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

CONTENTS

Annexes

SECTION A. General description of project activity

A.1 Title of the project activity:

Itaoca Landfill Gas Project
Version 4.a.rev1[1]
07/12/2010

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 m², 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 CO2 equivalent emissions for the project and its baseline. The results found that the project has the capacity to generate 258, 869 tonnes of "certified emission reductions 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.

[1] The only change to this PDD in relation to the previous version submitted for registration is the clarification included in section B.6.1 to address the request for review at registration raised by the CDM EB.

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
Kingdom of Spain	International Bank for Reconstruction and Development (IBRD) as Trustee of the Spanish Carbon Fund (SCF)	Yes
(*) In accordance with the CDM modalities and procedures, at the time of making the CDM-PDD public at the stage of validation, a Party involved may or may not have provided its approval. At the time of requesting registration, the approval by the Party (ies) involved is required.		

A.4. Technical description of the project activity:

A.4.1. Location of the project activity:

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

A.4.1.1. Host Party(ies):

Brazil

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

Rio de Janeiro

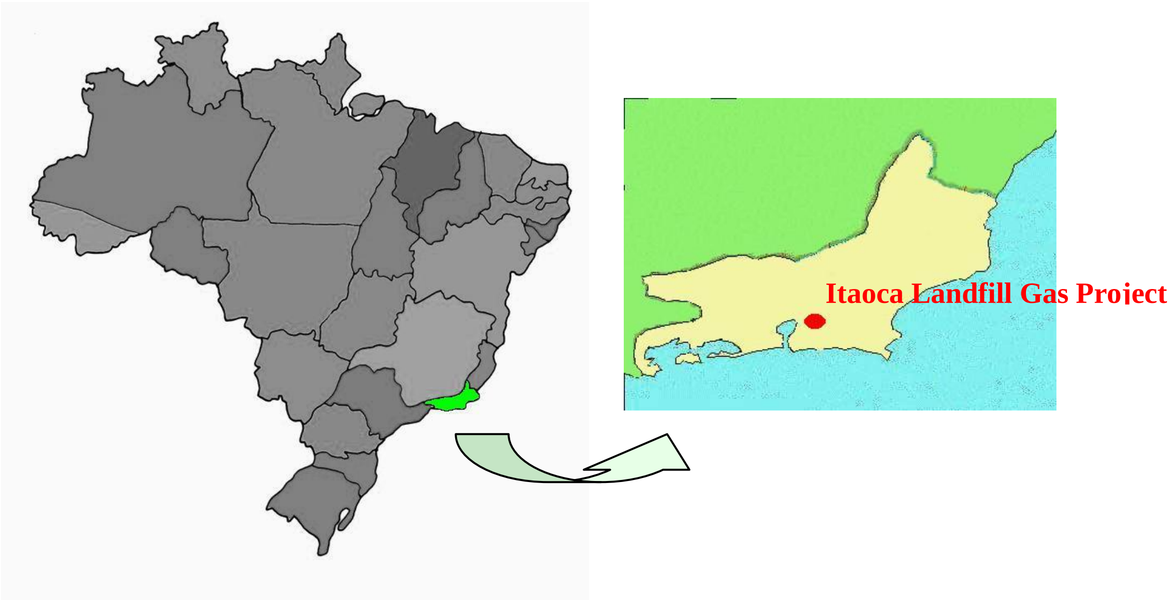
A.4.1.3. City/Town/Community etc:

Community: Salgueiro; City: São Gonçalo

A.4.1.4. Detail of physical location, including information allowing the unique identification of this project activity (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.

Figure 1– Localization of the Itaoca Landfill Gas Project[2]



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[3] (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.

---

[2] Source: IBGE. Adapted from <http://mapas.ibge.gov.br>

[3] 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%[4]. 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.

<u>Landfill gas collection System:</u>
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

[4] 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.

<u>Landfill gas flaring system:</u>
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^3/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[5]. 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[6].

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

[5] Source: Manufacturer (John Zinc) technical specifications

[6] Ibid

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.

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

Table 2: Estimated emission reductions

Year	**Annual estimation of emission reductions in tons of Carbon Dioxide equivalent (tCO_2e)**
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_2e)	**258,869**
Total number of crediting years	**10**
Annual average over the crediting period of estimated reductions (tCO_2e)	**25,887**

A.4.5. Public funding of the project activity:

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 approved baseline and monitoring methodology applied to the project activity:

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_2 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 project 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 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

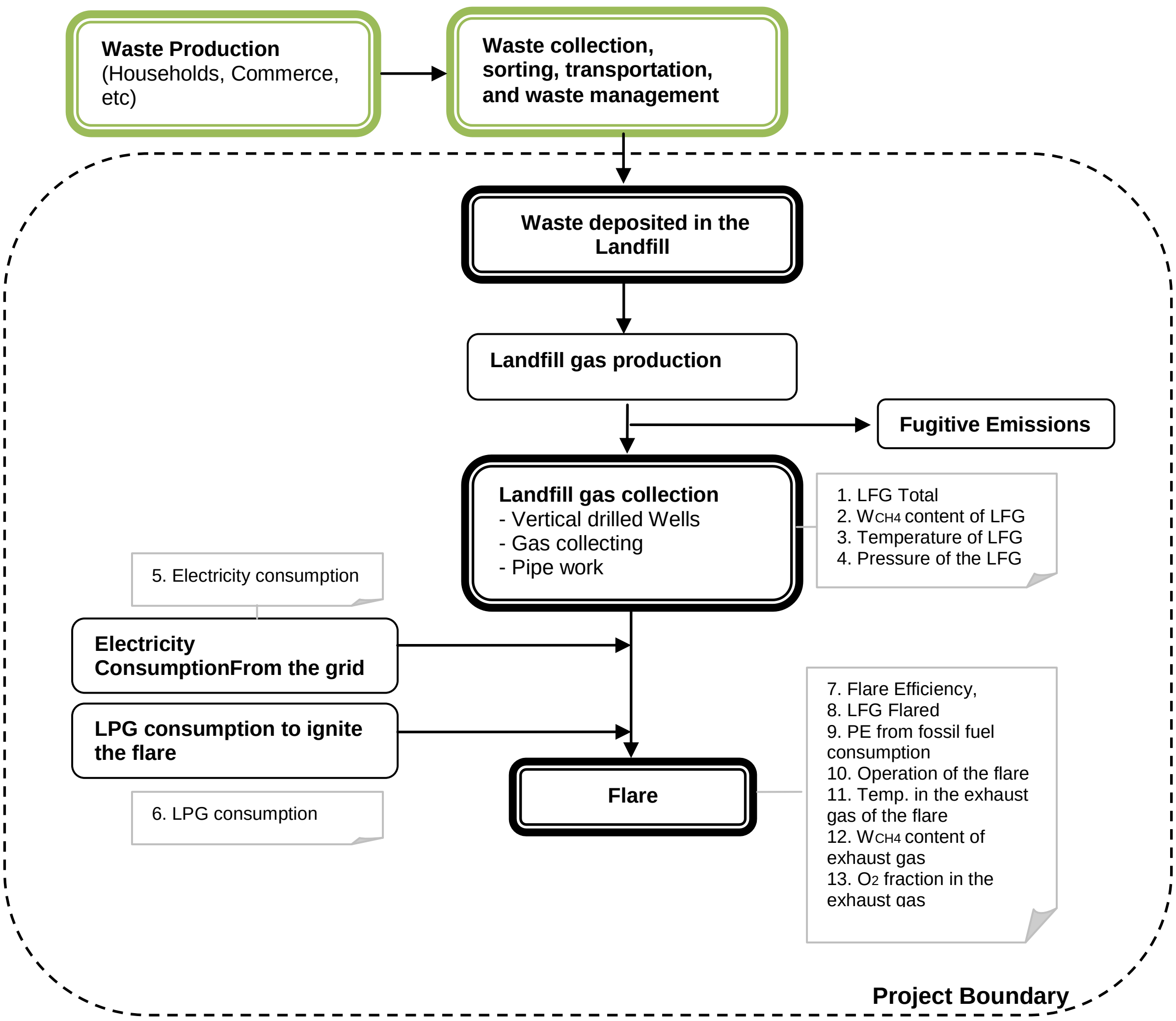
The table below shows the gases involved in the transformation of the methane within the project boundary. Emissions in the baseline from electricity consumption and thermal energy generation were not applicable. This is also indicated in the subsequent figure on the project boundary below the table.

Table 3: Sources and gases included in the project boundary

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

	thermal energy generation	CH_4	No	Excluded for simplification. This is conservative.
		N_2O	No	Excluded for simplification. This is conservative.
Project activity	Emissions from on-site electricity use	CO_2	Yes	May be an important emission source.
		CH_4	No	Excluded for simplification. This emission source is assumed to be very small.
		N_2O	No	Excluded for simplification. This emission source is assumed to be very small.
	On-site fossil fuel consumption due to the project activity other than for electricity generation	CO_2	Yes	May be an important emission source.
		CH_4	No	Excluded for simplification. This emission source is assumed to be very small.
		N_2O	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 baseline scenario 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.

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.

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 LFG Collection and Flaring systems[7]

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**

[7] 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 € 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.

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 € 72,000/year), with insurance and other fixed costs it amounts to slightly more than € 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.

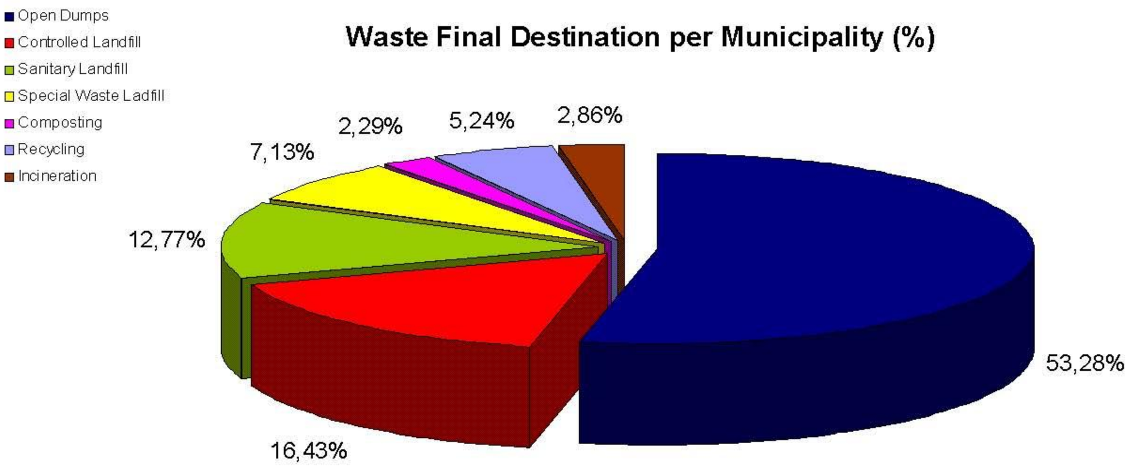
Step 3. Barrier analysis
Since the additionality is demonstrated using financial analysis, the barrier analysis is not undertaken.

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 [8]



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.

[8] Source: Table 109. PNSB, 2000. Web site: http://www.ibge.gov.br/home/estatistica/populacao/condicaodevida/pnsb/pnsb.pdf

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[9].

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 Number
• 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 - Bragança Landfill.	1247
• ESTRE Itapevi Landfill	0911
• Quintaúna Landfill	0912
• ESTRE Pedreira Landfill	1134
• Salvador da Bahia Landfill	0052
• ESTRE Paulínia Landfill	0165

[9] Sistema Nacional de Informações sobre Saneamento: diagnóstico do manejo de resíduos sólidos urbanos – 2007. Brasília: MCIDADES.SNSA, 2009. Available at http://www.snis.gov.br/

• 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
• 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_2 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

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

Where:

BE_y =	Baseline emissions in year y (tCO_2e).
$MD_{project,y}$ =	The amount of methane would have been destroyed during the year, in tons of methane (tCH_4) in project scenario.

$MD_{BL,y}$ = 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_4).
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_2 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 TJ.
$CEF_{ther,BL,y}$ = CO_2 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_2e/TJ.

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

$MD_{BL,y}$ = 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 (t CH_4)
$EL_{LFG,y}$ = Assumed to be zero since there is no electricity generation.
$ET_{LFG,y}$ = Assumed to be zero since there is no thermal heat generation.
$MD_{project,y}$ = Will be determined ex-post by metering the actual quantity of methane captured and destroyed once the project activity is operational. The methane destroyed by the project activity ($MD_{project,y}$) during a year is determined by monitoring the quantity of methane actually flared.

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

$$BE_y = (MD_{project,y} - MD_{BL,y}) * GWP_{CH4} \quad (2)$$

Where the term $MD_{BL,y}$ is calculated using the following equation:

$$MD_{BL,y} = MD_{project,y} * AF$$

Where *AF* is the "Adjustment Factor" that accounts for the "collection and destruction of methane mandated by regulatory or contractual requirements, or is undertaken for other reasons". In the case of the Itaoca landfill, the term *AF* is equal to zero since there are no regulations or contractual agreements requiring capture and flaring of methane, nor is there any collection being undertaken. The Brazilian legislation establishes that each state is responsible for the environmental license process for landfills. Thus, each state defines the laws, minimum standards, technologies, restrictions and environmental requirements for the landfills. For the case of the Itaoca landfill site, which is located in the state of Rio de Janeiro, the environmental agency of the state did not require the landfill to install any landfill gas collection and flare system, including passive flaring. This is the common practice in the state of Rio de Janeiro.

As a result the term *AF* is equal to zero, and hence $MD_{BL,y}$ is equal to zero.

Ex-ante estimation of the amount of methane that would have been destroyed in project scenario during the year y, in tones of methane ($MD_{project,y}$)

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 $BE_{CH4,SWDS,y}$ 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 (tCO_2e).
As per the tool, we have that:

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

Where:

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

Where:

$BE_{CH4,SWDS,y}$ =	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_2e).
φ =	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 *j.*
k_j =	Decay rate for the waste type *j.*
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).
y =	Year for which methane emissions are calculated.

The LFG collection efficiency (40%)[10], 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 ($MD_{project,y}$)

[10] Prefeasibility Study. Itaoca. April 2008

According to the Methodology, *ex post* $MD_{project,y}$ is determined by:

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

Where:

$MD_{flared,y}$ = Quantity of methane destroyed by flaring (tCH_4)

$MD_{electricity,y}$ = Quantity of methane destroyed by generation of electricity (tCH_4)

$MD_{thermal,y}$ = Quantity of methane destroyed for the generation of thermal energy (tCH_4)

$MD_{PL,y}$ = Quantity of methane sent to the pipeline for feeding to the natural gas distribution network (tCH_4)

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

$$\boldsymbol{MD_{project,\,y} = MD_{flared,\,y}} \quad (6)$$

Where:

$MD_{flared,y}$ is determined by:

$$MD_{flared,y} = \{LFG_{flare,y} * w_{CH4,y} * D_{CH4}) - (PE_{flare,y} / \mathrm{GWP}_{CH4}) \quad (7)$$

Where:

$LFG_{flare,y}$ =- 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^3CH_4 / m^3LFG).

D_{CH4}- = 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 *"Tool to determine project emissions from flaring gases Containing Methane" Version 1*. The project uses an enclosed flaring system and monitoring will be done continuously.

According to the tool. $PE_{flare,y}$ 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:

$$fm_{j,h} = \frac{\sum_{i} fv_{i,h} \cdot AM_j \cdot NA_{j,i}}{MM_{RG,h}} \tag{8}$$

Where:

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

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:

$$TV_{n,FG,h} = V_{n,FG,h} \times FM_{RG,h} \tag{9}$$

Where:

SEE REFERENCES TO DRY BASIS BELOW

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

$$V_{n,FG,h} = V_{n,CO_2,h} + V_{n,O_2,h} + V_{n,N_2,h} \tag{10}$$

Where:

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

$$V_{n,O_2,h} = n_{O_2,h} \times MV_n \tag{11}$$

Where:

Variable	SI Unit	Description
$V_{n,O2,h}$	m^3/kg residual gas	Quantity of O_2 volume free in the exhaust gas of the flare at normal conditions per kg of residual gas in the hour *h*
$n_{O2,h}$	kmol/kg residual gas	Quantity of moles O_2 in the exhaust gas of the flare per kg residual gas flared in hour *h*
MV_n	m^3/kmol	Volume of one mole of any ideal gas at normal temperature and pressure (22.4 L/mol)

$$V_{n,N_2,h} = MV_n * \left\{ \frac{fm_{N,h}}{200 AM_N} + \left(\frac{1 - MF_{O_2}}{MF_{O_2}} \right) * \left[F_h + n_{O_2,h} \right] \right\} \tag{12}$$

Where:

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

$$V_{n,CO_2,h} = \frac{fm_{C,h}}{AM_C} * MV_n \tag{13}$$

Where:

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

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

Where:

Variable	SI Unit	Description
$n_{O2,h}$	kmol/kg residual gas	Quantity of moles O_2 in the exhaust gas of the flare per kg residual gas flared in hour *h*
$t_{O2,h}$	-	Volumetric fraction of O_2 in the exhaust gas in the hour *h*
MF_{O2}	-	Volumetric fraction of O_2 in the air (0.21)
F_h	kmol/kg residual gas	Stochiometric quantity of moles of O_2 required for a complete oxidation of one kg residual gas in hour *h*
$fm_{j,h}$	-	Mass fraction of element *j* in the residual gas in hour *h* (from Equation 8)
AM_j	kg/kmol	Atomic mass of element *j*
j		The elements carbon (index C) and nitrogen (index N)

$$F_h = \frac{fm_{C,h}}{AM_C} + \frac{fm_{H,h}}{4AM_H} - \frac{fm_{O,h}}{2AM_O} \qquad (15)$$

Where:

Variable	SI Unit	Description
F_h	kmol O_2/kg residual gas	Stoichiometric quantity of moles of O_2 required for a complete oxidation of one kg residual gas in hour *h*
$fm_{j,h}$	-	Mass fraction of element *j* in the residual gas in hour *h* (from Equation 8)
AM_j	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:

$$TM_{FG,h} = \frac{TV_{n,FG,h} * fv_{CH4,FG,h}}{1000000} \qquad (16)$$

Where:

Variable	SI Unit	Description
$TM_{FG,h}$	kg/h	Mass flow rate of methane in the exhaust gas of the flare in dry basis at normal conditions in the hour *h*
$TV_{n,FG,h}$	m^3/h exhaust gas	Volumetric flow rate of the exhaust gas in dry basis at normal conditions in hour *h*
$fv_{CH4,FG,h}$	mg/m^3	Concentration of methane in the exhaust gas of the flare in dry basis at normal conditions in 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 60ºC), 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).

$$TM_{RG,h} = FV_{RG,h} \times fv_{CH4,RG,h} \times \rho_{CH4,n} \qquad (17)$$

Where:

Where:

Variable	SI Unit	Description
$TM_{RG,h}$	kg/h	Mass flow rate of methane in the residual gas in the hour *h*
$FV_{RG,h}$	m^3/h	Volumetric flow rate of the residual gas in dry basis at normal conditions in hour *h*
$fv_{CH4,RG,h}$	-	Volumetric fraction of methane in the residual gas on dry basis in hour *h* (NB: this corresponds to $fv_{i,RG,h}$ where *i* refers to methane).
$\rho_{CH4,n}$	kg/m^3	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* (η *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* :

$$\eta_{flare,h} = 1 - \frac{TM_{FG,h}}{TM_{RG,h}} \qquad (18)$$

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

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* (η*flare,h*), as follows:

$$PE_{flare,y} = \sum_{h=1}^{8760} TM_{RG,h} \times \left(1 - \eta_{flare,h}\right) \times \frac{GWP_{CH4}}{1000} \qquad (19)$$

Where:

Variable	SI Unit	Description
$PE_{flare,y}$	tCO_2e	Project emissions from flaring of the residual gas stream in year *y*
$TM_{RG,h}$	kg/h	Mass flow rate of methane in the residual gas in the hour *h*
$\eta_{flare,h}$	-	Flare efficiency in hour *h*
GWP_{CH4}	tCO_2e/tCH_4	Global Warming Potential of methane valid for the commitment period

<u>Project Emissions:</u>

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

$$PEy = PE_{EC\,y} + PE_{FC\,j\,y}, \qquad (20)$$

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 ($PE_{EC,y}$) 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; $PE_{EC,y}$ is calculated as follows:

$$PE_{EC,y} = EC_{PJ,y} * EF_{CP,y} * (1+TDL_y) \qquad (21)$$

Where:

$EC_{PJ,y}$ Quantity of electricity consumed by the project activity during the year (MWh)

$EF_{CP,y}$ Brazilian grid emission factor (tCO_2/MWh)

TDL_y 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:

$$PE_{FC,y} = FCy,.* COEF_y \qquad (22)$$

Where

FC_y is the fossil fuel (LPG) combusted (m^3)

$COEF_y$ is the CO_2 emission coefficient of the LPG (tCO2/ m^3 fuel)

The amount of LPG combusted (FC_y) 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[11], and then multiplying this by the number of ignitions during the year (ex-ante these are estimated by the project 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:

$$COEF_y = NCV_y * EF_{CO2y} \qquad (23)$$

Where

NCV_y Is the weighted average net calorific value of the fuel type (0.106 GJ/ m^3)

EF_{CO2y} ` Is the weighted average CO2 emission factor of fuel type (0.0656 tCO_2/GJ)

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

Leakage

No leakage effects need to be accounted under this methodology.

Emission Reductions

Emission reductions are calculated as follows:

$$\mathbf{ER_y = BE_y - PE_y} \qquad (24)$$

Where:

ER_y = Emission reductions in year *y* (tCO_2e/yr).

BE_y = Baseline emissions in year *y* (tCO_2e/yr).

PE_y = Project emissions in year *y* (tCO_2/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_{CH4}
Data unit:	tCO_2e/tCH_4
Description:	Global warming potential of CH_4
Source of data used:	IPCC
Value applied:	21
Justification of the choice of data or description of measurement methods and procedures actually applied :	Shall be updated accordingly to any future COP/MOP decisions
Any comment:	N/A

Data / Parameter:	D_{CH4}
Data unit:	tCH_4/m^3CH_4
Description:	Methane density
Source of data used:	IPCC
Value applied:	0.0007168
Justification of the choice of data or description of measurement methods and procedures actually applied :	At standard T and P (0 degrees C and 1,013 bar)
Any comment:	N/A

Data / Parameter:	$BE_{CH4, SWDS,y}$
Data unit:	tCO_2e
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 to determine methane emissions avoided from disposal of waste at a solid waste disposal site" –Version 5*
Value applied:	(see table below)
Justification of the choice of data or description of measurement methods and procedures actually applied :	As per the *"Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site" –Version 5*
Any comment:	Used for ex-ante estimation of the amount of methane that would have been destroyed/combusted during the year

Year	**$BE_{CH4,SWDS,y}$ (t CO_2e)**
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	**720,562**

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 choice of data or description of measurement methods and procedures actually applied :	Oonk et el. (1994) have validated several landfill gas models based on 17 realized landfill gas projects. The mean relative error of multi-phase models was assessed to be 18%. Given the uncertainties associated with the model and in order to estimate emission reductions in a conservative manner, a discount of 10% is applied to the model results.
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 choice of data or description of measurement methods and procedures actually applied :	According to the "*Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site*". *–Version 5*
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 choice of data or description of measurement methods and procedures actually applied :	All the methane generated was directly vented to the atmosphere prior to the project activity. Upon the implementation of the project activity, methane captured will only be flared.
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 choice of data or description of measurement methods and procedures actually applied :	According to the "*Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site" version 5. for managed solid waste disposal sites*" this value has been used for conservative reasons since the landfill has been using soil as cover.
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 choice of data or description of measurement methods and procedures actually applied :	According to the "*Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site"* version 5. *for managed solid waste disposal sites*" this value is to be applied to Itaoca Landfill as it is "for unmanaged solid waste disposal sites - deep and/or with high water table. This comprises all SWDS not meeting the criteria of managed SWDS and which have depths of greater than or equal to 5 meters and/or high water table at near ground level.
Any comment:	

Data / Parameter:	DOC_j
Data unit:	-
Description:	Fraction of degradable organic carbon (by weight) in the waste type *j*.
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 *j* are applied:
Justification of the choice of data or description of measurement methods and procedures actually applied :	In accordance with *"Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site", version 05*
Any comment:	The values applied are for wet waste.

Waste type *j*	**DOC_j (% 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

Data / Parameter:	DOC_f
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 choice of data or description of measurement methods and procedures actually applied :	According to the "*Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site"* version 05.
Any comment:	

Data / Parameter:	$\mathbf{k_j}$
Data unit:	-

Description:	Decay rate for the waste type *j*.
Source of data used:	IPCC 2006 Guidelines for National Greenhouse Gas Inventories (adapted from Volume 5, Table 3.3)
Value applied:	The following values for the different waste types *j* are applied: (see table below)
Justification of the choice of data or description of measurement methods and procedures actually applied :	In accordance with *"Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site", version 05.*
Any comment:	The values applied are for tropical (MAT> 20°C) and wet (MAP > 1000m) conditions.

Waste type j		Tropical (MAT > 20ºC) Wet (MAP > 1000 mm)
Slowly Degrading	Pulp, paper, cardboard (other than sludge), textiles	0.07
	Wood,wood products and straw	0.035
Moderately Degrading	Other (non-food) organic putrescible garden and park waste	0.17
Rapidly Degrading	Food, food waste, sewage sludge, beverages and tobacco	0.40

Data / Parameter:	$\mathbf{E_{DS}}$
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 choice of data or description of measurement methods and procedures actually applied :	The collection efficiency value considers the physical conditions of this landfill (partially managed) as well as the capping material (soil cover) used to cover the waste. According to the feasibility study, 40% is a reasonable conservative factor for unmanaged site and in terms of the nature of the cover materials and leachate levels, and the resultant effect on LFG collection.
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 choice of data or description of measurement methods and procedures actually applied :	Based on Project Developer operations, receiving an average of 800 tpd and operating 280 days per year.
Any comment:	

Data / Parameter:	$p_{n,j,x}$
Data unit:	%
Description:	Weight fraction of the waste type *j* in the sample *n* 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:	see table below
Justification of the choice of data or description of measurement methods and procedures actually applied :	Based on specific waste composition study done for Itaoca dumpsite
Any comment:	

Waste Composition		
Pulp, paper, Cardboard (other than Sludge)	% of Wet MSW	12.79
Textiles	% of Wet MSW	4.05
Food and Food Waste, beverages and tobacco (other than sludge)	% of Wet MSW	46.54
Garden,Yard and Park Waste	% of Wet MSW	0
Wood & Wood Products	% of Wet MSW	0.9

Data / Parameter:	z
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 choice of data or description of measurement methods and procedures actually applied :	The research was conducted by Grupo de Estudos em Tratamento de Resíduos (GETRES) / University of Rio de Janeiro for Haztec in year 2010.

Any comment:	

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

Data / Parameter:	MM_{CO}
Data unit:	kg/kmol
Description:	Molecular mass of carbon monoxide
Source of data used:	Constant
Value applied:	28.01
Justification of the choice of data or description of measurement methods and procedures actually applied :	As per *"Tool to determine project emissions from flaring gases containing methane" version1*.
Any comment:	

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

Data / Parameter:	MM_{O2}
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 description of measurement methods and procedures actually applied :	*methane" version1*.
Any comment:	

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

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

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

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

Data / Parameter:	AM_O
Data unit:	kg/kmol
Description:	Atomic mass of oxygen
Source of data used:	Constant
Value applied:	16.00
Justification of the choice of data or description of measurement methods and procedures actually applied :	As per *“Tool to determine project emissions from flaring gases containing methane” version1*.
Any comment:	

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

Data / Parameter:	P_n
Data unit:	Pa
Description:	Atmospheric pressure at normal conditions
Source of data used:	Constant
Value applied:	101,325
Justification of the choice of data or description of	As per *“Tool to determine project emissions from flaring gases containing methane” version1*.

measurement methods and procedures actually applied :	
Any comment:	

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

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

Data / Parameter:	MF_{O2}
Data unit:	Dimensionless
Description:	O_2 volumetric fraction of air
Source of data used:	Constant
Value applied:	0.21
Justification of the choice of data or description of measurement methods and procedures actually applied :	As per *"Tool to determine project emissions from flaring gases containing methane" version1*.
Any comment:	

Data / Parameter:	MV_n
Data unit:	$m^3/Kmol$
Description:	Volume of one mole of any ideal gas at normal

Source of data used:	Constant
Value applied:	22.414
Justification of the choice of data or description of measurement methods and procedures actually applied :	As per “*Tool to determine project emissions from flaring gases containing methane” version1*
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

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

Calculation of $MD_{Project,y}$

a) Ex-ante estimation of the amount of methane generated by the disposal of waste at a solid waste disposal site during the year ($MD_{Project,y}$) 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).

Table 5: Annual calculation for $MD_{Project,y}$

Year	$BE_{CH4,SWDS,y}$ (t CO_2e)	$MD_{project,y}$ (t CH_4)
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 6: Baseline Emissions

	$MD_{project}$ *GWP_{CH4}	BE_y (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**

Project Emissions

$PEy = PE_{EC\,y} + PE_{FC\,j\,y}$,

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" $PE_{EC,y}$ is calculated as follows:

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

Thus since the grid emission factor for Brazil[12] is 0.1635 tCO_2/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 MWh * 0.1635 tCO2/MWh * (1+0.2) = 53.37tCO_2e

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_y * EF_{CO2y} (tCO_2/m^3)

[12] For complete details please refer to Annex 3

Where
NCVy Is the weighted average net calorific value of the fuel type (0.106 GJ/m^3)
EF_{CO2y} ` Is the weighted average CO_2 emission factor of fuel type (0.0656 tCO_2/GJ)

Thus in summary we have that:

Project emissions

Table 7: Project Emissions

Year	PE_{ECy} (tCO_2e)	PE_{FCy} (tCO_2e)	Cumulative Project emissions (tCO_2e)
2011	53.37	0.000000013	53.37
2012	53.37	0.000000013	53.37
2013	53.37	0.000000013	53.37
2014	53.37	0.000000013	53.37
2015	53.37	0.000000013	53.37
2016	53.37	0.000000013	53.37
2017	53.37	0.000000013	53.37
2018	53.37	0.000000013	53.37
2019	53.37	0.000000013	53.37
2020	53.37	0.000000013	53.37
Cumulative Total	**533.7**	**0,00000013**	**533.7**

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

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

Year	Estimation of project activity emissions (tCO_2e)	Estimation of baseline emissions (tCO_2e)	Estimation of emission reductions (tCO_2e)
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**

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

B.7.1 Data and parameters monitored:

Data / Parameter:	**$LFG_{total,y}$**
Data unit:	Nm^3
Description:	Total amount of landfill gas captured 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 calculating expected emission reductions in section B.5	3,829,515 (Annual average over the crediting period)
Description of measurement methods and procedures to be applied:	As per the methodology on page 15 "In the case where LFG is just flared, one flow meter for each flare can be used provided that these meters used are calibrated periodically by an officially accredited entity;" Thus LFG_{total} will be the same as LFG_{flare}, 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 be applied:	The flow meter will be calibrated as per manufacturer specifications. 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:	**$LFG_{flare,y}$**
Data unit:	Nm^3
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 calculating expected emission reductions in section B.5	3,829,515(Annual average over the crediting period)
Description of measurement methods and procedures to be applied:	Measured with a flow meter continuously (average value in a time interval not greater than an hour), data to be aggregated monthly and yearly
QA/QC procedures to be applied:	The flow meter will be calibrated as per manufacturer recommendations. It will be subject to a regular maintenance, testing and calibration regime in accordance with manufacturer specifications to ensure its accuracy, which is assumed to be above 95%.

Any comment:	There will be only one flare; $LFG_{flare,y}$ 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*" *Version 01* 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:	**$PE_{flare,y}$**
Data unit:	tCO_2e
Description:	Project emissions from flaring of the residual gas stream in year *y*
Source of data to be used:	Project Developer
Value of data applied for the purpose of calculating expected emission reductions in section B.5	2,882 (Annual average over the crediting period)
Description of measurement methods and procedures to be applied:	Calculated as per the "*Tool to determine Project emissions from flaring gases containing Methane*". *Version 01*
QA/QC procedures to be applied:	As per the "*Tool to determine Project emissions from flaring gases 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:	**$w_{CH4,y}$**
Data unit:	m³ CH_4/ m³ LFG
Description:	Methane fraction in the landfill gas on a wet basis
Source of data to be used:	Project Developer
Value of data applied for the purpose of calculating expected emission reductions in section B.5	50%
Description of measurement methods and procedures to be applied:	A LANDTEC gas analyzer will be adopted. It will sample and analyze the Methane, Carbon Dioxide and Oxygen content of LFG, providing continuous monitoring of the readings that will be connected to a monitoring system for storage of the information analyzed. The Methane is analyzed using laser and infra-red light technology.
QA/QC procedures to be used:	The gas analyzer will be calibrated bi-annually and subject to regular 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_4 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:	**T**
Data unit:	°C
Description:	Temperature of the landfill gas
Source of data to be used:	Project Developer
Value of data applied for the purpose of calculating expected emission reductions in section B.5	
Description of measurement methods and procedures to be applied:	Measured continuously to determine the density of methane D_{CH4}.
QA/QC procedures to be used:	The temperature gauge will be calibrated as per manufacturer recommendations. It will be subject to a regular maintenance, testing and calibration regime in accordance with manufacturer specifications to ensure 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:	**P**
Data unit:	Pa
Description:	Pressure of the landfill gas
Source of data to be used:	Project developer
Value of data applied for the purpose of calculating expected emission reductions in section B.5	
Description of measurement methods and procedures to be applied:	Measured continuously to determine the density of methane D_{CH4}
QA/QC procedures to be used:	Measuring instruments shall be subject to a regular maintenance and testing 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:	**T_{flare}**
Data unit:	°C
Description:	Temperature in the exhaust gas of the flare
Source of data to be used:	Project Developer
Value of data applied for the purpose of calculating expected emission reductions in section B.5	
Description of measurement methods and procedures to be applied:	The temperature in the exhaust gas will be measured continuously with a type N thermocouple and continuously monitored as described in the "*Tool to determine project emissions from flaring gases containing methane*" *Version 01*.
QA/QC procedures to be used:	The thermocouple will be replaced or calibrated every year.
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:	**$t_{O2,h}$**
Data unit:	--
Description:	Volumetric fraction of O_2 in the exhaust gas of the flare in the hour *h*
Source of data to be used:	Project Developer
Value of data applied for the purpose of calculating expected emission reductions in section B.5	
Description of measurement methods and procedures to be applied:	An in situ LANDTEC Gas analyzer will be adopted. The gas analyzer will: 1) sample and analyze the methane, carbon dioxide and oxygen content of LFG, 2) provide continuous monitoring of the parameter and 3) transfer data to monitoring system for storage of the information. The Oxygen is analyzed using Cell Absorption technology.
QA/QC procedures to be used:	Analyzers will be calibrated bi-annually according to the manufacturer's 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:	**$NCV_{i,y}$**
Data unit:	GJ/m3
Description:	Weighted average net calorific value of fuel type I (LPG) in year y
Source of data to be used:	Fuel supplier

Value of data applied for the purpose of calculating expected emission reductions in section B.5	0.1059
Description of measurement methods and procedures to be applied:	Values provided by the fuel supplier. Undertaken in line with national or international fuel standards The NCV will be obtained for each fuel delivery, from which weighted average annual values should be calculated
QA/QC procedures to be used:	Values will be verified to check that they are within the uncertainty range of the IPCC default values as provided in Table 1.2, Vol. 2 of the 2006 IPCC Guidelines.
Any comment:	

Data / Parameter:	$\mathbf{EF_{CO2,i,y}}$
Data unit:	tCO_2/GJ
Description:	Weighted average CO_2 emission factor of fuel type i in year y
Source of data to be used:	IPCC default values at the upper limit of the uncertainty at a 95% confidence 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 for the purpose of calculating expected emission reductions in section B.5	0.0656
Description of measurement methods and procedures to be applied:	-
QA/QC procedures to be used:	Will be checked against any future revision of IPCC Guidelines
Any comment:	-

Data / Parameter:	$\mathbf{TDL_y}$
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	20

emission reductions in section B.5	
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:	**$fv_{CH4,h}$**
Data unit:	--
Description:	Volumetric fraction of methane in the residual gas in the hour h
Source of data to be used:	Project developer
Value of data applied for the purpose of calculating expected emission reductions in section B.5	-
Description of measurement methods and procedures to be applied:	Continuously measured on wet basis when the residual gas temperature exceeds 60 ºC
QA/QC procedures to be used:	Gas chromatograph. Analyzers will be periodically calibrated according to the 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:	**$FV_{RG,h}$**
Data unit:	m^3/h
Description:	Volumetric flow rate of the residual gas in wet basis at normal conditions in the hour h
Source of data to be used:	Project developer
Value of data applied for the purpose of calculating expected emission reductions in section B.5	-
Description of measurement methods and procedures to be applied:	Continuously measured on wet basis .

QA/QC procedures to be used:	Flow meters are to be periodically calibrated according to the manufacturer.s 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:	**$fv_{CH4,FG,h}$**
Data unit:	Mg/m^3
Description:	Concentration of methane in the exhaust gas of the flare in dry basis at normal conditions in the hour h
Source of data to be used:	Project developer
Value of data applied for the purpose of calculating expected emission reductions in section B.5	-
Description of measurement methods and procedures to be applied:	Continuously measured. Values to be averaged hourly or at a shorter time interval.
QA/QC procedures to be used:	Gas chromatograph. Analysers will be periodically calibrated according to 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:	**$EC_{PJ,y}$**
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 for the purpose of calculating expected emission reductions in section B.5	272.0 (ex-ante estimate from Project Developer, based on electricity capacity to be installed in the landfill and a number of operating hours per day)
Description of measurement methods and procedures to be applied:	Electricity will be measured continuously using an electricity meter. Data will be aggregated at least annually as stated in the "*Tool to calculate Project emissions from electricity consumption*" *version 01*.
QA/QC procedures to be used:	Electricity meter will be subject to regular maintenance and testing in accordance 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 CERs for the project activity

Data / Parameter:	$\mathbf{FC_y}$
Data unit:	m^3/yr
Description:	Onsite combustion of fossil fuels attributable to the project activity during the year y
Source of data to be used:	Project Developer
Value of data applied for the purpose of calculating expected emission reductions in section B.5	1.908E-06 (ex-ante estimate from Project Developer, based on monitored consumption by same equipment installed at a project site run by the same project developer)
Description of measurement methods and procedures to be applied:	Gas Flow Meter will be employed as per the "*Tool to calculate project or leakage CO2 emissions from fossil fuel combustion*" *version 02*. There will be a book of control for recording the measurements.
QA/QC procedures to be used:	The flow meter will be calibrated as per manufacturer specifications. 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:	$\mathbf{PE}_{EC,y}$
Data unit:	t_{CO2}
Description:	Project emissions from electricity consumption by the project activity during the year y
Source of data to be used:	Calculated as per the "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	53.37
Description of measurement methods and procedures to be applied:	As per the "*Tool to calculate Project emissions from electricity consumption*" *version 01*.
QA/QC procedures to be used:	As per the "*Tool to calculate Project emissions from electricity consumption*" *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:	$\mathbf{PE}_{FC,y}$
Data unit:	tCO_2e

Description:	Project emissions from fossil fuel combustion
Source of data to be used:	Calculated as per the "Tool to calculate project or leakage CO2 emissions from fossil fuel combustion" *version 02*.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	1.326E-08
Description of measurement methods and procedures to be applied:	Calculated as per the "*Tool to calculate project or leakage CO2 emissions from fossil fuel combustion*" *version 02*.
QA/QC procedures to be used:	Cross check measurement results with invoices for purchased fuel
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:	$\mathbf{EF_{grid,BM,y}}$
Data unit:	tCO_2/MWh
Description:	Build Margin for Brazil
Source of data to be used:	Published available data for the year 2009
Value of data applied for the purpose of calculating expected emission reductions in section B.5	0.0794
Description of measurement methods and procedures to be applied:	Calculated as per the "*Tool to calculate the emission factor for an electricity system*" version 02.
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:	$\mathbf{EF_{grid,OM,y}}$
Data unit:	tCO_2/MWh
Description:	Operating Margin for Brazil
Source of data to be used:	Published available data for 2009
Value of data applied for the purpose of calculating expected emission reductions in section B.5	0.2476

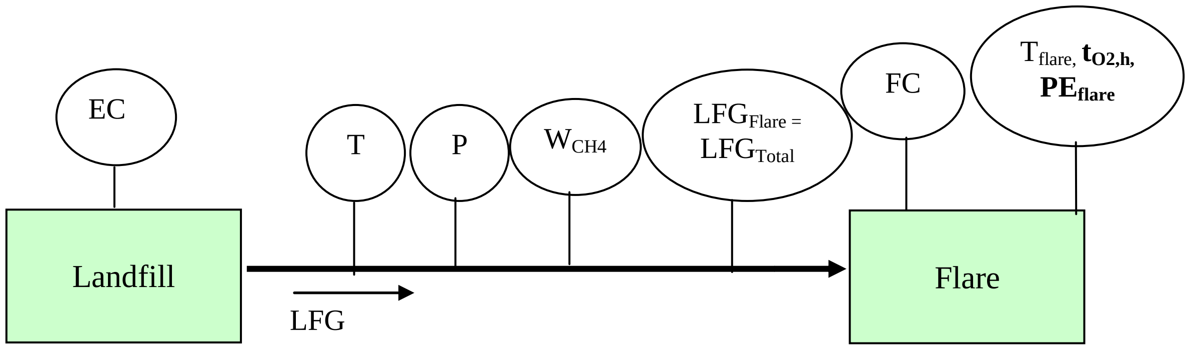
Description of measurement methods and procedures to be applied:	Calculated as per the "*Tool to calculate the emission factor for an electricity system*" version 02.
QA/QC procedures to be used:	
Any comment:	For details on the calculations please refer to Annex 3. This value will be monitored ex-post. 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.
- 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_{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
$t_{O2,h,}$ = 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 Nm³, 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 ($LFG_{total,y}$) since they will be the same as the quantities fed to the flare ($LFG_{flare,y}$). $LFG_{flare,y}$ 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 non-conformance 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.
  - 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 non-standard 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, follow-up inspections
  - Annual monitoring review

- 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 project activity:

C.1.1. Starting date of the project activity:

20/07/2010[13] 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.[14]

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

C.2.1. Renewable crediting period

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

Left Blank on purpose

C.2.1.2. Length of the first crediting period:

Left Blank on purpose

C.2.2. Fixed crediting period:

C.2.2.1. Starting date:

1/1/2011.or registration date, whichever is later

C.2.2.2. Length:

10 years and 0 month

[13] 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.

[14] 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).

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[15] (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 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.

[15] 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

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 host Party, please provide conclusions and all references to support documentation of an environmental impact assessment undertaken in accordance with the procedures as required by the host Party:

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.

SECTION E. Stakeholders' comments

E.1. Brief description how comments by local stakeholders 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.

Annex 1
CONTACT INFORMATION ON PARTICIPANTS IN THE PROJECT ACTIVITY

Organization:	Haztec Tecnologia e Planejamento Ambiental SA
Street/P.O.Box:	Rua Sao Jose, 70; 18º andar; Centro
Building:	São Jose
City:	Rio de Janeiro
State/Region:	Rio de Janeiro
Postfix/ZIP:	20010-020
Country:	Brazil
Telephone:	+55-21-3974-6150
FAX:	+55-21-3974-6705
E-Mail:	Eduardo.gaiotto@haztec.com.br
URL:	www.haztec.com.br
Represented by:	Eduardo Gaiotto
Title:	Project Manager
Salutation:	Mr.
Last Name:	Gaiotto
Middle Name:	
First Name:	Eduardo
Department:	Waste Management Department
Mobile:	+55-21-9611-4412
Direct FAX:	+55-21-3974-6705
Direct tel:	+55-21-397-9140
Personal E-Mail:	

Organization:	International Bank for Reconstruction and Development (IBRD) as Trustee of the Spanish Carbon Fund (SCF)
Street/P.O.Box:	1818 H street NW
Building:	MC
City:	Washington
State/Region:	DC
Postfix/ZIP:	20433
Country:	USA
Telephone:	1202 473 9189
FAX:	1202 522 7432
E-Mail:	IBRD-carbonfinance@worldbank.org
URL:	www.carbonfinance.org
Represented by:	Joelle Chassard
Title:	Manager, Carbon Finance Unit
Salutation:	Ms
Last Name:	Chassard
Middle Name:	
First Name:	Joelle
Department:	World Bank Carbon Finance Business Unit
Mobile:	-
Direct FAX:	1-202-522-7432

Direct tel:	1-202-473-9189
Personal E-Mail:	-

Organization:	Kingdom of Spain - Ministry of Environment and Rural and Marine Affairs
Street/P.O.Box:	C/Alcalá 92, 28009
Building:	
City:	Madrid
State/Region:	
Postfix/ZIP:	28009
Country:	Spain
Telephone:	+34 91-4361549
FAX:	+34 91-4361501
E-Mail:	and@mma.es
URL:	
Represented by:	
Title:	Director General
Salutation:	
Last Name:	MONTALVO
Middle Name:	
First Name:	Alicia
Department:	Spanish Office of Climate Change (OECC)
Mobile:	
Direct FAX:	
Direct tel:	
Personal E-Mail:	and@mma.es

Organization:	Kingdom of Spain - Ministry of Economy and Finance
Street/P.O.Box:	Po de La Castellana, 162
Building:	
City:	Madrid
State/Region:	
Postcode/ZIP:	28046
Country:	Spain
Telephone:	+34 91 583 76 59
FAX:	+34 91 583 52 11
E-Mail:	dgfint@meh.es
URL:	
Represented by:	
Title:	Director General for International Finance
Salutation:	
Last name:	FERNANDEZ GARCIA
Middle name:	
First name:	Maria Jesus
Department:	Directorate-General of International Financing
Mobile:	

Direct FAX:	
Direct tel:	
Personal e-mail:	

Annex 2

INFORMATION REGARDING PUBLIC FUNDING

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

Annex 3

BASELINE INFORMATION

1) Information used to determine the baseline[16]

Table 9. Baseline determination information

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

[16] Sources of the information were provided to the DOE during the validation visit

Table 10: Waste Disposal History[17]

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

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 genertation has been assumed aimed to back-calculated the waste genertation data from 1980 to 2004. The

[17] 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;
2008- 2009 data comes directly from weigh measurements. The value for 2010 has been estimated using the measurement recorded from January to August 2010.

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

Table 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, $EF_{grid,CM,y}$

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 (http://www.mct.gov.br/upd_blob/0024/24562.pdf), 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.

$$EF_{grid,CM,y} = w_{OM}.EF_{grid,OM,y} + w_{BM}.EF_{grid,BM,y}$$

Where

$EF_{grid,OM,y}$ =	Operating margin CO2 emission factor in year *y* (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, $EF_{grid,OM,y}$, 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
y =	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:

$EF_{EL,n,y}$	CO_2 emission factor of power unit n in year y (tCO_2/MWh);

$EG_{n,h}$	Net quantity of electricity generated and delivered to the grid by power unit n in hour h (MWh);
n	Power units in the top of the dispatch.

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:

$$EF_{grid,CM,y,} = 0.5 \times 0.0794 + 0.5 \times 0.2476 = 0.1635 \ tCO_2/MWh$$

Annex 4

MONITORING INFORMATION

Not applicable