM0001, Version 11. The responsible person and entity is provided in Annex 1.

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

#### C.1 Duration of the <u>project activity</u>:

#### C.1.1. <u>Starting date of the project activity:</u>

 $20/07/2010^{12}$  which as per the Glossary of Terms is the date when "the project participant has committed to expenditures related to the implementation or related to the construction of the project activity".

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

19 years and 21 days.<sup>13</sup>

<sup>&</sup>lt;sup>12</sup> The data of the purchase of the clay is used for the starting date of the project. As the preliminary step the coverage of clay signifies the start of the project activity. Notably, for a dumpsite, it is not obliged for the project participants to pave coverage of clay.

<sup>&</sup>lt;sup>13</sup>Although initially the expected lifetime of the project was defined as 21 years, because of the lifetime of the equipment, this number has been changed to 19 years and 21 days due to the constraint given by the concession period. The concession of the dumpsite was granted on August 10, 2004 for an initial period of 15 years, which can be extended 10 more years. Taking into account 25 years of operation the closure date will be August 10, 2029. Since the project start date is July 20, 2010, the duration of the project activity is 19 years and 21 days, which is calculated from July 20, 2010 to August 10, 2029. Supporting documentation on the length of the concession contract was provided to the DOE for validation (Contrato de concessão PMSG No 001/2004).



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C.2 Choic	e of the <u>crediti</u>	ng period and related information:	
C.2.1.	Renewable c	rediting period	
	C.2.1.1.	Starting date of the first crediting period:	
Left Blank on	purpose		
	C.2.1.2.	Length of the first crediting period:	
Left Blank on	purpose		
C.2.2.	Fixed crediti	ing period:	
	C.2.2.1.	Starting date:	
1/1/2011.or reg	gistration date,	whichever is later	
	C.2.2.2.	Length:	
10 years and 0	month		

#### **SECTION D.** Environmental impacts

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

According to the national GHG Emissions inventory conducted by CETESB<sup>14</sup> (Companhia de Tecnologia de Saneamento Ambiental) in 1994, at that time Brazil had over 6,000 waste depositing sites, receiving over 60,000 tons of waste per day. Most of this waste, (76%) was deposed in 'dumpsites' (lixões) with no management, gas collection, or water treatment and usually operated without any license or controls by the environmental agencies concerned. According to the same study, 84% of Brazil's methane emissions come from the deposition of waste in uncontrolled dumpsites. The remaining 24% of waste is deposed in 'controlled' landfills, but these are usually highly ineffective in relation to emissions and percolate control. In the few cases where gases are collected, this is done for safety reasons (to avoid explosions), and it is often the case that the amounts effectively collected are very low, due to high levels of percolates (which are often not drained or treated, as well) blocking the drainage pipes.

By collecting and combusting landfill gas, the Itaoca Landfill Gas Project will reduce both global and local environmental effects of uncontrolled releases. The major components of landfill gas, methane and carbon dioxide, are colourless and odourless. The main global environmental concern is that

<sup>&</sup>lt;sup>14</sup> Source: Inventario Brasileiro de gas metano gerado por residuos. CETESB. Sao Paulo. September 2001. Web site: http://www.cetesb.sp.gov.br/geesp/docs/docs\_cetesb/3.pdf



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methane is a greenhouse gas. The carbon dioxide in LFG and from the combustion of methane is considered to be carbon neutral as they are derived from organic biomass.

Although the majority of landfill gas emissions are quickly diluted in the atmosphere, in confined spaces there is a risk of asphyxiation and/or toxic effects if landfill gas is present at high concentrations. 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. Through appropriate management of the Itaoca dumpsite, landfill gas will be captured and combusted, removing the risks of toxic effects on the local community and local environment.

Landfill gas flares can also produce nitrogen oxide emissions that vary widely from one site to another, depending on the type of system and the extent to which steps have been taken to minimise such emissions. Combustion of landfill gas can also result in the release of organic compounds and trace amounts of toxic materials, including mercury and dioxins, although such releases are at levels significantly lower than if the landfill gas is flared. These emissions are also viewed as significantly less than the continued uncontrolled release of landfill gas.

Groundwater and surface water can be contaminated by untreated leachate from landfill sites. Leachate may cause serious water pollution if not properly managed. Surface water runoff from a landfill site can also cause unacceptable sediment loads in receiving waters, while uncontrolled surface water run-off can lead to excessive generation of leachate and migration of contaminated waters off-site.

To develop the environmental recovery of old dump sites; and gas extraction and flare system projects in dump sites, is not necessary studies like EIA (Estudo de Impacto Ambiental – "Environmental Impact Study"), following a simple approach, a Simplified Environmental Report (RAS - Relatório Ambiental Simplificado) and other complementary studies for Environmental Diagnostic were developed by ARCADIS, and offered for the analyses to the Rio de Janeiro State Environmental Agency.

As soon as the State Environmental Agency (INEA - Instituto Ambiental do Estado do Rio de Janeiro), finishes the analyses, it will grant the License for the Installation (LI) of the gas extraction and flare system and the environmental recovery.

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

According to INEA, the State Environmental Agency, only one license is necessary for all activities that will be developed in the processes of the environmental recovery in area of the dumpsite and activities for exploration the landfill gas collection and flaring.

Novagerar / Haztec has made a request (License for Installation and Operation for the Project Activities) to the State Environmental Agency for an environmental recovery license for the Itaoca disposal site (Protocol Number: E-07.202.754/07). The license request was submitted on 05/09/2007. This is the only license required for the landfill gas capture and flare system to be installed and operated at the Itaoca disposal site.



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#### SECTION E. <u>Stakeholders'</u> comments

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

As required by the Interministerial Commission on Global Climate Change (CIMGC), the Brazilian DNA – Designated National Authority, invitations must be sent for comments to local stakeholders as part of the procedures for analyzing CDM projects and issuing letters of approval. This procedure was followed by Itaoca Landfill Gas Project to present its GHG mitigation initiative to the public. Letters and the Executive Summary of the project were sent to the following local stakeholders:

- Prefeitura Municipal de São Gonçalo RJ / Municipal Administration of São Gonçalo RJ.
- Secretaria Municipal de Meio Ambiente de São Gonçalo RJ / Municipal Secretariat of Environment of São Gonçalo RJ.
- Câmara dos Vereadores de São Gonçalo RJ / Municipal Legislation Chamber of São Gonçalo - RJ.
- FEEMA Fundação Estadual de Engenharia do Meio Ambiente Rio de Janeiro / Rio de Janeiro State Foundation of Engineering and Environment.
- Ministério Público do Estado do Rio de Janeiro / Public Ministry of Rio de Janeiro State.
- Fórum Brasileiro de Movimentos e Organizações Sociais (FBMOS) / Brazilian NGO Fórum.
- Estruturar Cooperativa de catadores de Itaoca São Gonçalo RJ / Estruturar Cooperative of scavengers of Itaoca São Gonçalo RJ.
- ABES Rio Associação Brasileira de Engenharia Sanitária e Ambiental / Brazilian Association of Sanitary and Environment Engineering.
- Ministério Público Federal no Rio de Janeiro / Federal Public Ministry of Rio de Janeiro.

Resolution #7 of the GIMGC has been followed. The PDD in Portuguese as well as Annex III of the resolution will be available at the following website until registration.

#### www.haztec.com.br.

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

According with the comment of FEEMA, the entity expresses gratitude for the correspondence dispatched by Novagerar / Haztec. FEEMA stimulates this kind of project because it will use clean and efficiency technology such as landfill gas project installed in Nova Iguaçu that received license by this agency.

The other comment from FBMOS was received; the entity expresses gratitude for the correspondence dispatched by Novagerar / Haztec and proposes another tool for analyses of the sustainable development (Gold Standards).

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

Novagerar / Haztec appreciated the comments from FEEMA and FBMOS. A letter was sent from Novagerar / Haztec expressing its gratitude for the considerations about the Itaoca Landfill Gas Project. FBMOS (Forum Brasilerio de Moviementos e Organizacoes Sociais) suggested that the project follow Gold Standard provisions. However, the project already is required to comply with World Bank safeguard requirements that cover environmental, social, and related standards. These safeguards standards provide a rigorous set of controls on project performance.



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#### <u>Annex 1</u> CONTACT INFORMATION ON PARTICIPANTS IN THE <u>PROJECT ACTIVITY</u>

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#### Annex 2

#### INFORMATION REGARDING PUBLIC FUNDING

There is no public funding involved in Itaoca Landfill Gas Project.



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#### Annex 3

#### **BASELINE INFORMATION**

#### 1) Information used to determine the baseline<sup>15</sup>

Tal	ole 9. Baseline	e determination in	nformation			
DATA	VALUE	UNIT	SOURCE			
Year of opening	1980					
Year of closure	2010					
Rx	Average 800t/d variable	t/day				
Waste composition						
Paper/cardboard						
Textile	12.79%	Percentage of				
Food waste	4.05%	total waste	CETRES Sant 2010			
Garden waste	46.54%		GETRES Sept 2010			
Wood&Wood	0.9%					
Products						
MCF	0.8		IPCC 2006			
K- decay rate						
Pulp, paper,	0.07					
Cardboard Textiles	0.07		IPCC 2006			
Food and Food Waste	0.4		For tropical wet climate			
Garden, Yard and	0.17		•			
Park Waste						
DOCf	0.5		IPCC 2006			
DOCj						
Wood and Wood Products	43					
Pulp, paper and Cardboard	40	(%wet basis)	IPCC 2006			
Food, Food Waste Textiles	15					
Garden, Yard and Park Waste	20					

<sup>&</sup>lt;sup>15</sup> Sources of the information were provided to the DOE during the validation visit



Table	<b>10</b> : Waste Disposal History <sup>16</sup>
Year	Waste generation (tonnes)
1980	153,568
1981	156,702
1982	159,900
1983	163,163
1984	166,493
1985	169,891
1986	173,358
1987	176,896
1988	180,506
1989	184,190
1990	187,949
1991	191,785
1992	195,699
1993	199,692
1994	203,768
1995	207,926
1996	212,170
1997	216,500
1998	220,918
1999	225,427
2000	230,027
2001	234,721
2002	239,512
2003	244,400
2004	249,387
2005	254,477
2006	315,117
2007	242,039
2008	268,738
2009	315,058
2010	621,843

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Table 10 shows the annual waste filling in Itaoca landfill. Data from 2005 to August 2010 are provided by project participant NovaGerar based on weigh scale data. 2% annual increase in waste generation has been assumed aimed to back-calculated the waste generation data from 1980 to 2004. The assumption is consistent with the growth of population in the area. The 2010 annual value has been estimated using the January to August 2010 measured value

<sup>&</sup>lt;sup>16</sup> 1980-2007 data are based on Pre-feasibility Study for the Preparation of Landfill Gas Project in Latin American and the Caribbean. Itaoca-Landfill Site São Gonçalo, Rio de Janeiro, Brazil, April 2008;

<sup>2008- 2009</sup> data comes directly from weigh measurements. The value for 2010 has been estimated using the measurement recorded from January to August 2010.



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Tal	ble 11. Monthly precipitation
Month	Mean precipitation in mm
Jan	165,7
Feb	137,7
Mar	140,45
Apr	111,35
May	102,8
Jun	87,6
Jul	70,7
Aug	74,2
Sep	103,3
Oct	92
Nov	136,15
Dec	186,35
Mean annual	1,346

#### **Table 12.** Mean monthly temperature

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Máx	29°C	30°C	29°C	28°C	27°C	25°C	26°C	26°C	25°C	26°C	27°C	29°C
Mín	23°C	23°C	23°C	22°C	21°C	19°C	18°C	19°C	19°C	20°C	22°C	22°C
Méan	26°C	27°C	26°C	24°C	23°C	22°C	21°C	22°C	22°C	23°C	24°C	25°

#### Brazilian Grid Emission Factor, EF<sub>grid,CM,y</sub>

According to the *"Tool to calculate the emission factor for an electricity system"* version 02 the following steps have been followed:

STEP 1. Identify the relevant electricity systems.

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

STEP 3. Select a method to determine the operating margin (OM).

- STEP 4. Calculate the operating margin emission factor according to the selected method.
- STEP 5. Identify the group of power units to be included in the build margin (BM).

STEP 6. Calculate the build margin emission factor.

STEP 7. Calculate the combined margin (CM) emissions factor.

The official calculation was developed by the Brazilian DNA (Inter-ministerial Commission on Climate Change) and was used. The methodology and calculations are detailed below, as well as the source data published by the DNA.

Version 02 of the "*Tool to calculate the emission factor for an electricity system*" considers the determination of the emissions factor for the grid to which the project activity is connected as the core data to be determined in the baseline scenario. In the meeting of the April 29, 2008 the Brazilian DNA decided, by the information note (<u>http://www.mct.gov.br/upd\_blob/0024/24562.pdf</u>), to use a unique national system (SIN) for entire Brazilian grid.

According to the tool, we have that:

The grid emission factor is calculated as the weighted average of the operating margin emission factor and the build margin emission factor and is expressed in  $tCO_2/MWh$ .



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$$EF_{grid,CM,y} = W_{OM} \cdot EF_{grid,OM,y} + W_{BM} \cdot EF_{grid,BM,y}$$

Where

$EF_{grid,OM,y} =$	Operating margin CO2 emission factor in year <i>y</i> (tCO2/MWh)
$EF_{grid,BM,y} =$	Build margin CO2 emission factor in year y (tCO2/MWh)
$w_{OM} =$	Weighting for operating margin emission factor (%)
$w_{BM} =$	Weighting for build margin emission factor (%)

In this case, for weighting these two factors, the default value of 50% will be considered for both the operating margin and the build margin emission factors (i.e.,  $w_{OM} = w_{BM} = 0.5$ ).

For both Operating and Build margins, the Brazilian DNA has decided to suppress the informational barrier by making the calculations available on a daily and monthly basis.

For the calculation of the Operation Margin, EF<sub>grid,OM,y</sub>, the dispatch data analysis was used, option (C) of the "Tool to calculate the emission factor for an electricity system". According to the tool we have that:

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

Where:

$EF_{grid,OM-DD,y} =$	Dispatch data analysis operating margin CO2 emission factor in year y
	(tCO2/MWh)
$EG_{PJ,h} =$	Electricity displaced by the project activity in hour h of year y (MWh)
$EF_{EL,DD,h} =$	CO2 emission factor for grid power units in the top of the dispatch order in
	hour h in year y (tCO2/MWh)
$EG_{PJ,y} =$	Total electricity displaced by the project activity in year y (MWh)
h =	Hours in year y in which the project activity is displacing grid electricity
<i>y</i> =	Year in which the project activity is displacing grid electricity

The hourly emissions factor is calculated based on the energy efficiency of the power unit and the fuel type used, as follows:

$$EF_{EL,DD,h} = \frac{\sum_{n} EG_{n,h} \cdot EF_{EL,ny}}{\sum_{n} EG_{n,h}}$$

Where:

CO<sub>2</sub> emission factor of power unit n in year y (tCO<sub>2</sub>/MWh);  $EF_{EL.n.v}$ Net quantity of electricity generated and delivered to the grid by power unit n in hour h  $EG_{n,h}$ (MWh); Power units in the top of the dispatch.

п



For the *ex-ante* calculation of the Operation Margin (OM) Emission Factor, the arithmetic average of the OM Emission Factor published by the DNA was used with the latest available data.. (http://www.mct.gov.br/index.php/content/view/307492.html)

OPERATING MARGIN											
Emission Factor (tCO2/MWh) - Monthly											
						2009					
January	February	March	April	May	June	July	August	September	October	November	December
0,2813	0,2531	0,2639	0,2451	0,4051	0,3664	0,2407	0,1988	0,1622	0,1792	0,181	0,194
										Mean	0.2476

Thus,  $EF_{grid,OM-DD,y} = 0.2476$ 

For the calculation of the Build Margin, the latest published information by the Brazilian DNA is that for the year 2009; thus we have that:

BUILDING MARGIN
Emission Factor (tCO2/MWh) - Annual
2009
0.0794

 $EF_{grid,BM,y} = 0.0794$ 

We are using the values divulged for 2009.

Finally, using the formula for the combined grid emission factor we have that:

 $EF_{grid,CM,y}$  =0.5 × 0.0794 + 0.5 × 0.2476 = 0.1635 tCO<sub>2</sub>/MWh



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#### Annex 4

#### MONITORING INFORMATION

Not applicable