PROJECT DESIGN DOCUMENT FORM
FOR CDM PROJECT ACTIVITIES (F-CDM-PDD)
Version 04.1

PROJECT DESIGN DOCUMENT (PDD)

Title of the project activity	ESTRE Piratininga Landfill Gas Project
Version number of the PDD	2
Completion date of the PDD	04/09/2012
Project participant(s)	Estre Ambiental S.A.
Host Party(ies)	Brazil
Sectoral scope and selected methodology(ies)	Sectoral Scope: 13 Methodology: ACM0001 – version 13.0.0
Estimated amount of annual average GHG emission reductions	68,899

SECTION A. Description of project activity

A.1. Purpose and general description of project activity

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The proposed project activity has the objective to capture, flare and generate electricity through the use of landfill gas (LFG)[1] produced in anaerobic conditions into the landfill called "*Centro de Gerenciamento de Resíduos Centro-Oeste*" (hereinafter referred to as *CGR Piratininga*) located in the municipality of Piratininga in the state of São Paulo, Brazil.

The project activity will result in greenhouse gas (GHG) emission reduction from the CGR Piratininga through two ways:

- Burning CH_4 in flares and/or group generators;
- The amount of electricity generated in the project activity will be dispatched to the Brazilian national grid, avoiding the dispatch of an equal amount of energy produced by fossil-fuelled thermal plants to that grid. The initiative avoids CO_2 emissions and contributes to the regional and national sustainable development.

Prior to the implementation of the project activity the scenario for LFG destruction is the partial released to atmosphere through the exiting LFG passive capture system. Regarding the electricity generation, the scenario is generation in existing and/or new grid-connected power plants.

The baseline scenario is the scenario existing prior to the implementation of the project activity.

The estimate of:

- Annual average is 68,899 tCO_2e;
- Total GHG emission reduction is 482,293 tCO_2e.

The project activity includes two phases: The first phase (from 2014 to 2015) will be to capture and to flare the LFG. The second phase (2016 to 2038) will be the implementation of a power generation plant that will use LFG to generate electricity. The installed generation capacity will be expected to increase during the lifetime of the project, totalizing at the end 6.0 MW.

The first phase of the project will be to construct an efficient capture, collection and flaring system to burn CH_4 (a greenhouse gas), and this will reduce odours and adverse environmental impacts.

During the second phase, the project will install generators that will combust the LFG to produce electricity, using part of the electricity for self-consumption and the other part will be exported to the grid. The flares will be kept in operation due to LFG excess, periods when electricity will not be produced or other operational considerations. The LFG power plant will be expected to install up to 6.0 MW upon project completion. However, the final equipment that will be chosen (as well as the final installed capacity) may vary depending on the availability of the generation equipment on the market at the time of actual implementation of the second phase.

The LFG capture and collection systems and flaring station will consist on a LFG pipeline grid and a flaring station, equipped with flares, centrifugal blowers, and all other supporting mechanical and electrical subsystems and appurtenances necessary to run the system. The power generation facility will be comprised of LFG engine generator sets of high performance standards. The engine-generator sets will be the primary equipment to combust the collected LFG once they are installed. A fraction of the

[1] The gas is generated by the decomposition of waste in a solid waste disposal sites (SWDS). LFG is mainly composed of methane, carbon dioxide and small fractions of ammonia and hydrogen sulphide.

collected LFG will be diverted to flares, which will be used to combust any gas in excess of the fuel demand for the engines, as well as a contingency backup.

The landfill will begin the operation in January/2013 and receive solid waste (type Class II-A and Class II-B).

Contribution of the Project Activity to Sustainable Development:

The project will make a strong contribution to sustainable development in Brazil. In addition to reducing emissions of GHGs and generating clean electricity, the Project will provide other sustainable development benefits as follows:

a) Contribution to the environment:

Electrical generation in the second phase of the project will displace electricity generated by fossil fuel-fired power plants.

b) Contribution to the improvement of working conditions and employment creation:

During the operational phase, which will take place 24 hours/day, 7 days/week, there will be new jobs created locally for duties related to construction, operations and maintenance, landscaping, plumbing, monitoring and security personnel. These people will be fully trained by CGR Piratininga on their duties and tasks. Local manpower will be used in the project implementation, which entails installation of vertical wells, horizontal collection system and assembly and operation of equipment such as blowers, flares, and group-generators.

c) Contribution to income generation:

In addition to the local jobs created during its implementation and operation, the project will pay taxes to the municipality.

A.2. Location of project activity
A.2.1. Host Party(ies)
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Brazil

A.2.2. Region/State/Province etc.
>>
São Paulo

A.2.3. City/Town/Community etc.
>>
Piratininga

A.2.4. Physical/Geographical location
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CGR Piratininga is located at Railway Eng. João Baptista Cabral Renno, km 256, Piratininga, (city), São Paulo (State), Brazil.

Geographical Coordinates: (Latitude: 22° 22’ 18” S and Longitude: 49° 10’ 13” W) or (Latitude -22.371667° and Longitude: -49.170278°).

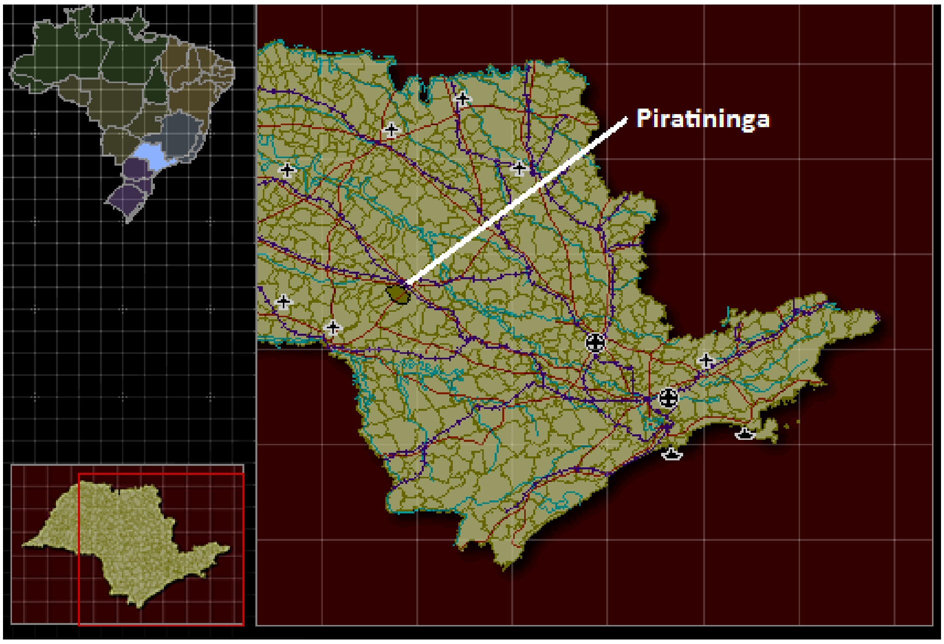

Figure 1 - Geographical position of Piratininga city, inside of São Paulo State in Brazil
(Source: http://www.ibge.gov.br/cidadesat/default.php)

A.3. Technologies and/or measures

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According to the executive project, the landfill will be operated under anaerobic conditions adopting the following conditions:

- Landfill surface every day covered;
- Mechanical compacting;
- Leveling of the waste.

In the proposed project activity, the used technology will be the improvement of biogas collection and flare produced in the landfill, through the installation of an active recovery system composed for:

- Collection system;
- Biogas transport pipe system;
- Gas suction and flare system (located in the Biogas Station).
- A power generation plant will also be installed.

<u>Collection system</u>

The biogas collection infrastructure of landfill is based in vertical drains. Those elements will be connected to a collection pipe that will accomplish the transport of gas to control stations (manifolds), used to control the drains loss of load.

Figure 2 – Example of control station (manifolds)
Source: ESTRE Ambiental S.A

CGR Piratininga intends to install and improve drains directly in the landfill. A covering layer will be installed around the drains to avoid the exhaust gases.

The top of the existing and new vertical drains will be equipped with headstocks. This element is important because it makes the connection between the drain and pipe collection. The headstocks are made of HDPE or similar. In the body of the head, a derivation of HDPE or similar will be installed and attached to a butterfly valve which is connected to a hose of HDPE or similar, which is finally connected to the tubing of collection.

Figure 3 - Example of well head
Source: ESTRE Ambiental S.A

The collection pipe will be built using HDPE or similar. The sizing of the piping was done considering the maximum production of landfill gas that can reach. Activities will be intense welding tubing to connect each station of the adjustment. The pipe will be covered with materials that do not pose any possibility of damage to the material.

Removers of condensate will be provided to drain humidity from the LFG. These removers are constructed at points of lower elevation of the tubing and collection stations, located before the adjustment. The condensate removed will be returned to the landfill, through pumps installed at the base of the removers.

All drains will be connected to the adjustment of station located around the landfill, through the collection pipes. The basic functions of the stations will promote the systematic control and monitoring of the characteristics of biogas extracted. Each station will have an adjustment of additional condensate remover, valves and regulating valves-drawer.

Transport System

The transmission pipeline is the last step of the collecting system. It transports the collected LFG to the flare. The transmission pipeline might be connected to all gas regulation stations around the landfill.

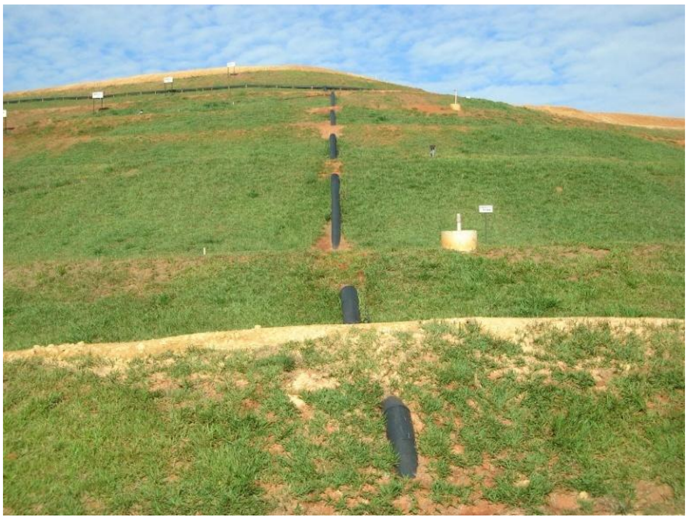

Figure 4 - Example of transmission pipelines
Source: ESTRE Ambiental S.A.

Blower System

The blowering system is responsible to give negative pressure to the landfill, blowing the gas to the pipeline. The dimensioning of the blowers will depend on flow of the landfill gas.

In order to preserve the operation of the blowers, a dewatering system is installed to remove the condensate. This equipment is a single knock-out dewatering component.

Figure 5 - Example of blower system
Source: ESTRE Ambiental S.A.

Flare System

The destruction of the methane content in the LFG collected will be made via enclosed flares, in order to assure higher methane destruction (above 99%)[2].

Basically, the flare is constructed using refractory material, a gas inlet, dampers to control the air inlet, an ignition spark, flame viewer and points to sample collection, as presented in the pictures below:

Figure 6 - Detail of Enclosed Flare
Source: ESTRE Ambiental S.A.

Biogas Station

The collection of gas within the landfill will be made by applying a pressure differential in each drain. The depressurization system shall be composed of a group of centrifugal multi-stage blowers, connected in parallel with the central collector. The depressurization of the system will depend on the pressure of operation of flares. In addition, the biogas station will have the following:

- Safety valve on/off;
- Remover of condensate;
- Gas analyzer;
- Meter flow.

[2] The destruction of the methane content in the LFG is above 99%, according to manufacturer specifications. The document (*Flare efficiency.pdf*) will be given to DOE in starting of the validation process.

Figure 7 - Example of a biogas station
Source: ESTRE Ambiental S.A.

The biogas station will have, even a system of destruction of methane through flares. This system will be composed initially by 1 enclosure flare with a capacity of 2,500 Nm^3/h and can get one additional unit of 2,500 Nm^3/h, according to the generation of gas. The flare is constructed in a vertical cylindrical combustion chamber, where the biogas is flared at a constant temperature (around 1,000 º C), controlled by the admission of air, and with a residence time minimum[3].

Power generation

The power generation system will be comprised of around 6.0 MW. The electricity generated by the project will be supplied to the grid.

This kind of technology is still not widely applied in Brazil. The publication named "Reducing the uncertainty of methane recovered (R) in greenhouse gas inventories from waste sector and of adjustment factor (AF) in landfill gas projects under the Clean Development Mechanism[4]" states that:

> *"…all of Brazilian landfills with collection and destruction system (active system) are implemented projects under the CDM…".*

Additionally, the PP carried out a survey in the Brazilian Electricity Regulatory Agency (ANEEL) website [5] along with UNFCCC's website in order to verify the existence of any landfill with electricity generation. The result of this survey concludes that there is no landfill generating electricity in Brazil without CDM benefits.

This kind of technology is still not widely applied in Brazil. Very few landfills have already installed equipment for flaring and combustion LFG. Therefore, the company will need engineers and other specialists with experience in this area to advice the company while implementing the project. These professionals will also train local operators and engineers on operations and maintenance of the facilities.

[3] The specification about the equipment were sent by the equipment manufacturer.
[4] Source: MAGALHÃES, G.HC.; ALVES, J.W.S.; SANTO FILHO. F.; COSTA, R.M.; KELSON. M. Reducing the uncertainty of methane recovered (R) in greenhouse gas inventories from waste sector and of adjustment factor (AF) in landfill gas projects under the clean development mechanism (2010). Page 174. (http://ghg.org.ua/fileadmin/user_upload/book/Proceedengs_UncWork.pdf), accessed on 25/06/2012.
[5] http://www.aneel.gov.br/aplicacoes/capacidadebrasil/capacidadebrasil.asp, accessed on 10/07/2012.

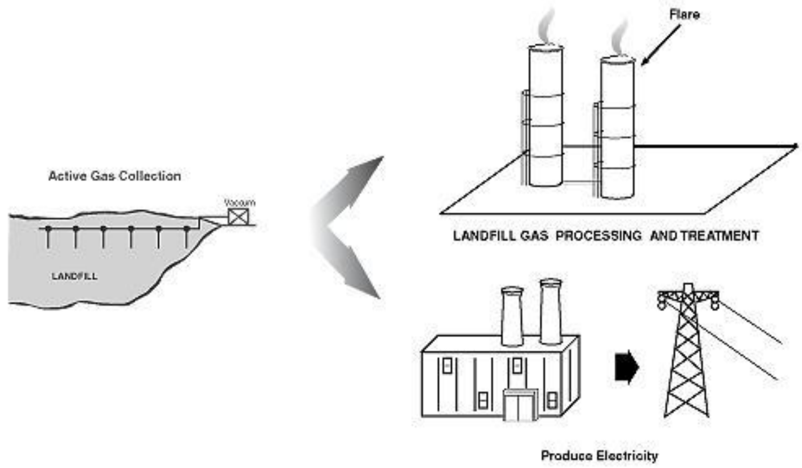

Figure 8 – Power generation diagram

The estimated number of group generators and the expected output is shown on the table below:

Table 1 - Electricity generation

Year	Number of flares installed (unit)*	Number of engines installed (unit)	Installed capacity (MW)*	Electricity generated in the plant (MWh)
2014	2.0	0	0.0	0
2015	2.0	0	0.0	0
2016	2.0	3	4.5	16,469
2017	2.0	3	4.5	16,469
2018	2.0	3	4.5	24,703
2019	2.0	3	4.5	24,703
2020	2.0	3	4.5	24,703

*It was considered the acquisition of one additional flare which will perform as a flaring system backup totalizing two flares during project activity. The reason which supports such decision is related to the operational experience acquired by Estre Ambiental S.A. in its CDM registered projects currently in operation. It has been observed the necessity to consider one (01) additional flare unit due to frequent system maintenance and cleaning downtime periods.
**The total installed capacity will be expected since 2024 with 6.0 MW and 4 installed group-generators.

The lifetime of the project is 25 years and it was based on group generator manufacturer[6]. The equipment that will be installed in the project site will be all new.

The baseline scenario of the project activity is the landfill operating as the following characteristics:

- Landfill area: 305,140 m²;
- Total waste volume: 8,000,000 m^3;
- The disposal waste is type Class II-A and Class II-B;
- The landfill lifetime is 25 years;
- Waterproofing with geomembrane and drainage of leachate;
- Leachate is collected through designed grid system and treated in wastewater treatment plant;
- Vertical drains which venting the LFG through passive LFG capture system.

[6] This information was provided to DOE.

The only drains in operation under the baseline scenario are the vertical drains which vent (release to the atmosphere) the LFG through passive LFG capture system. According to the ACM0001 (page 10), the baseline efficiency of the LFG capture system in the baseline is 20%. For active capture system, these exiting vertical drains will be improved to increase the LFG capture efficiency, according to described above.

The baseline scenario is the same scenario of the scenario exiting prior to the implementation of the project activity.

The load factor is 94% and the nominal engine efficiency is 40%. Both information it were based on manufacturer's specification[7].

Technology will have to come from the Europe, mainly from Italia. Hence, technology transfer will occur from countries with strict environmental legislative requirements and environmentally sound technologies.

The technology for biogas collection, flaring and power generation can be considered state of art in the Brazilian sanitation context.

The monitoring equipment and their location in the systems along with the balance of the system are presented below:

[7] The document will be available to DOE in validation visit.

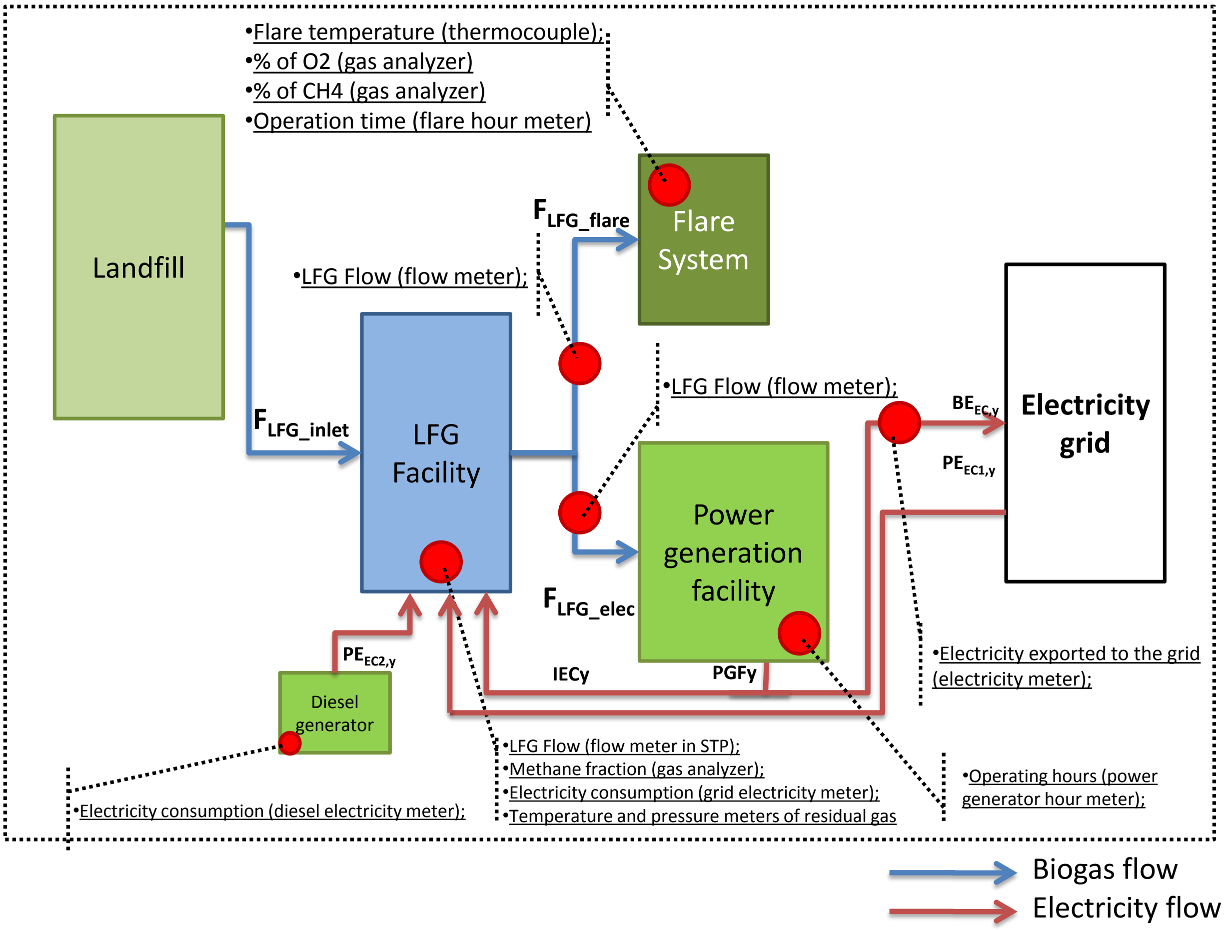

Figure 9 – Technologies and measures

Defined as:

F_{LFG_inlet}	Inlet LFG in the project activity
F_{LFG_flare}	LFG which is destroyed by flaring
F_{LFG_elec}	LFG which is used for electricity generation

Where:

$$\mathbf{F_{LFG\_inlet} = F_{LFG\_flare} + F_{LFG\_elec}}$$

And,

$BE_{EC,y}$	Electricity generation to the grid
$PE_{EC1,y}$	Electricity consumption from the grid
$PE_{EC2,y}$	Electricity consumption from the diesel generator
PGF_y	Electricity generated for internal needs and/or to the grid.
IEC_y	Electricity consumption by the auxiliary equipment generated in the power generation facility.

$$PE_{EC,y} = PE_{EC1,y} + PE_{EC2,y}$$

And,

$$PGF_y = BE_{EC,y} + IEC_y$$

A.4. Parties and project participants

Party involved (host) indicates a host Party	Private and/or public entity(ies) project participants (as applicable)	Indicate if the Party involved wishes to be considered as project participant (Yes/No)
Brazil (host)	Estre Ambiental S.A. (private entity)	No

CGR Piratininga belongs to:

- Estre Ambiental S.A. which is one of the largest companies of waste management in South America and;
- Geo Vision which is waste management company in Brazil;

A.5. Public funding of project activity

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There is no public funding involved in the project activity.

SECTION B. Application of selected approved baseline and monitoring methodology

B.1. Reference of methodology

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- ACM0001: "Flaring or use of landfill gas" (Version 13.0.0);
- Combined tool to identify the baseline scenario and demonstrate additionality (Version 04.0.0);
- Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion (Version 02);
- Emissions from solid waste disposal sites (Version 06.0.1);
- Tool to calculate baseline, project and/or leakage emissions from electricity consumption (Version 01);
- Tool to determine project emissions from flaring gases containing methane (Version 01), EB 28, Annex 13;
- Tool to determine the mass flow of a greenhouse gas in a gaseous stream (Version 02.0.0);
- Tool to determine the baseline efficiency of thermal or electric energy generation systems (Version 01);
- Tool to determine the remaining lifetime of equipment (Version 01).

B.2. Applicability of methodology

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The methodology ACM0001 is applicable to project activities which:

"...

a) Install a new LFG capture system in a new or existing SWDS; or

b) Make an investment into an existing LFG capture system to increase the recovery rate or change the use of the captured LFG, provided that:

i) The captured LFG was vented or flared and not used prior to the implementation of the project activity; and

ii) In the case of an existing active LFG capture system for which the amount of LFG can not be collected separately from the project system after the implementation of the project activity and its efficiency is not impacted on by the project system: historical data on the amount of LFG capture and flared is available.

c) Flare the LFG and/or use the captured LFG in any (combination) of the following ways:
i) Generating electricity;
ii) Generating heat in a boiler, air heater or kiln (brick firing only) or glass melting furnace; and/or
iii) Supplying the LFG to consumers through a natural gas distribution network.
d) Do not reduce the amount of organic waste that would be recycled in the absence of the project activity.

…"

Justification: - Part 1

The methodology is applicable because it will be made an investment into an existing LFG capture system to increase the recovery rate (collection efficiency) and change the use of the captured LFG (also electricity generation). The captured LFG was only vented and partially flared in open flares and not used prior to the implementation of the project activity.

In the first phase of the project activity the LFG will be only flared and during the second phase will generate electricity.

Moreover, the amount of organic waste will be the same in the project activity as well as in the absence of the project activity.

"…

The methodology is only applicable if the application of the procedure to identify the baseline scenario confirms that the most plausible baseline scenario is

a) Release of the LFG from the SWDS; and
b) In the case that the LFG is used in the project activity for generating electricity and/or generating heat in a boiler, air heater, glass melting furnace or kiln;
i) For electricity generation: that electricity would be generated in the grid or in captive fossil fuel fired power plants; and/or
ii) For heat generation: that heat would be generated using fossil fuels in on-site equipment.

This methodology is not applicable:
a) In combination with other approved methodologies. For instance, ACM0001 cannot be used to claim emission reductions for the displacement of fossil fuels in a kiln or glass melting furnace, where the purpose of the CDM project activity is to implement energy efficiency measures at kiln or glass melting furnace;
b) If the management of the SWDS in the project activity is deliberately changed in order to increase methane generation compared to the situation prior to the implementation of the project activity.

…"

Justification: - Part 2

According to Section B.4 and B.5, the methodology is applicable because:

- The most plausible baseline scenario is release the LFG to atmosphere from the SWDS, and;
- The electricity would be generated in the grid.

Moreover, there is neither a combination with other approved methodologies nor change in management of the landfill due to the project activity (e.g. addition of liquids, pre-treating waste or changing the shape of the landfill to increase the Methane Correction Factor).

B.3. Project boundary

Source		GHGs	Included?	Justification/Explanation
Baseline scenario	Emissions from decomposition of waste at the SWDS site	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 SWDS. This is conservative.
		CO_2	No	CO_2 emissions from decomposition of organic waste are not accounted since the CO_2 is also released under the project activity.
	Emissions from electricity generation	CO_2	Yes	Major emission source if power generation is included in the project activity.
		CH_4	No	Excluded for simplification. This is conservative.
		N_2O	No	Excluded for simplification. This is conservative.
	Emissions from heat generation	CO_2	No	There is no heat generation.
		CH_4	No	There is no heat generation.
		N_2O	No	There is no heat generation.
	Emissions from the use of natural gas	CO_2	No	There is no use of natural gas.
		CH_4	No	There is no use of natural gas.
		N_2O	No	There is no use of natural gas.
Project scenario	Emissions from fossil fuel consumption for purposes other than electricity generation or transportation due to the project activity	CO_2	No	There is no fossil fuel consumption for purposes other than electricity generation or transportation due to the project activity
		CH_4	No	There is no fossil fuel consumption for purposes other than electricity generation or transportation due to the project activity
		N_2O	No	There is no fossil fuel consumption for purposes other than electricity generation or transportation due to the project activity
	Emissions from electricity consumption due to the project activity	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.

The flow diagram is presented below:

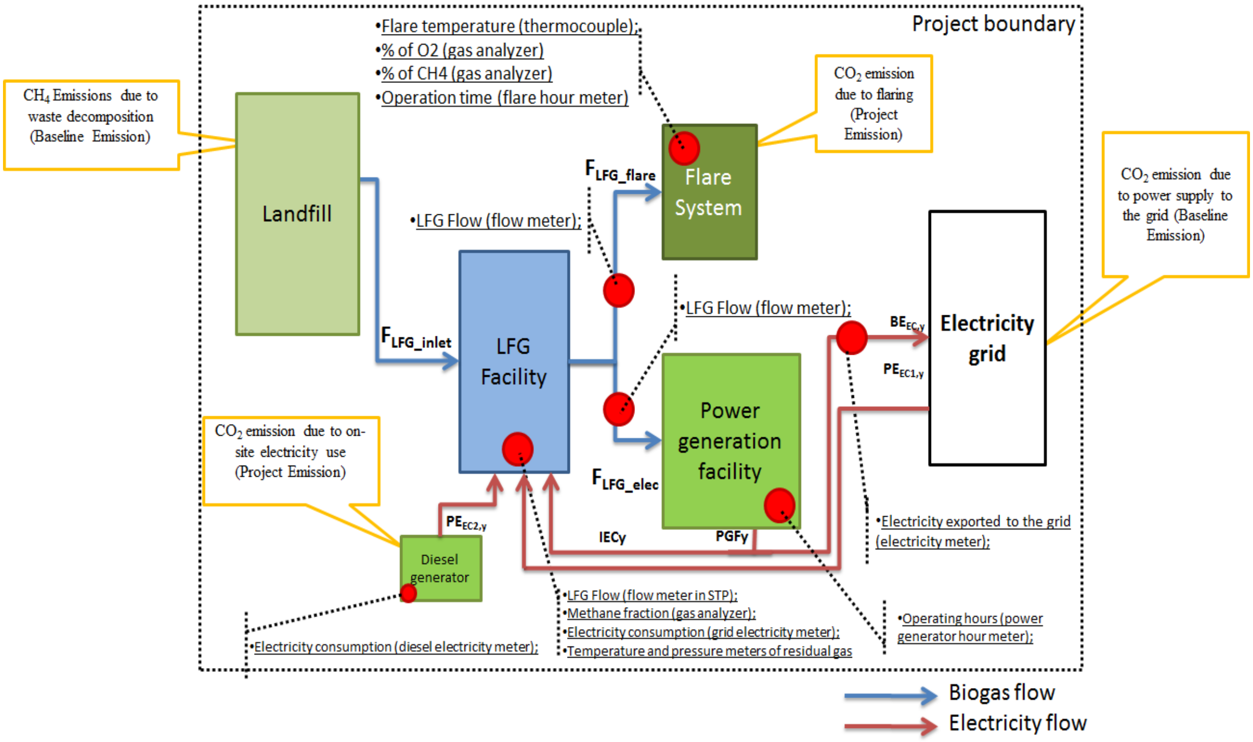

Figure 10 – Flow diagram project boundary

B.4. Establishment and description of baseline scenario

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The baseline scenario for the project activity is identified using step 1 of the 'Combined tool to identify the baseline scenario and demonstrate additionality", as agreed in ACM0001 "Flaring or use of landfill gas".

Realistic and credible alternatives to the project activity that can be part of the baseline scenario are defined through the following sub-steps:

STEP 0: Demonstration that a proposed project activity is the First-of-its-kind.

This step is not applied because the proposed project activity is not the First-of-its-kind.

Outcome of Step 0: The proposed project activity is not the First-of-its-kind.

Step 1: Identification of alternative scenarios

This Step serves to identify all alternative scenarios to the proposed CDM project activity(s) which can be the baseline scenario.

The project participants will monitor all relevant policies and circumstances at the beginning of each crediting period and adjust the baseline accordingly.

Step 1a: Define alternative scenarios to the proposed CDM project activity

The identified alternatives for the destruction of LFG in the absence of the project activity are:

LFG1	The project activity implemented without being registered as a CDM project activity (capture, flaring and use of LFG)

LFG2	Release of the LFG to atmosphere.

As the EIA (Environmental Impact Assessment) does not cover recycling, treatment or incineration of organic waste, alternatives LFG3, LFG4 and LFG5 should not be considered.

Thus, the remaining real alternatives for the destruction of LFG are LFG1, LFG2.

For electricity generation, the realistic and credible alternatives are:

E1	Electricity generation from LFG, undertaken without being registered as CDM project activity;
E3	Electricity generation in existing and/or new grid-connected power plants.

In the absence of project activity, no captive electricity consumption would be necessary. Thus, the alternative scenario E2 should not be considered.

According to the project activity configuration, there will be no heat generation or LFG supply to consumers through a natural gas distribution. Therefore, all alternative scenarios addressing these possibilities should not be considered.

Thus, the remaining real alternatives to the project activity are E1 and E3.

The combinations of the project activity compose the following scenarios:

Scenarios		Comments
1	LFG1 + E1	Possible
2	LFG1 + E3	Possible
3	LFG2 + E1	This alternative is not plausible because to generate electricity in the project activity, it is necessary to implement the capture, flaring and use of LFG.
4	LFG2 + E3	Possible

Outcome of Step 1a: Three realistic and credible alternative scenarios to the project activity were identified:

- Scenario 1 (LFG1 + E1);
- Scenario 2 (LFG1 + E3);
- Scenario 4 (LFG2 + E3).

Step 1b: Consistency with mandatory applicable laws and regulations

All alternative scenarios identified in Step *1a* comply with all applicable laws and regulations. Brazil's New National Solid Waste Policy (NSWP),[8] ratified by the President on 02/08/2010 after 19 years under discussion. The NSWP does not request the LFG capture and/or flare and there is not forecast to approve any regulation or policy in the next years with this requirement. The laws and regulations applicable for the electricity generation component are law 8987/95 and law 9074/95[9].

The scenario 4 which is a continuation of the current situation of the landfill (baseline scenario) represents the business as usual practice for the project site as well as for most of the landfills in Brazil.

The project participant will monitor all relevant policies and circumstances at the beginning of each crediting period and adjust the baseline accordingly.

[8] http://www.planalto.gov.br/ccivil_03/_ato2007-2010/2010/lei/l12305.htm
[9] http://www.aneel.gov.br/area.cfm?idArea=43

Outcome of Step 1b: Three realistic and credible alternative scenarios to the project activity are in compliance with mandatory legislation and regulations. The alternative scenarios remain the same:

- Scenario 1 (LFG1 + E1);
- Scenario 2 (LFG1 + E3);
- Scenario 4 (LFG2 + E3).

B.5. Demonstration of additionality
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The following table shows the timeline of the project activity showing that the CDM benefits were taken into account to implement it.

Table 2 - Implementation timeline of the Project

Key Events	Date
Prior Consideration of the CDM to UNFCCC and Brazilian DNA	10/04/2012
Contract between Designed Operational Entity (DOE) and the PP (Project Participant) for the validation process.	April/2012
Period of the Global Stakeholder Consultation (GSC)	25 May 12 - 23 Jun 12
The starting date of the project activity will be the purchase of the main equipment.*	July/2013
Start-up – Phase I*	January/2014
Commercial operation – Phase II*	January/2016

*Estimated

The project participants notified on 10/04/2012 the Brazilian DNA and UNFCCC of their intention to seek CDM status, according to “Clean development mechanism project cycle procedure” version 02.0.

The additionality of the project activity will be demonstrated and assessed using the “Combined tool to identify the baseline scenario and demonstrate additionality”.

The Step *0*, *1a* and *1b* are described above in section B.4.

Step 2: Barrier analysis

This step serves to identify barriers and to assess which alternative scenarios are prevented by these barriers as per the latest approved version of the “Guidelines for objective demonstration and assessment of barriers”. The following Sub-steps are applied:

Sub-step 2a: Identify barriers that would prevent the implementation of alternative scenarios

- **Investment barrier:** The implementation of the Scenario 2 (collection and destruction of LFG in enclosed flare + electricity generation in existing and/or new grid-connected power plants) requires a very high amount of investment from such project components:
    - Collection system;
    - Biogas transport pipe system;
    - Blowering System;
    - Flare System;

- Biogas Station (edifications).

In Brazil, flaring LFG in enclosed flare does not generate any revenues and has only expenditures. Therefore, the high investment regarding project components described above is not feasible in the economical point of view.

Outcome of Step 2a: the identified barrier (investment barrier) as described above prevent the scenario 2. However, the identified barrier does not prevent the occurrence of the other scenarios (scenarios 1 and 4).

Step 2b: Eliminate alternative scenarios which are prevented by the identified barriers

As the investment in Scenario 2 does not generate any revenues and has only expenditures for the PP, this scenario is not economical/financial attractive.

Outcome of Step 2b: The two realistic and credible alternative scenarios to the project activity are:

- Scenario 1 (LFG1 + E1);
- Scenario 4 (LFG2 + E3).

Step 3: Investment analysis

For the purpose of assessing the financial/economic attractiveness, the indicator used was the Net Present Value (NPV).

The discount rate used for this analysis was the value pointed out in Appendix A (Group 1 - Brazil) of the "Guidelines on the assessment of investment analysis" - version 05. The value was 11.75%.

The following assumptions were taken for the purpose of the calculation of the financial indicator in all alternatives:

Table 3 - Financial parameters of the cash flow[10]

	Parameter	Value	Unit	Reference
Assumptions	Discount rate	11.75%	%	Guidelines on the assessment of investment analysis - version 05, Group 1 (Brazil).
	Asset's Life time	25	Years	Technical specification of the group generators manufacturer
	Installed capacity for each engine	1.50	MW	Technical specification of the group generators manufacturer
	Total installed capacity	6.0	MW	Technical specification of the group generators manufacturer
	Price per MW installed	2,391,688	BRL/MWe	Based on the manufacturer proposal
	Capex - Biogas plant	4,409	kBRL	Cash flow
	Capex - Energy generation plant	14,350	kBRL	Cash flow
	Capex Total	18,759	kBRL	Cash flow
	Load factor	94.00%	%	Technical specification from the group generator provider
	O&M electricity costs	58.48	BRL/MWh	Calculated in the cash flow spreadsheet based on group generator proposal
	O&M biogas plant - Staff (6 people)	203,040.00	BRL/year	Calculated in the cash flow spreadsheet based on biogas plant provider proposal
	O&M biogas plant - Maintenance service	8%	%	Calculated in the cash flow spreadsheet based on biogas plant provider proposal
	O&M biogas plant - Administration Cost	50,000.00	BRL/year	Calculated in the cash flow spreadsheet based on biogas plant provider proposal
	Electricity price	103.06	BRL/MWh	The highest value from the last auctions held in Brazil 3 years prior to the starting date of the project activity. (Source: Electric Power Commercialization Chamber - CCEE)
	Tax - IRPJ 15% (income tax on total EBT	15%	%	Available on http://www.receita.fazenda.gov.br/legislacao/leis/ant2001/lei924995.htm, accessed on 10/07/2012
	Tax - IRPJ 10% (income tax on total EBT minus kBRL 240)	10%	%	
	Tax - CSLL (social contribution)	9%	%	Social contribution (http://www.planalto.gov.br/ccivil_03/LEIS/L7689.htm), accessed on 04/07/2012
	Tax (PIS)	1.65%	%	Contribution to the Social Integration Program and Civil Service Asset Formation Program – PIS/PASEP (http://www.receita.fazenda.gov.br/principal/Ingles/SistemaTributarioBR/Taxes.htm), accessed on 04/07/2012
	Tax (Cofins)	7.60%	%	COFINS - Contribution to Social Security Financing (http://www.receita.fazenda.gov.br/principal/Ingles/SistemaTributarioBR/Taxes.htm), accessed on 04/07/2012
	Depreciation	5	years	Secretary of the Federal Revenue of Brazil. Available on http://www.receita.fazenda.gov.br/legislacao/ins/ant2001/1998/in16298ane1.htm, accessed on 04/07/2012. Itens: 8502 and 8416. As the group generators will work in 3 shift of operation, a coefiecient of 2 was considered for accelerated depreciation, according to Federal Revenue of Brazil (RIR/99, art. 313). Available on http://www.receita.fazenda.gov.br/pessoajuridica/dipj/2002/pergresp2002/pr371a375.htm, accessed on 04/07/2012.
	Commercial Lending rate	10.97%	%	Available on http://www.bndes.gov.br/SiteBNDES/bndes/bndes_pt/Institucional/Apoio_Financeiro/Produtos/FINEM/energias_alternativas.html, accessed on 04/07/2012
	Debt term	16	years	Available on http://www.bndes.gov.br/SiteBNDES/bndes/bndes_pt/Institucional/Apoio_Financeiro/Produtos/FINEM/energias_alternativas.html, accessed on 04/07/2012
	Salvage value	0	kBRL	Calculated in the cash flow spreadsheet
	Imported electricity	648	MWh	CERs spreadsheet (imported electricity in 2014 and 2015)

Note: All numbers are in Brazilian Real (BRL).

Scenario 1

The scenario 1 is the project activity (capture and flare of LFG and power generation) undertaken without being registered as a CDM project activity, the estimated project cash flow has been made available to DOE in the validation visit.

According to the cash flow, the NPV of scenario 1 is R$ -12,866,444.34. Consequently, this scenario is not deemed attractive by the project participants.

Scenario 4

The scenario 4 is the continuation of the current practice, which is in compliance with all applicable regulations and policies.

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[10] Source of salvage value calculation in the cash flow:

Regarding the salvage value, it was considered in accordance with Aswath Damodaran (Applied Corporate Finance: A User's Manual, Aswath Damodaran, Wiley Frontiers in Finance, page 56- 57.).

"We can assume that the project will end at the end of the analysis period and that the assets will be sold for salvage. While we can try to estimate salvage value directly, a common assumption that is made is that salvage value is equal to the book value of the assets. For fixed assets, this will be the undepreciated portion of the initial investment whereas for working capital, it will be the aggregate value of the investments made in working capital over the course of the project life."

According to "Combined tool to identify the baseline scenario and demonstrate additionality", if the alternative scenario does not involve any investment costs, operational costs or revenues for the Project Participant, the NPV will be equal to zero.

Therefore, NPV = 0.

A short list showing the scenarios of the project activity is presented below according to the NPV (financial indicator).

Table 4 - Financial indicator comparison

Scenario	NPV @ 11.75% (R$)
Scenario 1	-12,866,444.34
Scenario 4	0

Sensitivity analysis

The sensitivity analysis was performed varying the electricity tariff (revenues), the capital expenses (CapEx) and operational and maintenance costs (O&M) for the alternatives. All parameters ranging from -10% to +10%, as the result presented below:

Table 5 - Sensitivity analysis

	Variation	NPV (R$)	
		Scenario 1	Scenario 4
CapEx	-10%	-11,522,595.52	0
	10%	-14,211,933.48	0
Revenues	-10%	-14,298,153.79	0
	10%	-11,459,203.25	0
O&M	-10%	-11,520,668.30	0
	10%	-14,226,494.92	0

As presented above, the project Net Present Values are always below zero in all sensitivity analyses.

The figures below show the sensitivity analysis for scenarios 1 and 4, respectively.

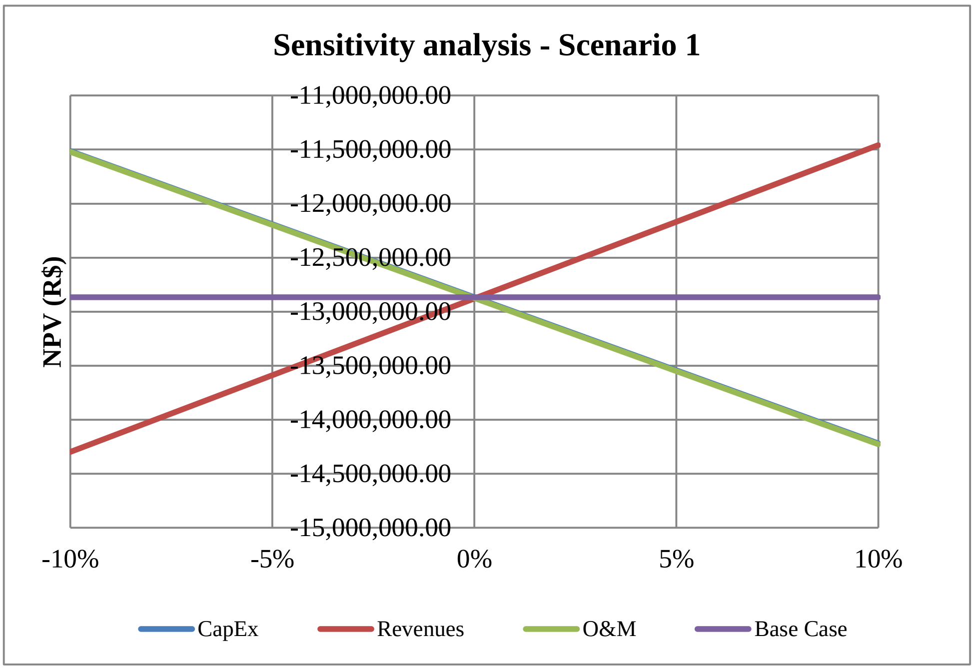

Figure 11 - Sensitivity analysis – Scenario 1 (in Brazilian Reais - R$)

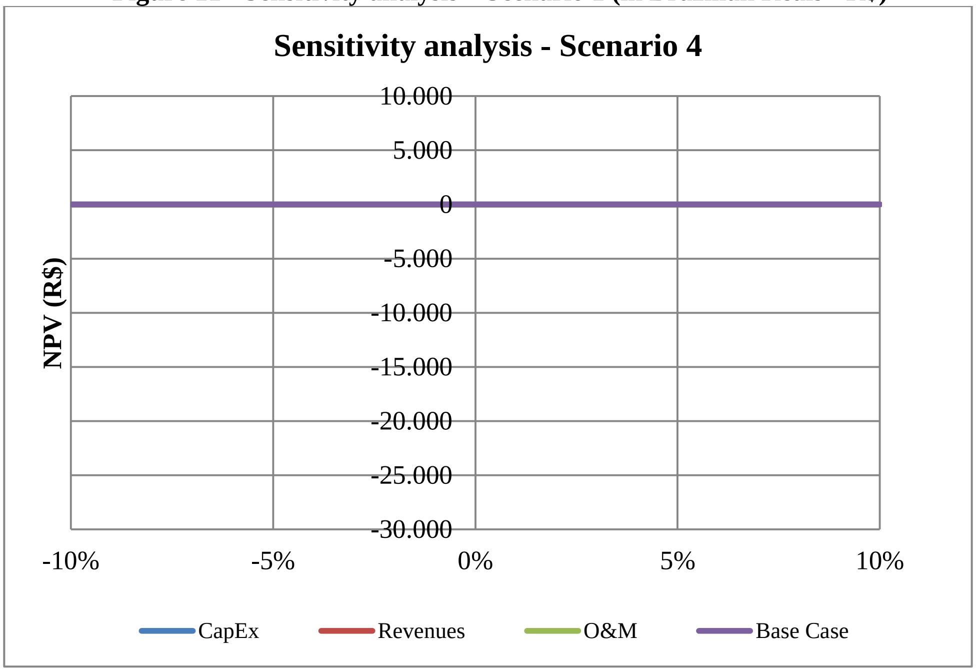

Figure 12 - Sensitivity analysis – Scenario 4 (in Brazilian Reais - R$)

<u>Breakeven point</u>

To ensure the additionality of this project activity, the project proponents varied the three identified parameters (CapEx, Revenues and O&M) until each of them reached the benchmark (i.e. NPV=0). The results are presented below for each scenario (1 and 4) and the spreadsheet will be provided to the audit team:

- **<u>Scenario 1 (LFG1 + E1)</u>**

Capital Expenditures (CapEx) – To reach the benchmark, the Capital Expenditures should be reduced in 102.8%. This result is extremely unlikely to happen in the future, as this reduction is too large for any kind of project which has a reliable investment estimate.

Revenues – This value should be increased in 101.2% to reach the benchmark. This means that the electricity tariff should reach R$ 207.37 or the maximum annual electricity generated reaches 66,274 MWh[11], deemed unrealistic as this value is far superior to the values from the latest electricity sale auctions in Brazil.

The table below shows the electricity price for the alternatives auctions held in Brazil 3 years prior to the starting date of the project activity. The maximum electricity price in auctions was 103.06 R$/MWh. In addition, in Brazil the energy auctions are reverse auctions, therefore power is acquired at the lowest prices.

[11] Note: It is important to notice that for the revenues to reach 101.2% the LFG production should increase 134.9% since the collection efficiency of the biogas plant is 75%. This scenario is unreal.

Table 6 - Results of the alternatives sources auctions held in Brazil

Date	Name of the Auction	Electricity price (R$/MWh)
17/08/2011	12th New Energy Auction	102.41
20/12/2011	13th New Energy Auction	103.06[12]

Source: Electric Power Commercialization Chamber – CCEE (http://www.ccee.org.br), accessed on 02/04/2012.

O&M – Also, to reach the benchmark, the O&M shall be reduced in -105.9%. This means that PPs should reduce all O&M costs, practically. Consequently, this scenario is unreal. Thus, the PPs deemed this situation to be unlikely to happen in the future.

- **Scenario 4 (LFG2 + E3)**

As in this alternative there are no revenues or expenditures, the NPV is zero. Thus, it is not possible to carry out the breakeven point.

Outcome of Step 3

A short list raking the alternatives of the project activity is presented below according to the best NPV (financial indicator), taking into account the results of the sensitivity analysis.

Table 7 – Rank of the alternatives scenarios

Scenarios	NPV @ 11.75% (R$)	Rank
Scenario 1	-12,866,444.34	Worst scenario
Scenario 4	0	Best scenario

As a result the sensitivity analysis was conclusive and the most financially attractive alternative scenario is considered to be the scenario 4.

Therefore, it seems reasonable to conclude that the project activity (Scenario 1) is unlikely to be the most financially attractive scenario.

Step 4. Common practice analysis

According to “Combined tool to identify the baseline scenario and demonstrate additionality”, the common practice analysis establishes the following items below:

- **Applicable geographical area:** Brazil is the largest country in South America and the world's fifth largest country in the world. Therefore, the entire host country (Brazil) is considered suitable for this analysis;
- **Measure:** The project activity covers methane destruction;
- **Output:** the service delivered by the project is electricity (MWh);
- **Technology:** the technology used in the project is electricity generation through biogas combustion in group generators.

[12] This value was considered in the financial analysis for the electricity tariff.

As the project activity applies measure that are listed in the definitions section of the "Combined tool to identify the baseline scenario and demonstrate additionality", the Step 4 a was applied.

Step 4a: The proposed CDM project activity(s) applies measure(s) that are listed in the definitions section above

The common practice analysis consists of the following steps:

Sub-step 4a (1): *Calculate applicable output range as +/-50% of the design output or capacity of the proposed project activity.*

The installed capacity of the project is 6.0 MW. Then, the output range of the project activity is from 3.0 to 9.0 MW.

Sub-step 4a (2): *In the applicable geographical area, identify all plants that deliver the same output or capacity within the applicable output range, calculated in Step 1, as the proposed project activity and have started commercial operation before the start date of the project. Note their number N_{all}. Registered CDM project activities and projects activities undergoing validation shall not be included in this step.*

All the plants in Brazil within the calculated output range (from 3.0 MW to 9.0 MW)[13] and within the same measure (methane destruction) are registered CDM project activities or projects activities undergoing validation[14][15]. Therefore, $N_{all} = 0$.

Sub-step 4a (3): Within plants identified in Step 2, identify those that apply technologies different that the technology applied in the proposed project activity. Note their number N_{diff}.

The technology of the project activity is electricity generation through biogas. All projects in Brazil which generates electricity through biogas are registered CDM project activities or projects activities undergoing validation. Therefore, there is no project with the same technologies as the project activity.

As N_{all} is zero, N_{diff} is also zero.

Sub-step 4a (4): Calculate factor $F=1 - N_{diff}/N_{all}$ representing the share of plants using technology similar to the technology used in the proposed project activity in all plants that deliver the same output or capacity as the proposed project activity.

$$F = 1 - \left(\frac{N_{diff}}{N_{all}}\right)$$

As the N_{all} is zero, the calculation of the F cannot be determined mathematically and the next steps are not applicable.

<u>**Outcome of common practice analysis.**</u>

The project activity is not a common practice because any of the plants identified has been implemented without CERs benefits.

[13] http://www.aneel.gov.br/aplicacoes/capacidadebrasil/capacidadebrasil.asp,a accessed on 10/07/2012.
[14] Source: MAGALHÃES, G.HC.; ALVES, J.W.S.; SANTO FILHO. F.; COSTA, R.M.; KELSON. M. Reducing the uncertainty of methane recovered (R) in greenhouse gas inventories from waste sector and of adjustment factor (AF) in landfill gas projects under the clean development mechanism (2010). Page 174. (http://ghg.org.ua/fileadmin/user_upload/book/Proceedengs_UncWork.pdf), accessed on 25/06/2012.
[15] The UNFCCC website project database has been last accessed on 26/07/2012, in order to cross-check the information. Source: https://cdm.unfccc.int/Projects/projsearch.html.

B.6. Emission reductions
B.6.1. Explanation of methodological choices
>>
Baseline emission calculation

The baseline emission was calculated according to the following formula:

$$BE_y = BE_{CH4,y} + BE_{EC,y} + BE_{HG,y} + BE_{NG,y}$$

Where:

BE_y	=	Baseline emissions in year *y* (t CO_2e/yr)
$BE_{CH4,y}$	=	Baseline emissions of methane from the SWDS in year *y* (t CO_2e/yr)
$BE_{EC,y}$	=	Baseline emissions associated with electricity generation in year *y* (t CO_2/yr)
$BE_{HG,y}$	=	Baseline emissions associated with heat generation in year *y* (t CO_2/yr)
$BE_{NG,y}$	=	Baseline emissions associated with natural gas use in year *y* (t CO_2/yr)

As the project only aims flare LFG and generate electricity, the $BE_{HG,y} = 0$ *and* $BE_{NG,y} = 0$.

Therefore, $BE_y = BE_{CH4,y} + BE_{EC,y}$

Step (A): Baseline emissions of methane from the SWDS ($BE_{CH4,y}$)

$$BE_{CH4,y} = (1-OX_{top\_layer}) \times (F_{CH4,PJ,y} - F_{CH4,BL,y}) \times GWP_{CH4}$$

Where:

$BE_{CH4,y}$	=	Baseline emissions of LFG from the SWDS in year *y* (t CO_2e/yr)
OX_{top_layer}	=	Fraction of methane in the LFG that would be oxidized in the top layer of the SWDS in the baseline (dimensionless)
$F_{CH4,PJ,y}$	=	Amount of methane in the LFG which is flared and/or used in the project activity in year *y* (t CH_4/yr)
$F_{CH4,BL,y}$	=	Amount of methane in the LFG that would be flared in the baseline in year *y* (t CH_4/yr)
GWP_{CH4}	=	Global warming potential of CH_4 (t CO_2e/t CH_4)

Step A.1: *Ex-post* determination of $F_{CH4,PJ,y}$

During the operation period, the $\mathbf{F_{CH4,PJ,y}}$ will be determined as follows:

$$F_{CH4,PJ,y} = F_{CH4,flared,y} + F_{CH4,EL,y} + F_{CH4,HG,y} + F_{CH4,NG,y}$$

Where:

$F_{CH4,PJ,y}$	=	Amount of methane in the LFG which is flared and/or used in the project activity in year y (tCH_4/yr)
$F_{CH4,flared,y}$	=	Amount of methane in the LFG which is destroyed by flaring in year y (t CH_4/yr)
$F_{CH4,EL,y}$	=	Amount of methane in the LFG which is used for electricity generation in year y (t CH_4/yr)
$F_{CH4,HG,y}$		Amount of methane in the LFG which is used for heat generation in year y (t CH_4/yr)
$F_{CH4,NG,y}$	=	Amount of methane in the LFG which is sent to the natural gas distribution network in year y (t CH_4/yr)

As the project only aims flare LFG and generate electricity, the $F_{CH4,HG,y}$ = *0 and* $F_{CH4,NG,y}$ = *0.*Thus, the equation is:

$$F_{CH4,PJ,y} = F_{CH4,flared,y} + F_{CH4,EL,y}$$

$F_{CH4,EL,y}$ is determined using the "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" and monitoring the working hours of the power plant, so that no emission reduction are claimed, for methane destruction during non-working hours. This is taken into account by monitoring the hours that the equipment utilizing the LFG is operating in year y ($Op_{j,h,y}$). The following requirements apply:

- The gaseous stream the tool shall be applied to is the LFG delivery pipeline to each item of electricity generation.
- $F_{CH4,EL,y}$ is then calculated as the sum of mass flows to each item of electricity generation;
- CH_4 is the greenhouse gases for which the mass flow should be determined;
- The simplification offered for calculating the molecular mass of the gaseous stream is valid
- (equations 3 or 17 in the tool); and
- The mass flow should be calculated on an hourly basis for each hour h in year *y*;
- The mass flow calculated for hour h is 0 if the equipment is not working in hour *h* ($O_{pj,h}$=not working), the hourly values are then summed to a yearly unit basis.

The amount of methane destroyed by flaring ($F_{CH4,flared,y}$) will be determined as follows:

$$F_{CH4,flared,y} = F_{CH4,sent\_flare,y} - (PE_{flare,y}/GWP_{CH4})$$

Where:

$F_{CH4,flared,y}$	=	Amount of methane in the LFG which is destroyed by flaring in year y (t CH_4/yr)
$F_{CH4,sent\_flare,y}$	=	Amount of methane in the LFG which is sent to the flare in year y (t CH_4/yr)
$PE_{flare,y}$	=	Project emissions from flaring of the residual gas stream in year y (t CO_2e/yr)
GWP_{CH4}	=	Global warming potential of CH_4 (t CO_2e/t CH_4)

$F_{CH4,sent\_flare,y}$ will be determined directly using the "Tool to determine the mass flow of a greenhouse gas in a gaseous stream", applying the requirements described above where the gaseous stream the tool shall be applied to is the LFG delivery pipeline to the flare(s).

According to "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" the following options will be considered for the present project activity:

- Option A (Volume flow in dry basis and volumetric fraction in dry basis) when the temperature of the gaseous stream is less than 60^{o}C (333.15 K) at the flow measurement point

  And

- Option B (Volume flow in wet basis and volumetric fraction in dry basis) when the temperature of the gaseous stream is higher than 60^{o}C (333.15 K) at the flow measurement point.

Option A

Flow measurement on a dry basis is not doable for a wet gaseous stream. Therefore, it is necessary to demonstrate that the gaseous stream is dry to use this option. The demonstration will be made as following:

- Demonstrate that the temperature of the gaseous stream (T_t) is less than 60ºC (333.15 K) at the flow measurement point.

The mass flow of greenhouse gas i ($F_{i,t}$) is determined as follows:

$$F_{i,t} = V_{t,db} * v_{i,t,db} * \rho_{i,t}$$

With

$$\rho_{i,t} = \frac{P_t * MM_i}{R_u * T_t}$$

Where:

$F_{i,t}$ = Mass flow of greenhouse gas *i* in the gaseous stream in time interval *t* (kg gas/h)
$V_{t,db}$ = Volumetric flow of the gaseous stream in time interval *t* on a dry basis (m³ dry gas/h)
$v_{i,t,db}$ = Volumetric fraction of greenhouse gas *i* in the gaseous stream in a time interval *t* on a dry basis (m³ gas *i*/m³ dry gas)
$\rho_{i,t}$ = Density of greenhouse gas *i* in the gaseous stream in time interval *t* (kg gas *i*/m³ gas *i*)
P_t = Absolute pressure of the gaseous stream in time interval *t* (Pa)
MM_i = Molecular mass of greenhouse gas *i* (kg/kmol)
R_u = Universal ideal gases constant (8,314 Pa.m^3/kmol.K)
T_t = Temperature of the gaseous stream in time interval *t* (K)

If it cannot be demonstrated that the gaseous stream is dry, then the flow measurement should be assumed to be on a wet basis and the option B should be applied instead.

Option B

The mass flow of greenhouse gas *i* ($F_{i,t}$) is determined using equations used to Option A. The volumetric flow of the gaseous stream in time interval *t* on a dry basis ($V_{t,db}$) is determined by converting the measured volumetric flow from wet basis to dry basis as follows:

$$V_{t,db} = V_{t,wb}/(1 + v_{H2O,t,db})$$

Where:

$V_{t,db}$ = Volumetric flow of the gaseous stream in time interval *t* on a dry basis (m³ dry gas/h)
$V_{t,wb}$ = Volumetric flow of the gaseous stream in time interval *t* on a wet basis (m³ wet gas/h)
$v_{H2O,t,db}$ = Volumetric fraction of H_2O in the gaseous stream in time interval *t* on a dry basis (m³ H_2O/m³ dry gas)

The volumetric fraction of H_2O in time interval *t* on a dry basis ($v_{H2O,t,db}$) is estimated according to following equation.

$$v_{H2O,t,db} = \frac{m_{H2O,t,db} * MM_{t,db}}{MM_{H2O}}$$

Where:

$v_{H2O,t,db}$ = Volumetric fraction of H_2O in the gaseous stream in time interval *t* on a dry basis (m³ H_2O/m³ dry gas)
$m_{H2O,t,db}$ = Absolute humidity in the gaseous stream in time interval *t* on a dry basis (kg H_2O/kg dry gas)
$MM_{t,db}$ = Molecular mass of the gaseous stream in time interval *t* on a dry basis (kg dry gas/kmol dry gas)
MM_{H2O} = Molecular mass of H_2O (kg H_2O/kmol H_2O)

The absolute humidity of the gaseous stream (mH_2O,t,db) will be determined using Option 2 (simplified calculation without measurement of the moisture content):

Option 2: Simplified calculation without measurement of the moisture content

This option provides a simple and conservative approach to determine the absolute humidity by assuming the gaseous stream is dry or saturated depending on which is the conservative situation[16].

Concerning the project activity, the conservative situation will be to assume that the gaseous stream is saturated, then $m_{H2O,t,db}$ is assumed to equal the saturation absolute humidity ($m_{H2O,t,db,sat}$) and calculated using the following equation.

$$m_{H20,t,db,Sat} = \frac{P_{H2O,t,Sat} * MM_{H2O}}{(P_t - P_{H2O,t,Sat}) * MM_{t,db}}$$

Where:

$m_{H2O,t,db,sat}$	= Saturation absolute humidity in time interval *t* on a dry basis (kg H_2O/kg dry gas)
$p_{H20,t,Sat}$	= Saturation pressure of H_2O at temperature Tt in time interval t (Pa)
T_t	= Temperature of the gaseous stream in time interval *t* (K)
P_t	= Absolute pressure of the gaseous stream in time interval *t* (Pa)
MM_{H2O}	= Molecular mass of H_2O (kg H_2O/kmol H_2O)
$MM_{t,db}$	= Molecular mass of the gaseous stream in a time interval *t* on a dry basis (kg dry gas/kmol dry gas)

Parameter $MM_{t,db}$ is estimated using the following equation.

$$MM_{t,db} = \sum_k v_{k,t,db} * MM_k)$$

Where:

$MM_{t,db}$	= Molecular mass of the gaseous stream in time interval *t* on a dry basis (kg dry gas/kmol dry gas)
$v_{k,t,db}$	= Volumetric fraction of gas *k* in the gaseous stream in time interval *t* on a dry basis (m³ gas k/m³ dry gas)
MM_k	= Molecular mass of gas *k* (kg/kmol)
k	= All gases, except H_2O, contained in the gaseous stream (e.g. N_2 and CH_4). See available simplification below

The determination of the molecular mass of the gaseous stream ($MM_{t,db}$) requires measuring the volumetric fraction of all gases (*k*) in the gaseous stream. However as a simplification, the volumetric fraction of only the gases k that are greenhouse gases and are considered in the emission reduction calculation in the underlying methodology must be monitored and the difference to 100% may be considered as pure nitrogen. The simplification is not acceptable if it is differently specified in the underlying methodology.

[16] An assumption that the gaseous stream is saturated is conservative for the situation that the mass flow of greenhouse gas *i* is underestimated (applicable for calculating baseline emissions). Conversely, an assumption that the gas stream is dry is conservative for the situation that the greenhouse gas *i* is overestimated (applicable for calculating project emissions).

$PE_{flare,y}$ shall be determined using the "Tool to determine project emissions from flaring gases" containing methane. If LFG is flared through more than one flare, then $PE_{flare,y}$ is the sum of the emissions for each flare determined separately.

Enclosed flare(s) will be installed in the project activity to increase the destruction efficiency. Those flares reach 99% (minimum)[17] of methane destruction efficiency.

To determine the project emissions from flaring gases were used the "Tool to determine project emissions from flaring gases containing methane". According to this tool, the project emissions should be calculated in 7 steps.

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

The density of the residual gas is determined based on the volumetric fraction of all components in the gas:

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

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

And

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

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

And,

$$MM_{RG,h} = \sum_i (fv_{i,h} \cdot MM_i)$$

$fv_{i,h}$ = Volumetric fraction of component *i* in the residual gas in the hour *h*;
MM_i = Molecular mass of residual gas component *i* (kg/kmol/);
i = Gas components;

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

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

[17] The document about the specification of the flare efficiencies will provide to DOE (*flare efficiency.pdf*).

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

$fm_{j,h}$ = Mass fraction of element *j* in the residual gas in hour *h*;
AM_j = Atomic mass of element *j* (kg/kmol);
$NA_{j,i}$ = Number of atoms of element *j* in component *i*;
$MM_{RG,h}$ = Molecular mass of the residual gas in hour *h (kg/kmol)*;
j = The elements carbon, hydrogen, oxygen and nitrogen;
i = The components CH_4 and N_2 (according to the simplification used);

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

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

Where:

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

$$V_{n,FG,h} = V_{n,CO2,h} + V_{n,O2,h} + V_{n,N2,h}$$

Where:

$V_{n,N2,h}$ = 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* (m^3/ kg residual gas);
$V_{n,O2,h}$ = 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* (m^3/ kg residual gas);
$V_{n,CO2,h}$ = 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* (m^3/ kg residual gas);

$$V_{n,O2,h} = n_{O2,h} \times MV_n$$

$n_{O2,h}$ = Quantity of moles O_2 in the exhaust gas of the flare per kg residual gas flared in hour *h* ($kmol/kg_{residual\_gas}$);
MV_n = Volume of one mole of any ideal gas at normal temperature and pressure (22.4 L/mol) (in m^3/kmol);

$$V_{n,CO2,h} = \frac{fm_{C,h}}{AM_C} \times MV_n$$

$fm_{C,h}$ = Mass fraction of carbon in the residual gas in the hour h;
AM_C = Atomic mass of carbon (kg/kmol);
MV_n = Volume of one mole of any ideal gas at normal temperature and pressure (22.4 L/mol) (in m^3/kmol);

And

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

Where:

$fm_{N,h}$ = Mass fraction of nitrogen in the residual gas in the hour h
AM_n = Atomic mass of nitrogen (kg/kmol);
MF_{O2} = O_2 volumetric fraction of air (0.21);
F_h = Stochiometric quantity of moles of O_2 required for a complete oxidation of one kg residual gas flared in hour h (kmol/kg residual gas);
$n_{O2,h}$ = Quantity of moles O_2 in the exhaust gas of the flare per kg residual gas flared in hour h (kmol/kg residual gas);

$$n_{O_2,h} = \frac{t_{O_2,h}}{(1-(\frac{t_{O_2,h}}{MF_{O_2}}))} \times \left[\frac{fm_{C,h}}{AM_C} + \frac{fm_{N,h}}{2AM_N} + \left(\frac{1-MF_{O2}}{MF_{O2}} \right) \times F_h \right]$$

$t_{O2,h}$ = Volumetric fraction of O_2 in the exhaust gas in the hour *h*;
MF_{O2} = O_2 volumetric fraction of air (0.21);
F_h = Stochiometric quantity of moles of O_2 required for a complete oxidation of one kg residual gas in hour *h* (kmol/kg residual gas);
AM_j = Atomic mass of element *j* (kg/kmol);
j = The elements carbon, hydrogen, oxygen and nitrogen;

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

Where:

$fm_{j,h}$ = Mass fraction of element *j* in the residual gas in hour *h;*

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

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:

$$TM_{FG,h} = \frac{TV_{n,FG,h} \cdot fv_{CH4,FG,h}}{1000000}$$

Where:

$TV_{n,FG,h}$ = Volumetric flow rate of the exhaust gas in dry basis at normal conditions in hour *h* (m^3/h exhaust gas);
$fv_{CH4,FG,h}$ = Concentration of methane in the exhaust gas of the flare in dry basis at normal conditions in hour *h* (mg/m^3).

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 ($FV_{RG,h}$), the volumetric fraction of methane in the residual gas ($fv_{CH4,RG,h}$) and the density of methane ($\rho_{CH4,n,h}$) in the same reference conditions (normal conditions and dry or wet basis).

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

$FV_{RG,h}$ = Volume flow rate of the residual gas in dry basis at normal conditions in hour h (m^3/h);
$fv_{CH4,RG,h}$ = Volumetric fraction of methane in the residual gas on dry basis in hour h (NB: this corresponds to fvi,RG,h where i refers to methane).
$\rho_{CH4,n}$ = Density of methane at normal conditions (0.716 kg/m^3);

STEP 6. Determination of the hourly flare efficiency

The determination of the hourly flare efficiency depends on the operation of flare (through temperature), the type of flare used (enclosed) and the approach selected (continuous).

For the project activity, the case of enclosed flares and continuous monitoring of the flare efficiency, the flare efficiency in the hour h is:

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

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

Where:

$TM_{FG,h}$ = Methane mass flow rate in exhaust gas averaged in a hourly period of time *t* (kg/h);
$TM_{RG,h}$ = Mass flow rate of methane in the residual gas in the hour *h* (kg/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 ($TM_{RG,h}$) and the flare efficiency during each hour *h* ($\eta_{flare,h}$), as follows:

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

$TM_{RG,h}$ = Mass flow rate of methane in the residual gas in the hour *h* (kg/h);
$\eta_{flare,h}$ = Flare efficiency in hour *h*;

The table below presents the parameters used in the "Tool to determine project emissions from flaring gases containing methane"

Table 8 – Parameters used in the Tool to determine project emissions from flaring gases containing methane

Parameter	Description	Value	Unit
P_n	Atmospheric pressure at normal conditions	101,325	Pa
R_u	Universal ideal gas constant	8,314	Pa.m^3/kmol.K
T_n	Temperature at normal conditions	273.15	K
MF_{O2}	O_2 volumetric fraction of air	0.21	-
$\rho_{CH4,n}$	Density of methane at normal conditions	0.716	kg/m^3
AM_c	Atomic mass of carbon	12.00	kg/kmol

AM_h	Atomic mass of hydrogen	1.01	kg/kmol
AM_o	Atomic mass of oxygen	16.00	kg/kmol
AM_n	Atomic mass of nitrogen	14.01	kg/kmol
MV_n	Volume of one mole of any ideal gas at normal	22.414	m^3/Kmol

Step A.1.1: *Ex-ante* estimation of $F_{CH4,PJ,y}$

An *ex ante* estimate of $F_{CH4,PJ,y}$ is required to estimate baseline emission of methane from the SWDS in order to estimate the emission reductions of the proposed project activity in the CDM-PDD. It is determined as follows:

$$F_{CH4,PJ,y} = \eta_{PJ} \times \frac{BE_{CH4,SWDS,y}}{GWP_{CH4}}$$

Where:

$F_{CH4,PJ,y}$ = Amount of methane in the LFG which is flared and/or used in the project activity in year *y* (tCH_4/yr)

$BE_{CH4,SWDS,y}$ = Amount of methane in the LFG that is generated from the SWDS in the baseline scenario in year *y* (tCO_2e/yr)

η_{PJ} = Efficiency of the LFG capture system that will be installed in the project activity

GWP_{CH4} = Global warming potential of CH_4 (tCO_2e/tCH_4)

$BE_{CH4,SWDS,y}$ is determined using the methodological tool "Emissions from solid waste disposal sites". The calculation of $BE_{CH4,SWDS,y}$ according the tool is:

$$BE_{CH4,SWDS,y} = \varphi_y \times (1 - f_y) \times GWP_{CH4} \times (1 - OX) \times \frac{16}{12} \times F \times DOC_{f,y} \times MCF_y \times \sum_{x=1}^{y} \sum_{j} W_{j,x} \times DOC_j \times e^{-k_j(y-x)} \times (1 - e^{-k_j})$$

Where:

$BE_{CH4,SWDS,y}$ = Baseline, project or leakage methane emissions occurring in year y generated from waste disposal at a SWDS during a time period ending in year y (t CO_2e / yr)

X = Years in the time period in which waste is disposed at the SWDS, extending from the first year in the time period (x = 1) to year y (x = y).

Y = Year of the crediting period for which methane emissions are calculated (y is a consecutive period of 12 months)

$DOC_{f,y}$ = Fraction of degradable organic carbon (DOC) that decomposes under the specific conditions occurring in the SWDS for year y (weight fraction)

$W_{j,x}$ = Amount of solid waste type j disposed or prevented from disposal in the SWDS in the year x (t)

φ_y = Model correction factor to account for model uncertainties for year y

f_y = Fraction of methane captured at the SWDS and flared, combusted or used in another manner that prevents the emissions of methane to the atmosphere in year y

GWP_{CH4} = Global Warming Potential of methane

OX = Oxidation factor (reflecting the amount of methane from SWDS that is oxidised in the soil or other material covering the waste)

F = Fraction of methane in the SWDS gas (volume fraction)

MCF_y Methane correction factor for year *y*

DOC_j = Fraction of degradable organic carbon in the waste type *j* (weight fraction)

k_j = Decay rate for the waste type *j* (1 / yr)

J = Type of residual waste or types of waste in the MSW

Step A.2: Determination of $F_{CH4,BL,y}$

In the baseline there are no regulatory or contractual requirements, or to address safety and odour concerns to capture and destroy LFG. Thus, the case of the project activity for determining methane captured and destroyed in the baseline is **Case 3** because there is existing LFG capture system (passive system), however there is no requirement to destroy methane. In this case:

$$F_{CH4,BL,sys,y} = F_{CH4,sent\_flare,y}$$

Where:

$F_{CH4,BL,sys,y}$	=	Amount of methane in the LFG that would be flared in the baseline in year y for the case of an existing LFG capture system (t CH_4/yr)
$F_{CH4,sent\_flare,y}$	=	Amount of methane in the LFG which is sent to the flare in year y (t CH_4/yr)

The amount of methane captured with the existing system will be monitored along with the amount captured under the project activity and there is no historic data on the amount of methane that was captured in the year prior to the implementation of the project activity. Thus, the situation to determine $F_{CH4,BL,y}$ is:

If there is no monitored or historic data on the amount of methane that was captured in the year prior to the implementation of the project situation, then:

$F_{CH4,BL,sys,y} = 20\% \times F_{CH4,PJ,y}$; or

$F_{CH4,BL,y} = 20\% \times F_{CH4,PJ,y}$

Step (B): Baseline emissions associated with electricity generation ($BE_{EC,y}$)

It was used the “Tool to calculate baseline, project and/or leakage emissions from electricity consumption” to calculate the baseline emissions associated with electricity generation.

$$BE_{EC,y} = EC_{BL,k,y} \times EF_{EL,k,y} \times (1 + TDL_{k,y})$$

Where:

$BE_{EC,y}$	Baseline emissions associated with electricity generation in year y (tCO_2/yr)
$EC_{BL,k,y} = EG_{PJ,y}$	Amount of electricity generated using LFG by the project activity in year (MWh);
$EF_{EL,k,y} = EF_{grid,CM}$	Emission factor for electricity generation for source k in year y (tCO2/MWh)
$TDL_{k,y}$	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 (dimensionless).
k	Sources of electricity consumption in the baseline

Emission Factor calculation

The emission reductions derived from the displacement of fossil fuels used for electricity generation from other sources are estimated for the Brazilian Interconnected System and guided by “Tool to calculate baseline, project and/or leakage emissions from electricity consumption. The combined margin emission factor” was calculated by the “Tool to calculate the emission factor for an electricity system” – version 02.2.1, as follows:

Step 1. Identify the relevant electric power system

For the purpose of determining the electricity emission factors, a project electricity system is defined by the spatial extent of the power plants that are physically connected through transmission and distribution lines to the project activity (e.g. the renewable power plant location or the consumers where electricity is being saved) and that can be dispatched without signification transmission constraints.

The Brazilian DNA published an official delineation of the project electricity system in Brazil, considering a national interconnected system.[18]

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

Option I: Only grid power plants are included in the calculation.
The Brazilian DNA is responsible for calculating the emission factors and it is not included in calculation the off-grid power plants.

Step 3. Select a method to determined the operating margin (OM)

The calculation of the operating margin emission factor ($EF_{grid,OM,y}$) is based on one of the following methods:

a) Simple OM, or
b) Simple adjusted OM, or
c) Dispatch data analysis OM, or
d) Average OM.

The Brazilian DNA is responsible for calculating the OM emission factor in Brazil. It uses the method c) Dispatch data analysis OM.

For the dispatch data analysis OM, it is necessary to use the year in which the project activity displaces grid electricity and to update the emission factor annually during monitoring.

Step 4. Calculate the operating margin emission factor according to the selected method

The dispatch data analysis OM emission factor ($EF_{grid,OM-DD,y}$) is determined based on the power units that are actually dispatched at the margin during each hour h where the project is displacing electricity. This approach is not applicable to historical data and, thus, requires annual monitoring of $EF_{grid,OM-DD,y}$.

The emission factor is calculated as follows:

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

Where:

$EF_{grid,OM-DD,y}$	=	Dispatch data analysis operating margin CO_2 emission factor in year *y* (tCO_2/MWh)
$EG_{PJ,h}$	=	Electricity displaced by the project activity in hour *h* m of year *y* (MWh)
$EF_{EL,DD,h}$	=	CO_2 emission factor for power units in the top of the dispatch order in hour *h* in year *y* (tCO_2/MWh)
$EG_{PJ,y}$	=	Total electricity displaced by the project activity in year *y* (MWh)

[18] DNA Resolution n.8 was published on 26/05/2008 on http://www.mct.gov.br/index.php/content/view/14797.html, accessed on 04/07/2012.

h = hours in year y in which the project activity is displacing grid electricity
y = Year in **w**hich the project activity is displacing grid electricity

The $EF_{EL,DD,m}$ is displayed on the Brazilian DNA website[19], for the year 2011.

In order to estimate the emission reductions for the first crediting period the $EF_{EL,DD,2011}$ was calculated as a mean average of the $EF_{EL,DD,m}$. Then,

$EF_{grid,OM-DD,2011} =$ 0.2920 tCO/MWh.

Step 5. Calculate the build margin (BM) emission factor

The Brazilian DNA is responsible for calculating the BM emission factor in Brazil.

In terms of vintage of data, project participants can choose between one of the following two options:

Option 1: For the first crediting period, calculate the build margin emission factor *ex-ante* based on the most recent information available on units already built for sample group m at the time of CDM-PDD submission to the DOE for validation. For the second crediting period, the build margin emission factor should be updated based on the most recent information available on units already built at the time of submission of the request for renewal of the crediting period to the DOE. For the third crediting period, the build margin emission factor calculated for the second crediting period should be used. This option does not require monitoring the emission factor during the crediting period.

Option 2: For the first crediting period, the build margin emission factor should be updated annually, ex-post, including those units built up to the year of registration of the project activity or, if information up to the year of registration is not yet available, including those units built up to the latest year for which information is available. For the second crediting period, the build margin factor shall be calculated ex-ante, as described in option 1 above. For the third crediting period, the build margin emission factor calculated for the second crediting period should be used.

The *Option 2* was chosen for the proposed project.

The build margin emissions factor is the generation-weighted average emission factor (tCO_2/MWh) of all power units m during the most recent year y for which power generation data is available, calculated as follows:

$$EF_{grid,BM,y} = \frac{\sum_m EG_{m,y} \times EF_{EL,m,y}}{\sum_m EG_{m,y}}$$

The $EF_{grid,BM,2011}$ is displayed on the Brazilian DNA website, for the year 2011

$EF_{grid,BM,2011} =$ 0.1056 tCO_2/MWh

Step 6. Calculate the combined margin emissions factor

The option a) weighted average CM was used to calculate the combined margin (CM).

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

[19] Source: http://www.mct.gov.br/index.php/content/view/333605.html#ancora , accessed on 10/07/2012.

The default weights are as follows: w_{OM} = 0.5 and w_{BM} = 0.5, fixed for the first crediting period. That gives:

$$EF_{2011} = 0.2920 \times 0.5 + 0.1056 \times 0.5 = 0.1988 \text{ tCO2/MWh}$$

The build margin CO_2 emission factor and operating margin CO_2 emission factor will be ex-post.

Therefore, the combined margin CO_2 emission factor will be ex-post.

Project emissions

$$PE_y = PE_{EC,y} + PE_{FC,y}$$

Where:

PE_y	=	Project emissions in year *y* (tCO_2/yr)
$PE_{EC,y}$	=	Emissions from consumption of electricity due to the project activity in year *y* (tCO_2/yr)
$PE_{FC,y}$	=	Emissions from consumption of fossil fuels due to the project activity, for purpose other than electricity generation, in year *y* (tCO_2/yr)

There is no consumption of fossil fuels due to the project activity for purpose other than electricity generation, in year *y* (tCO_2/yr), therefore $PE_{FC,y} = 0$

Thus,

$$PEy = PE_{EC,y}$$

Calculation of $PE_{EC,y}$ – project emission from consumption of electricity

According to *"Tool to calculate baseline, project and/or leakage emissions from electricity consumption"*, the project emission from consumption of electricity will be from two sources:

- $PE_{EC1,y}$ - Grid (Brazilian interconnected electric system);
- $PE_{EC2,y}$ - Diesel generator(s) (off-grid captive power plant)

Thus,

$$PE_{EC,y} = PE_{EC1,y} + PE_{EC2,y}$$

$PE_{EC1,y}$ - Project emission from the grid

As electricity will be consumed from the grid, the option A1 of the scenario A was chosen, as follows:

> *Option A1: Calculate the combined margin emission factor of the applicable electricity system, using the procedures in the latest approved version of the "Tool to calculate the emission factor for an electricity system" ($EF_{EL,j/k/l,y} = EF_{grid,CM,y}$).*

Thus, the project emission is calculated as following:

$$PE_{EC1,y} = EC_{PJ1,y} \times EF_{grid,CM,y} \times \left(1 + TDL_{j,y}\right)$$

Where:

$EC_{PJ1,y} = EG_{EC1,y}$	Quantity of electricity consumed from the grid by the project activity during the year *y* (MWh);
$EF_{grid,CM,y}$	The emission factor for the grid in year *y* (tCO_2/MWh);
$TDL_{j,y}$	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.

<u>$PE_{EC2,y}$ - Project emission from diesel generator(s)</u>

As electricity will be consumed from diesel generators (off-grid captive power plant), a conservative approach was adopted and the option B2 of the scenario B was chosen because: "The electricity consumption source is a project or leakage electricity consumption source". Therefore, the value used for emission factor ($EF_{EL,j,y}$) will be 1.3 tCO_2/MWh for project emission from diesel generator(s).

$$PE_{EC2,y} = EC_{PJ2,y} \times EF_{EL,j,y}$$

Where:

$EC_{PJ2,y} = EG_{EC2,y}$	= quantity of electricity consumed from diesel generator by the project activity during the year *y* (MWh);
$EF_{EL,j,y}$	= the emission factor for the diesel generator in year *y* (tCO_2/MWh);

<u>Calculation of $PE_{FC,y}$ – project emission from consumption of heat</u>

There is no consumption of fossil fuels due to the project activity, for purpose other than electricity generation. Therefore, $PE_{FC,y} = 0$.

Leakage:

In accordance with the ACM0001, no leakage effects need to be accounted.

Emission Reduction

Emission reductions are calculated as follows:

$$ER_y = BE_y – PE_y,$$

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_2e/yr);

B.6.2. Data and parameters fixed ex ante

Data / Parameter	OX_{top_layer}
Unit	Dimensionless
Description	Fraction of methane that would be oxidized in the top layer of the SWDS in the baseline
Source of data	Consistent with how oxidation is accounted for in the methodological tool "Emissions from solid waste disposal sites"
Value(s) applied	0.1
Choice of data or Measurement methods and procedures	Default value used, according to ACM0001
Purpose of data	Calculation of baseline emission
Additional comment	Applicable to Step A

Data / Parameter	GWP_{CH4}
Unit	t CO_2e/t CH_4
Description	Global warming potential of CH_4
Source of data	IPCC
Value(s) applied	21 for the first commitment period. Shall be updated according to any future COP/MOP decisions
Choice of data or Measurement methods and procedures	Default value used, according to ACM0001
Purpose of data	Calculation of baseline emission
Additional comment	-

Data / Parameter	NCV_{CH4}
Unit	TJ/t CH4
Description	Net calorific value of methane at reference conditions
Source of data	Technical literature
Value(s) applied	0.0504
Choice of data or Measurement methods and procedures	Default value used, according to ACM0001
Purpose of data	Calculation of baseline emission
Additional comment	-

Data / Parameter	η_{PJ}
Unit	Dimensionless
Description	Efficiency of the LFG capture system that will be installed in the project activity
Source of data	Biogas Plant Manufacturer[20]
Value(s) applied	75%
Choice of data or Measurement methods and procedures	Based on the active LFG capture system to be installed, according to technical specifications from the equipment provider.
Purpose of data	Calculation of baseline emission
Additional comment	-

Data / Parameter	$\varphi_{default}$
Unit	-
Description	Default value for the model correction factor to account for model uncertainties
Source of data	Tool "Emissions from solid waste disposal sites"
Value(s) applied	0.75
Choice of data or Measurement methods and procedures	According to "Emissions from solid waste disposal sites", the *Application A* was used because the project activity mitigates methane emissions from the landfill and the default value was applied for the wet climatic condition.
Purpose of data	Calculation of baseline emission
Additional comment	-

[20] The document "75% Landfill gas capture efficiency BTG.pdf" has been made available to the DOE.

Data / Parameter	OX
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	Based on an extensive review of published literature on this subject, including the IPCC 2006 Guidelines for National Greenhouse Gas Inventories
Value(s) applied	0.1
Choice of data or Measurement methods and procedures	Default value used according to “Emissions from solid waste disposal sites”
Purpose of data	Calculation of baseline emission
Additional comment	When methane passes through the top-layer, part of it is oxidized by methanotrophic bacteria to produce CO_2. The oxidation factor represents the proportion of methane that is oxidized to CO_2.This should be distinguished from the methane correction factor (MCF) which is to account for the situation that ambient air might intrude into the SWDS and prevent methane from being formed in the upper layer of SWDS.

Data / Parameter	F
Unit	-
Description	Fraction of methane in the SWDS gas (volume fraction)
Source of data	IPCC 2006 Guidelines for National Greenhouse Gas Inventories
Value(s) applied	0.5
Choice of data or Measurement methods and procedures	Default value used according to “Emissions from solid waste disposal sites”
Purpose of data	Calculation of baseline emission
Additional comment	Upon biodegradation, organic material is converted to a mixture of methane and carbon dioxide

Data / Parameter	$DOC_{f,default}$
Unit	Weight fraction
Description	Default value for the fraction of degradable organic carbon (DOC) in MSW that decomposes in the SWDS
Source of data	IPCC 2006 Guidelines for National Greenhouse Gas Inventories
Value(s) applied	0.5
Choice of data or Measurement methods and procedures	The default value was used for type Application A). according to "Emissions from solid waste disposal sites"
Purpose of data	Calculation of baseline emission
Additional comment	This factor reflects the fact that some degradable organic carbon does not degrade, or degrades very slowly, in the SWDS. This default value can be used for Application A.

Data / Parameter	$MCF_{default}$
Unit	-
Description	Methane correction factor
Source of data	IPCC 2006 Guidelines for National Greenhouse Gas Inventories
Value(s) applied	1.0
Choice of data or Measurement methods and procedures	The project activity is an anaerobic managed solid waste disposal sites with controlled placement of waste (i.e. waste directed to specific deposition areas, a degree of control of scavenging and a degree of control of fires) and is include: (i) cover material; (ii) mechanical compacting and (iii) levelling of the waste;
Purpose of data	Calculation of baseline emission
Additional comment	-

<table>
<tr><td>Data / Parameter</td><td>DOC_j</td></tr>
<tr><td>Unit</td><td>-</td></tr>
<tr><td>Description</td><td>Fraction of degradable organic carbon in the waste type j (weight fraction)</td></tr>
<tr><td>Source of data</td><td>IPCC 2006 Guidelines for National Greenhouse Gas Inventories (adapted from Volume 5, Tables 2.4 and 2.5)</td></tr>
<tr><td>Value(s) applied</td><td><table>
<tr><th>Waste type j</th><th>DOCj
(% wet waste)</th></tr>
<tr><td>Wood and wood products</td><td>43</td></tr>
<tr><td>Pulp, paper and cardboard (other than sludge)</td><td>40</td></tr>
<tr><td>Food, food waste, beverages and tobacco (other than sludge)</td><td>15</td></tr>
<tr><td>Textiles</td><td>24</td></tr>
<tr><td>Garden, yard and park waste</td><td>20</td></tr>
<tr><td>Glass, plastic, metal, other inert waste</td><td>0</td></tr>
</table></td></tr>
<tr><td>Choice of data
or
Measurement methods and procedures</td><td>IPCC default value for anaerobic managed solid waste disposal site is applied.</td></tr>
<tr><td>Purpose of data</td><td>Calculation of baseline emission</td></tr>
<tr><td>Additional comment</td><td>-</td></tr>
</table>

<table>
<tr><td>Data / Parameter</td><td>k_j</td></tr>
<tr><td>Unit</td><td>1/yr</td></tr>
<tr><td>Description</td><td>Decay rate for the waste type j</td></tr>
<tr><td>Source of data</td><td>IPCC 2006 Guidelines for National Greenhouse Gas Inventories (adapted from Volume 5, Table 3.3)</td></tr>
<tr><td>Value(s) applied</td><td>
<table>
<tr><th colspan="2" rowspan="2">Waste type j</th><th>Tropical (MAT > 20 °C)</th></tr>
<tr><th>Wet (MAP > 1,000mm)</th></tr>
<tr><td rowspan="2">Slowly degrading</td><td>Pulp, paper, cardboard (other than sludge), textiles</td><td>0.07</td></tr>
<tr><td>Wood, wood products and straw</td><td>0.035</td></tr>
<tr><td>Moderately degrading</td><td>Other (non-food) organic putrescible garden and park waste</td><td>0.17</td></tr>
<tr><td>Rapidly degrading</td><td>Food, food waste, sewage sludge, beverages and tobacco</td><td>0.40</td></tr>
</table>
</td></tr>
<tr><td>Choice of data or Measurement methods and procedures</td><td>IPCC default value for anaerobic managed solid waste disposal site is applied.</td></tr>
<tr><td>Purpose of data</td><td>Calculation of baseline emission</td></tr>
<tr><td>Additional comment</td><td>The mean annual temperature (MAT) is 23.0ºC and the mean annual precipitation (MAP) is 1,019 mm. Source: EIA</td></tr>
</table>

<table>
<tr><td>Data / Parameter</td><td>MM_i</td></tr>
<tr><td>Unit</td><td>kg/kmol</td></tr>
<tr><td>Description</td><td>Molecular mass of greenhouse gas i</td></tr>
<tr><td>Source of data</td><td>Tool to determine the mass flow of a greenhouse gas in a gaseous stream</td></tr>
<tr><td>Value(s) applied</td><td>
<table>
<tr><th>Compound</th><th>Structure</th><th>Molecular mass (kg/kmol)</th></tr>
<tr><td>Methane</td><td>CH_4</td><td>16.04</td></tr>
</table>
</td></tr>
<tr><td>Choice of data or Measurement methods and procedures</td><td>According to “Tool to determine the mass flow of a greenhouse gas in a gaseous stream”</td></tr>
<tr><td>Purpose of data</td><td>Calculation of baseline emissions</td></tr>
<tr><td>Additional comment</td><td>-</td></tr>
</table>

Data / Parameter	MM_k
Unit	kg/kmol
Description	Molecular mass of gas *k*
Source of data	Tool to determine the mass flow of a greenhouse gas in a gaseous stream
Value(s) applied	Compound: Nitrogen; Structure: N_2; Molecular mass (kg/kmol): 28.01
Choice of data or Measurement methods and procedures	According to "Tool to determine the mass flow of a greenhouse gas in a gaseous stream"
Purpose of data	Calculation of baseline emissions
Additional comment	-

Data / Parameter	MM_{H2O}
Unit	kg/kmol
Description	Molecular mass of water
Source of data	Tool to determine the mass flow of a greenhouse gas in a gaseous stream
Value(s) applied	18.0152
Choice of data or Measurement methods and procedures	According to "Tool to determine the mass flow of a greenhouse gas in a gaseous stream"
Purpose of data	Calculation of baseline emissions
Additional comment	-

B.6.3. Ex ante calculation of emission reductions
>>
Emission reduction

Baseline emission calculation

The total of methane generation at the site has been estimated based on the waste tonnage of the landfill using the first order decay model presented in the *"Emissions from solid waste disposal sites"* and considering the following equation as mentioned previously.

Ex-ante estimation of $F_{CH4,PJ,y}$

The assumptions used to calculate $\mathbf{F_{CH4,PJ,y}}$ are:

- Methane content in LFG = 50% (default value);
- LFG collection efficiency = 75%: (Based on technical specifications from the equipment provider for the active LFG capture system);

- Density of methane = 0.716 kg/m^3 (as per "*Tool to determine project emissions from flaring gases containing methane*").

The landfill gas collection and utilization system will capture only a portion of the generated landfill gas. Thus, an estimate of 75% LFG collection was applied to the estimate of LFG produced, under assumption that generated LFG is composed of 50% methane.

The ex ante estimation of the $F_{CH4,PJ,y}$ is presented below:

$$F_{CH4,PJ,y} = \eta_{PJ} \times \frac{BE_{CH4,SWDS,y}}{GWP_{CH4}}$$

Where:

$F_{CH4,PJ,y}$	=	Amount of methane in the LFG which is flared and/or used in the project activity in year y (tCH_4/yr)
$BE_{CH4,SWDS,y}$	=	Amount of methane in the LFG that is generated from the SWDS in the baseline scenario in year y (tCO_2e/yr)
η_{PJ}	=	Efficiency of the LFG capture system that will be installed in the project activity
GWP_{CH4}	=	Global warming potential of CH_4 (tCO_2e/tCH_4)

The table below illustrates the ex-ante estimation of $F_{CH4,PJ,y}$ by the project activity during the crediting period.

Table 9 - Ex-ante estimation of $F_{CH4,PJ,y}$

Year	$F_{CH4,PJ,y}$ (tCH_4/yr)
2014	2,686
2015	3,501
2016	4,112
2017	4,574
2018	4,936
2019	5,228
2020	5,474

Determination of $F_{CH4,BL,y}$

$F_{CH4,BL,y} = 20\% \times F_{CH4,PJ,y}$

Table 10 - Ex-ante estimation of FCH4,BL,y

Year	$F_{CH4,BL,y}$ (tCH_4/yr)
2014	537
2015	700
2016	822
2017	915
2018	987
2019	1,046
2020	1,095

Step (A): Baseline emissions of methane from the SWDS ($BE_{CH4,y}$)

The equation of the $BE_{CH4,y}$ is:

$$BE_{CH4,y} = (1-OX_{top\_layer}) \times (F_{CH4,PJ,y} - F_{CH4,BL,y}) \times GWP_{CH4}$$

Where the OX_{top_layer} = 0.1 (default value) and $F_{CH4,PJ,y}$ and $F_{CH4,BL,y}$ are calculated above. The results are presented below:

Table 11 - Baseline emissions of methane from the SWDS (BECH4,y)

Year	$BE_{CH4,y}$ (tCO_2/year)
2014	40,612
2015	52,935
2016	62,173
2017	69,155
2018	74,630
2019	79,045
2020	82,764

Step (B): Baseline emissions associated with electricity generation ($BE_{EC,y}$)

The ex-ante calculation is:

$$BE_{EC,y} = EC_{BL,k,y} \times EF_{grid,CM,y}$$

As explained above, the $EF_{grid,CM,y}$ = 0.1988 tCO_2/MWh

Table 12 - Baseline emissions associated with electricity generation (BEEC,y)

Year	$EC_{BL,k,y}$ (MWh/yr)	$BE_{EC,y}$ (tCO_2/yr)
2014	-	-
2015	-	-
2016	16,469	3,274
2017	16,469	3,274
2018	24,703	4,910
2019	24,703	4,910
2020	24,703	4,910

The equation of the baseline emission calculation is:

$$BE_y = BE_{CH4,y} + BE_{EC,y}$$

The result is:

Table 13 - baseline emission calculation

Year	$BE_{CH4,y}$ (tCO_2/year)	$BE_{EC,y}$ (tCO_2/yr)	BE_y (tCO_2/yr)
2014	40,612	-	40,612
2015	52,935	-	52,935
2016	62,173	3,274	65,446
2017	69,155	3,274	72,428
2018	74,630	4,910	79,541
2019	79,045	4,910	83,955
2020	82,764	4,910	87,675

Project emissions

$$PE_y = PE_{EC} + PE_{FC,y}$$

Where:

PE_y	=	Project emissions in year y (tCO_2/yr)
$PE_{EC,y}$	=	Emissions from consumption of electricity due to the project activity in year y (tCO_2/yr)
$PE_{FC,y}$	=	Emissions from consumption of fossil fuels due to the project activity, for purpose other than electricity generation, in year y (tCO_2/yr)

<u>Calculation of $PE_{EC,y}$ – project emission from consumption of electricity</u>

There are two emission project sources:

- $PE_{EC1,y}$ - Grid (Brazilian interconnected electric system);
- $PE_{EC2,y}$ - Diesel generator(s) (off-grid captive power plant)

$$PE_{EC,y} = PE_{EC1,y} + PE_{EC2,y}$$

$PE_{EC1,y}$ - Project emission from the grid

In the project activity, the annual electricity consumption from the grid is estimated around 648 MWh/year only in the first years. The subsequent year it will be installed the power plant and it not expected to import electricity from the grid. However, this variable will be monitored during the whole crediting period.

In the option A1 of the "*Tool to calculate baseline, project and/or leakage emissions from electricity consumption*", states that a value of the combined margin emission factor ($EF_{grid,CM,y}$) may be used as the emission factor ($EF_{ELj/k/l,y}$). Therefore a value of 0.1988 tCO_2/MWh will be used.

Finally the technical transmission and distribution losses ($TDL_{j,y}$) value has been assumed to be 16%, according to technical article from researcher at Brazilian (UTFPR).[21] Table below summarizes the project emissions resulting from electrical consumption in the plant.

Table 14 - Electricity consumption from the grid resulting due to project activity

Year	Electricity consumption from the grid - $EC_{PJ1,y}$ (MWh/yr)	$PE_{EC1,y}$ (tCO_2/year)
2014	648	149
2015	648	149
2016	0	0
2017	0	0
2018	0	0
2019	0	0
2020	0	0

$PE_{EC2,y}$ - Project emission from diesel generator(s)

According to information above (Project emission from the grid), the ex-ante estimation was not considered. However, this parameter will be continuously monitored and measured ex-post.

The emission factor from the diesel generator(s) is 1.3 tCO_2/MWh. The following table represents the project emissions from the use of the standby generator over the crediting period. Table below presents the project emissions associated with fossil fuel combustion at the project site.

Table 15 - Project emissions from diesel generator

Year	$PE_{el,diesel}$ - $EC_{PJ2,}$ (MWh/year)	$PE_{EC2,y}$ (tCO_2/year)
2014	0	0
2015	0	0
2016	0	0
2017	0	0
2018	0	0
2019	0	0
2020	0	0

Leakage:

[21] The article was made available to DOE during the validation process (*Perdas de transmissão e distribuição de energia elétrica - Brasil.pdf*).

In accordance with the ACM0001, no leakage effects need to be accounted.

Emission Reduction

Emission reductions are calculated as follows:

$$ER_y = BE_y – PE_y,$$

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_2e/yr);

Year	BE_y (tCO_2/year)	PE_y (tCO_2/year)	ER_y (tCO_2/year)
2014	40,612	149	40,463
2015	52,935	149	52,786
2016	65,446	-	65,446
2017	72,428	-	72,428
2018	79,541	-	79,541
2019	83,955	-	83,955
2020	87,675	-	87,675

B.6.4. Summary of ex ante estimates of emission reductions

Year	Baseline emissions (t CO_2e)	Project emissions (t CO_2e)	Leakage (t CO_2e)	Emission reductions (t CO_2e)
2014	40,612	149	0	40,463
2015	52,935	149	0	52,786
2016	65,446	0	0	65,446
2017	72,428	0	0	72,428
2018	79,541	0	0	79,541
2019	83,955	0	0	83,955
2020	87,675	0	0	87,675
Total	**482,592**	**299**	**0**	**482,293**
Total number of crediting years	**7**			
Annual average over the crediting period	**68,942**	**43**	**0**	**68,899**

B.7. Monitoring plan
B.7.1. Data and parameters to be monitored

Flaring or use of landfill gas

Data / Parameter	Management of SWDS
Unit	-
Description	Management of SWDS
Source of data	Use different sources of data: • Original design of the landfill; • Technical specifications for the management of the SWDS; • Local or national regulations
Value(s) applied	-
Measurement methods and procedures	Project participants should refer to the original design of the landfill to ensure that any practice to increase methane generation have been occurring prior to the implementation of the project activity. Any change in the management of the SWDS after the implementation of the project activity should be justified by referring to technical or regulatory specifications
Monitoring frequency	Annually
QA/QC procedures	-
Purpose of data	Calculation of baseline emissions
Additional comment	-

Data / Parameter	$O_{pj,h}$
Unit	-
Description	Operation of the equipment that consumes the LFG
Source of data	Measurements by Project participant using a device integrated with the operational software at the landfill gas plant.
Value(s) applied	n/a
Measurement methods and procedures	For each equipment unit j using the LFG monitor that the plant is operating in hour h by the monitoring parameter below: • Temperature. Determine the location for temperature measurements and minimum operational temperature based on manufacturer’s specifications of the burning equipment. Document and justify the location and minimum threshold in the PDD; $O_{pj,h}$=0 when: • One or more temperature measurements are missing or below the minimum threshold in hour h (instantaneous measurements are made at least every minute); Otherwise, Opj,h=1 The accuracy and uncertainty of the monitoring equipment may range up to 1.5%.
Monitoring frequency	Hourly
QA/QC procedures	The calibration of this equipment is not applicable since it is a device integrated with the operational software at the landfill gas plant.
Purpose of data	Calculation of baseline emissions
Additional comment	-

Tool to determine the mass flow of a greenhouse gas in a gaseous stream

Data / Parameter	$V_{t,db} = V_{t,wb} = FV_{RG,h}$
Unit	m³ /h
Description	For: • $V_{t,db}$ = Volumetric flow of the gaseous stream in time interval t on a dry basis; • $V_{t,wb}$ = Volumetric flow of the gaseous stream in time interval t on a wet basis; • $FV_{RG,h}$ = Volumetric flow rate of the residual gas in dry basis at normal conditions in the hour h.
Source of data	Measurements by Project participants using a flow meter
Value(s) applied	n/a
Measurement methods and procedures	Regarding parameters $V_{t,db}$ and $V_{t,wb}$, the volumetric flow rate of the residual gas at normal conditions in the hour h will be measured according to the “Tool to determine the mass flow of a greenhouse gas in a gaseous stream”, the measurement option in the project activity will be: • Option (A) dry basis: when the temperature of gaseous stream is lower than 60ºC (333.15 K) at the flow measurement point; • Option (B) wet basis: when the temperature of gaseous stream is higher than 60^{o}C (333.15 K) at the flow measurement point; Regarding parameter $FV_{RG,h}$, Project Participant must ensure that the same basis (dry or wet) is considered for this measurement and the measurement of volumetric fraction of all components in the residual gas (fvi,h) when the residual gas temperature exceeds 60 ºC. The accuracy and uncertainty of the monitoring equipment may range up to 1.5%.
Monitoring frequency	Continuous recorded and hourly aggregated
QA/QC procedures	Periodic calibration against a primary device provided by an independent accredited laboratory is mandatory. The calibration frequency of this monitoring equipment should be in accordance with manufacturer’s specifications.
Purpose of data	Calculation of baseline emissions
Additional comment	The parameters $V_{t,db}$, $V_{t,wb}$, and $FV_{RG,h}$ have been considered in the same monitoring parameter table because all of them refers to volumetric flow rate of the residual gas in the hour h.

Data / Parameter	$v_{i,t,db} = fv_{i,,h}$
Unit	-
Description	Volumetric fraction of greenhouse gas *i* in a hourly time interval *t* on a dry basis
Source of data	Measurements by project participants using a gas analyzer
Value(s) applied	n/a
Measurement methods and procedures	Continuous gas analyzer operating in dry-basis. Volumetric flow measurement should always refer to the actual pressure and temperature Data will be monitored continuously and values will be averaged hourly or a shorter time interval. The accuracy and uncertainty of the monitoring equipment may range up to 1.5%.
Monitoring frequency	Continuously
QA/QC procedures	Calibration should include zero verification with an inert gas (e.g. N_2) and at least one reading verification with a standard gas (single calibration gas or mixture calibration gas). All calibration gases must have a certificate provided by the manufacturer and must be under their validity period The calibration frequency of this monitoring equipment should be according to the manufacturer's specifications.
Purpose of data	Calculation of baseline emissions
Additional comment	As a simplified approach, project participants may only measure the methane content of the gaseous stream and consider the remaining part as N_2, therefore i = CH_4 This parameter will be monitored to option A and B

Data / Parameter	T_t
Unit	K
Description	Temperature of the gaseous stream in time interval t
Source of data	Measurements by Project participant using a temperature meter
Value(s) applied	n/a
Measurement methods and procedures	Instruments with recordable electronic signal (analogical or digital) are required. Examples include thermocouples, thermo resistance, etc. The accuracy and uncertainty of the monitoring equipment may range up to 1.5%.
Monitoring frequency	Continuous
QA/QC procedures	Periodic calibration against a primary device provided by an independent accredited laboratory is mandatory. The calibration frequency of this monitoring equipment should be according to the manufacturer's specifications.
Purpose of data	Calculation of baseline emissions.
Additional comment	Provided all parameters are converted to normal conditions during the monitoring process, this parameter may not be needed except for moisture content determination and therefore it should be metered only when performing such measurements (with same frequency). However, if the applicability condition related to the gaseous stream flow temperature being below 60ºC is adopted, this parameter must be monitored continuously to assure the applicability condition is met

Data / Parameter	P_t
Unit	Pa
Description	Pressure of the gaseous stream in time interval t
Source of data	Measurements by Project participant using a pressure meter
Value(s) applied	n/a
Measurement methods and procedures	Instruments with recordable electronic signal (analogical or digital) are required. Examples include pressure transducers, etc. The accuracy and uncertainty of the monitoring equipment may range up to 1.5%.
Monitoring frequency	Continuous
QA/QC procedures	Periodic calibration against a primary device must be performed periodically and records of calibration procedures must be kept available as well as the primary device and its calibration certificate. Pressure transducers (either capacitive or resistive) must be calibrated monthly. In case the pressure meter is not a capacitive or resistive pressure transducer, the calibration frequency of this monitoring equipment should be according to the manufacturer's specifications.
Purpose of data	Calculation of baseline emissions.
Additional comment	Provided all parameters are converted to normal conditions during the monitoring process, this parameter may not be needed except for moisture content determination and therefore it should be metered only when performing such measurements (with same frequency)

Data / Parameter	$P_{H2O,t,Sat}$
Unit	Pa
Description	Saturation pressure of H_2O at temperature Tt in time interval *t*
Source of data	Provided by project participants
Value(s) applied	n/a
Measurement methods and procedures	This parameter is solely a function of the gaseous stream temperature Tt and can be found at reference [1] for a total pressure equal to 101,325 Pa
Monitoring frequency	
QA/QC procedures	
Purpose of data	
Additional comment	[1] Fundamentals of Classical Thermodynamics; Gordon J. Van Wylen, Richard E. Sonntag and Borgnakke; 4º Edition 1994, John Wiley & Sons, Inc.

Tool to calculate baseline, project and/or leakage emissions from electricity consumption

Data / Parameter	$EF_{grid,CM,y}$
Unit	tCO_2 /MWh
Description	Combined margin emission factor for the grid in year y
Source of data	Brazilian DNA
Value(s) applied	0.1988 (ex-ante estimate for year 2011)
Measurement methods and procedures	The emission factor will be calculated ex-post, as the weighted average of the dispatch data analysis OM (Operating Margin) and the BM (Build margin), as described in B.6.3.
Monitoring frequency	Annual
QA/QC procedures	Apply procedures in the “Tool to calculate the emission factor for an electricity system”.
Purpose of data	Calculation of baseline emissions and; Calculation of project emissions.
Additional comment	All data and parameters to determine the grid electricity emission factor, as required by the “Tool to calculate the emission factor for an electricity system”, were included in the monitoring plan. For more details, see appendix 4.

Data / Parameter	$TDL_{k,y}$ and $TDL_{j,y}$
Unit	-
Description	Average technical transmission and distribution losses for providing electricity to source j, k in year y
Source of data	Regional or national technical literature
Value(s) applied	16% (ex-ante estimate for year 2011)
Measurement methods and procedures	The technical distribution losses do not contain grid losses other than technical transmission and distribution.
Monitoring frequency	Annually. In the absence of annual information, It will be used information up to previous 5 years.
QA/QC procedures	-
Purpose of data	Calculation of project emissions.
Additional comment	The technical transmission and distribution losses ($TDL_{j,y}$) value has been assumed to be 16%, according to technical article from researcher at Brazilian (UTFPR).

<table>
<tr><td>Data / Parameter</td><td>$EG_{PJ,y} = EC_{BL,k,y}$</td></tr>
<tr><td>Unit</td><td>MWh</td></tr>
<tr><td>Description</td><td>Amount of electricity generated using LFG by the project activity in year y</td></tr>
<tr><td>Source of data</td><td>Electricity meter</td></tr>
<tr><td>Value(s) applied</td><td>The ex-ante estimation is:
<table>
<tr><th>Year</th><th>Amount of electricity generated using LFG (MWh/year)</th></tr>
<tr><td>2014</td><td>0</td></tr>
<tr><td>2015</td><td>0</td></tr>
<tr><td>2016</td><td>16,469</td></tr>
<tr><td>2017</td><td>16,469</td></tr>
<tr><td>2018</td><td>24,703</td></tr>
<tr><td>2019</td><td>24,703</td></tr>
<tr><td>2020</td><td>24,703</td></tr>
</table></td></tr>
<tr><td>Measurement methods and procedures</td><td>Monitor net electricity generation by the project activity using LFG.

The data will be collected continuously using an electricity meter. The net amount of electricity will be directly measured. The data will be archived throughout the crediting period and two years thereafter.
The accuracy and uncertainty of the monitoring equipment may range up to 1.5%.</td></tr>
<tr><td>Monitoring frequency</td><td>Continuously</td></tr>
<tr><td>QA/QC procedures</td><td>Electricity meter will be subject to regular (in accordance with stipulation of the meter supplier) maintenance and testing to ensure accuracy. Periodical calibration as per manufacturer specifications to ensure validity of data measured.

The calibration frequency of this monitoring equipment should be according to the manufacturer’s specifications. Nevertheless, the official standard ONS module 12, sub-module 12.3,[22] which defines a maximum 2-year frequency for preventive maintenance will be respected.</td></tr>
<tr><td>Purpose of data</td><td>Calculation of baseline emissions.</td></tr>
<tr><td>Additional comment</td><td>This parameter is required for calculating baseline emissions associated with electricity generation ($BE_{EC,y}$) using the “Tool to calculate baseline, project and/or leakage emissions from electricity consumption”</td></tr>
</table>

[22] http://www.ons.org.br/download/procedimentos/modulos/Modulo_12/Submodulo%2012.3_Rev_1.1.pdf , accessed on 06/07/2012

Data / Parameter	$EG_{EC1,y} = EC_{PJ1,y}$
Unit	MWh
Description	Quantity of electricity consumed from the grid by the project activity during the year y
Source of data	Electricity meter
Value(s) applied	The ex-ante estimation is: <table><tr><th>Year</th><th>Quantity of electricity consumed from the grid (MWh/year)</th></tr><tr><td>2014</td><td>648</td></tr><tr><td>2015</td><td>648</td></tr><tr><td>2016</td><td>0</td></tr><tr><td>2017</td><td>0</td></tr><tr><td>2018</td><td>0</td></tr><tr><td>2019</td><td>0</td></tr><tr><td>2020</td><td>0</td></tr></table>
Measurement methods and procedures	The data will be collected continuously using an electricity meter. The data will be archived throughout the crediting period and two years thereafter. The accuracy and uncertainty of the monitoring equipment may range up to 1.5%.
Monitoring frequency	Continuously
QA/QC procedures	Electricity meter will be subject to regular (in accordance with stipulation of the meter supplier) maintenance and testing to ensure accuracy. Periodical calibration as per manufacturer specifications to ensure validity of data measured. The calibration frequency of this monitoring equipment should be according to the manufacturer's specifications.
Purpose of data	Calculation of project emissions.
Additional comment	It was considered only the electricity consumption of 648 MWh for the first 2 year. The internal electricity consumption was based on the installed capacity of the equipment (74 kW) times number of hours per year (8,760). The power plant will be installed after 2015, and it not expected to import electricity from the grid. However, this variable will be monitored during the whole crediting period. This parameter is required for calculating project emissions from electricity consumption due to an alternative waste treatment process t ($PE_{EC1,y}$) using the "Tool to calculate baseline, project and/or leakage emissions from electricity consumption".

Data / Parameter	$EG_{EC2,y} = EC_{PJ2,y}$
Unit	MWh/y
Description	Quantity of electricity consumed from diesel generator by the project activity during the year y
Source of data	Measured by project participants using electricity meter
Value(s) applied	0 (zero) for ex-ante calculation
Measurement methods and procedures	The data will be collected continuously using an electricity meter. The data will be archived throughout the crediting period and two years thereafter. The accuracy and uncertainty of the monitoring equipment may range up to 1.5%.
Monitoring frequency	Continuously
QA/QC procedures	Calibration of equipment as per manufacturer specifications to ensure validity of data measured. The calibration frequency of this monitoring equipment should be according to the manufacturer's specifications.
Purpose of data	Calculation of project emissions.
Additional comment	This parameter is required for calculating project emissions from electricity consumption due to an alternative waste treatment process t ($PE_{EC2,y}$) using the "Tool to calculate baseline, project and/or leakage emissions from electricity consumption". However, it was considered zero for ex-ante calculation.

Tool to determine project emissions from flaring gases containing methane

Data / Parameter	$t_{O2,h}$
Unit	-
Description	Volumetric fraction of O_2 in the exhaust gas of the flare in the hour h
Source of data	Measurements by project participants using a continuous gas analyzer
Value(s) applied	-
Measurement methods and procedures	Extractive sampling analyzers with water and particulates removal devices or *in situ* analyzers for wet basis determination. The point of measurement (sampling point) shall be in the upper section of the flares (80% of total flare height). Sampling shall be conducted with appropriate sampling probes adequate to high temperature level. The accuracy and uncertainty of the monitoring equipment may range up to 1.5%.
Monitoring frequency	Continuously recorded and hourly aggregated
QA/QC procedures	The calibration frequency of this monitoring equipment should be according to the manufacturer's specifications. A zero check and a typical value check should be performed by comparison with a standard certified gas. Periodical calibration.
Purpose of data	Calculation of baseline emissions.
Additional comment	Monitoring of this parameter is only applicable in case of enclosed flares and continuous monitoring of the flare efficiency.

Data / Parameter	$fv_{CH4,FG,h}$
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	Measurements by project participants using a continuous gas analyzer
Value(s) applied	n/a
Measurement methods and procedures	Extractive sampling analyzers with water and particulates removal devices or *in situ* analyzers for wet basis determination. The point of measurement (sampling point) shall be in the upper section of the flares (80% of total flare height). Sampling shall be conducted with appropriate sampling probes adequate to high temperature level. Data will be recorded continuously and values will be averaged hourly or at a shorter time interval. The accuracy and uncertainty of the monitoring equipment may range up to 1.5%.
Monitoring frequency	Continuously. Values to be averaged hourly or at a shorter time interval.
QA/QC procedures	The calibration frequency of this monitoring equipment should be according to the manufacturer's specifications. A zero check and a typical value check should be performed by comparison with a standard certified gas. Periodical calibration.
Purpose of data	Calculation of baseline emissions.
Additional comment	Monitoring of this parameter is only applicable in case of enclosed flares and continuous monitoring of the flare efficiency. Measurement instruments will be read ppmv values or % values. To convert from ppmv to mg/m3 simply multiply by 0.716. 1% equals 10,000 ppmv.

Data / Parameter	T_{flare}
Unit	^{o} C
Description	Temperature on the exhaust gas of the flare
Source of data	Measurements by project participants using temperature meter
Value(s) applied	n/a
Measurement methods and procedures	Measure the temperature of the exhaust gas stream in the flare by a Type S thermocouple. A temperature above 500 ^{o}C indicates that a significant amount of gases are still being burnt and that the flare is operating. Data will be recorded continuously and values will be averaged hourly or at a shorter time interval. The accuracy of the monitoring equipment may range up to 1.5%. Regarding the monitoring equipment uncertainty, it may range up to 2.5%.
Monitoring frequency	Continuously
QA/QC procedures	Thermocouples will be replaced or calibrated every year
Purpose of data	Calculation of baseline emissions.
Additional comment	-

Data / Parameter	Other flare operation parameters
Unit	-
Description	This includes the parameter required to monitor whether the flare operates within the range of operating conditions according to the manufacturer´s specifications, the required parameters are the temperature of the exhaust gas, the inlet LFG flow and the LFG CH_4 concentration.
Source of data	Data collected from monitoring equipment (temperature meter, flow meter and gas analyser)
Value(s) applied	-
Measurement methods and procedures	According to the manufacturer specifications, the following parameters must be monitored in order to guarantee the properly flare operation with a complete CH4 combustion: 1. Flame temperature; 2. Inlet LFG flow; 3. LFG CH_4 concentration;
Monitoring frequency	Continuously
QA/QC procedures	The calibration frequency of the monitoring equipment (temperature meter, flow meter and gas analyser) should be in accordance with manufacturer's specifications.
Purpose of data	Baseline emissions
Additional comment	The parameters (LFG flow and LFG CH4 concentration) that are required to monitor whether the flare operates within the range of operating conditions according to the manufacturer´s specifications will be measured according to the monitoring plan of the parameters explained in tables above, being: 1. Flame temperature monitored as T_{flare}; 2. Inlet LFG flow monitored as $V_{t,db} = V_{t,wb} = FV_{RG,h}$; 3. LFG CH_4 concentration monitored as $v_{i,t,db} = fv_{i,,h}$. The approach of the flare operation parameters will be used only in cases where the continuous monitoring of the flare efficiency is not in place.

B.7.2. Sampling plan

>>

Not applicable.

B.7.3. Other elements of monitoring plan

>>

The monitoring plan will be done according to the methodology ACM0001 and the applicable tools. The monitoring equipment locations are presented in the picture below:

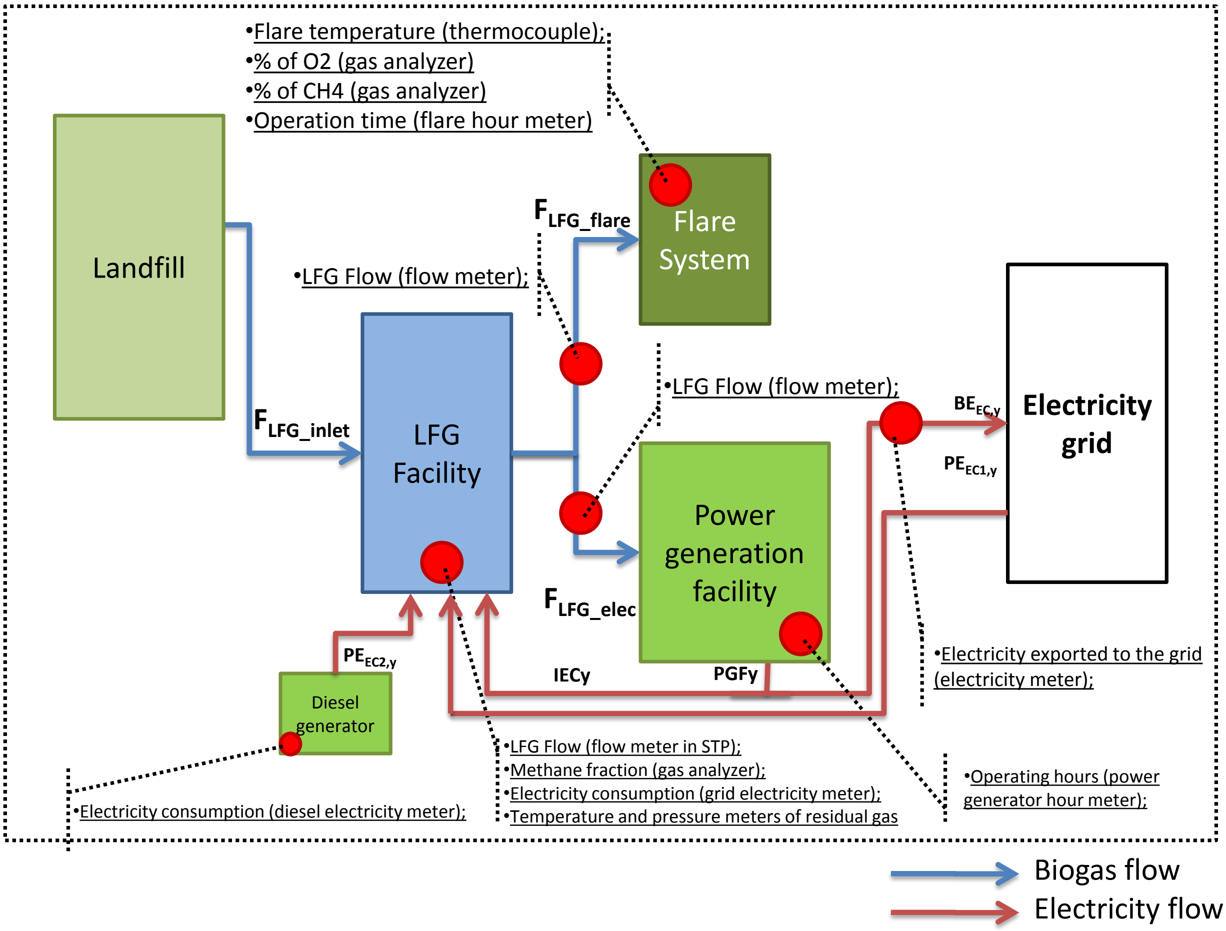

Figure 13 - Monitoring equipment locations

All continuously measured parameters (LFG flow, LFG CH_4 concentration, flare temperature, flare operating hours, engine operating hours, and electricity to the grid and from the grid (measured via a bi-directional electricity meter)) will be recorded electronically via a datalogger, located inside the site boundary which will have the capability to aggregate and print the collected data in the frequencies range specified above. It will be the Site Operator responsibility to provide all requested data logs which will be stored during the reporting period at the Site office. The data logs will be summarized into emission reduction calculations prior to each verification. This task will be completed by Project Participant and reported directly to the DOE. These logs will be available to the DOE when requested in order to prove the operational integrity of the Project.

1. Management Structure

The collected operational data will be used to support the periodic verification report requiring CER auditing. The herein discussed monitoring plan has been designed to meet or conservatively exceed the UNFCCC requirements (approved monitoring methodology ACM0001 version 13).

The monitoring program routine system required to determine emission reductions is discussed in section 2 below, while the additional system data collected to ensure the safe, correct, and efficient operation of the LFG management system is discussed in section 3.

1.1. Responsibility of the personnel involved

The Estre Ambiental S.A´s organizational structure is presented in the figure below:

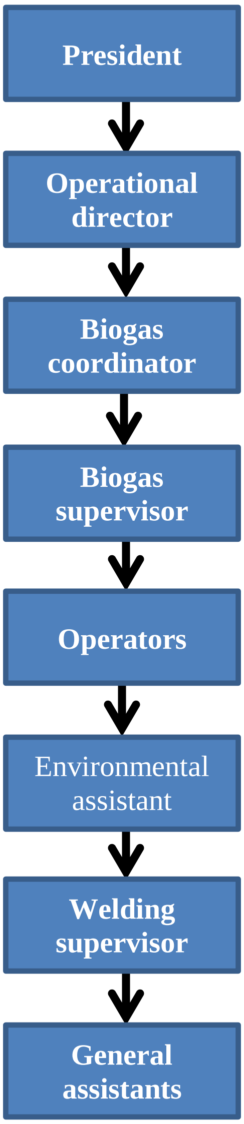

Figure 14 - Estre Ambiental S.A's organizational structure

The personnel involved in the monitoring will be responsible for carrying out the following tasks:

- Supervise and verify metering and recording (Estre Ambiental S.A responsibility): The staff will internally coordinate with other departments the adequate verification of data metering and recording.
- Collection of sales/billing receipts and additional data (Estre Ambiental S.A responsibility): The staff will collect sales receipts and additional data deemed necessary to calculate and report the emission reductions for each monitoring period, such as daily operational reports of project.
- Calibration (Estre Ambiental S.A responsibility): The staff will internally coordinate to ensure that calibration of the metering instruments will be carried out in accordance with the equipment manufacturers specifications. Third parties must be hired to conduct the calibration procedures.
- Preparation of monitoring report (Econergy responsibility): The staff will prepare the monitoring report for verification.

- Data Archives (Estre Ambiental S.A/Econergy responsibility): The project participant will be responsible for keeping all monitoring data, and making it available to the DOE for the verification of the emission reductions.

1.2. Installation of meters

All meters will be installed in order to fulfill the proposed monitoring plan.

2. Monitoring Work Program

The LFG monitoring program is designed to collect system operating data required for the safe system operation and for the verification of CERs. This data is collected in real time, and will provide continuous recording which can be easily monitored, reviewed, and validated.

The following sections will outline and discuss the key elements of the monitoring program presented below:

- LFG Flow;
- LFG quality;
- Uncombusted methane;
- Electricity consumption;
- Project electricity output;
- Regulatory requirements;
- Data records;
- Data assessment and reporting.

2.1. LFG Flow

The data will be collected continuously using 3 vortex flow meters located in the piping leading to the flare, to the electricity generation plant and the other on the main piping measuring the total collected landfill gas. The data will be aggregated monthly and yearly for the flare. The data will be archived for a minimum of two years after the end of the crediting period or the last issuance of CERs for this project activity, whichever occurs later.

The vortex meter will be provided with a normalizer unit which normalizes the flow rate at standard temperature and pressure.

The data could be measured in dry or wet basis using a flow meter according to the "Tool to determine the mass flow of a greenhouse gas in a gaseous stream". Project Participant must ensure that the same basis (dry or wet) is considered for the measurement of LFG Flow ($V_{t,db}$ = $V_{t,wb}$ = $FV_{RG,h}$) and the measurement of volumetric fraction of all components in the residual gas ($v_{i,t,db}$ = $fv_{i,,h}$). The equipment selected for the project activity will utilize a continuous monitoring system as defined in ACM0001, which measures and aggregates flow data.

For the determination of the LFG flow in dry basis when applicable, the parameters regarding temperature of the collected LFG (T_t) and pressure of collected LFG (P_t) must be continuously monitored using a temperature meter and pressure meter respectively.

More detailed information regarding those data is presented in section B.7.1.

2.2. LFG Quality

The concentration of methane will be measured via common sample line that runs to the main collection system piping and is measured in real time. The equipment selected for the site aggregates gas composition as per the definition of a continuous monitoring system in ACM0001.

Regular calibrations will be made according to manufacturer specification.

2.3. Uncombusted Methane

The efficiency of the enclosed flare will be measured as per the methodological “Tool to determine project emissions from flaring gases containing methane”.

2.4. Electricity

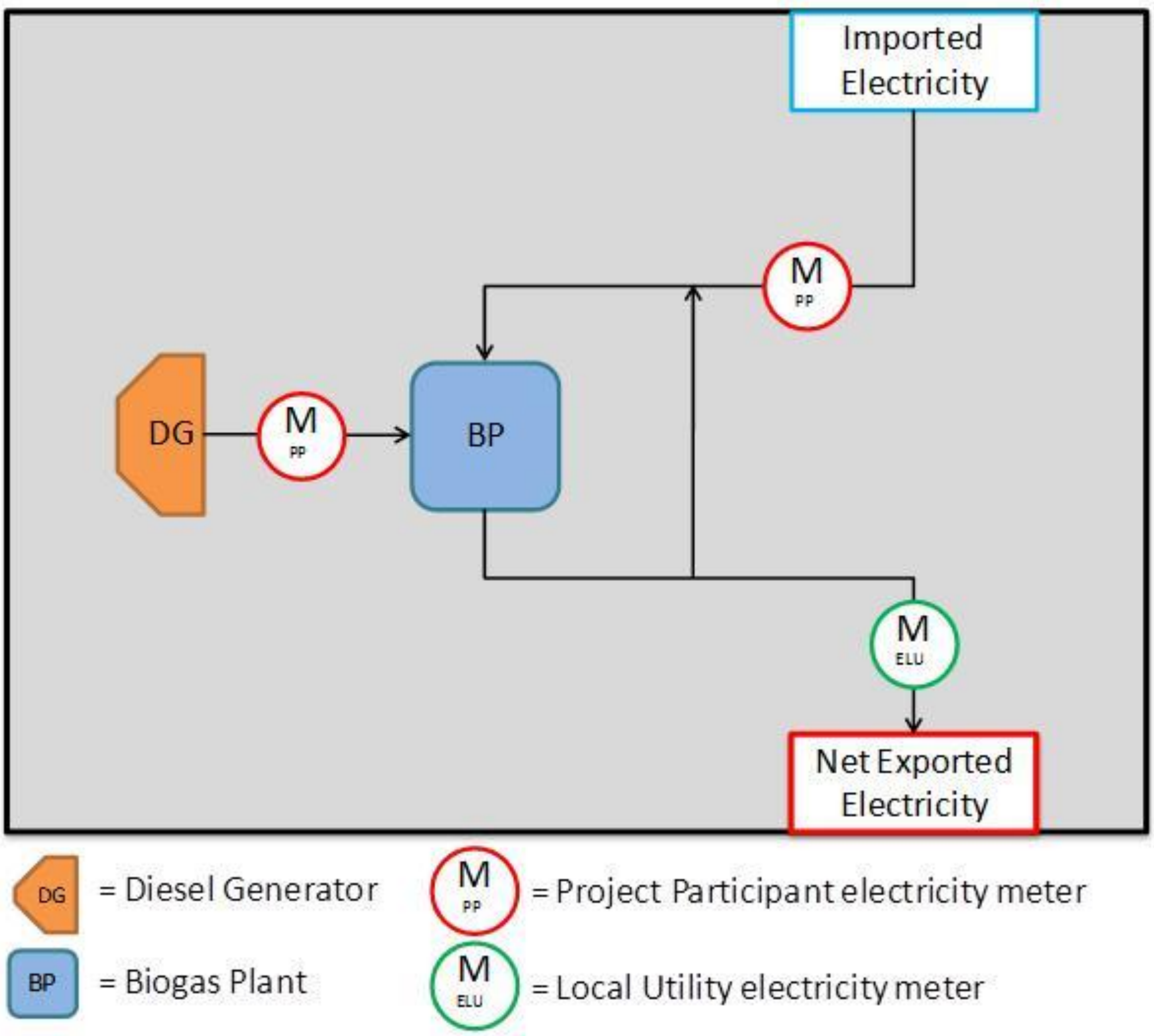

Figure 15 – Electricity Monitoring

2.4.1 Electricity for self consumption

The electricity supplied by the grid and diesel generators to LFG Plant will be continuously measured by electricity meters located in the LFG plant to define energy for self-consumption due to project activity.

Average technical transmission and distribution losses related to electricity consumption from the grid may be updated annually, using recent, accurate and reliable data available in the host country and in the absence of annual information, information up to previous 5 years will be used.

More detailed information regarding these data is presented in section B.7.1.

2.4.2 Project Electricity Output

The net generated electricity supplied to the grid by the project activity will be continuously measured by a Local Electricity Utility (LEU) meter and the respective data will be electronically recorded.

The operation of the equipment that supplies electricity to the grid will be hourly monitored using a device integrated with the operational software at the landfill gas plant.

More detailed information regarding these data is presented in section B.7.1.

2.5 Regulatory Requirements

Regulatory requirements relating to LFG projects will be evaluated annually by investigating municipal, state and national regulations regarding the LFG. This will be done through consultation with the appropriate regulatory agencies, on-going discussions with regulators and monitoring of publications delineating upcoming legislative changes governing landfills and LFG.

2.6 Data Records

Data collected from each of the parameter sensors is transmitted directly to an electronic database. Backup of the electronic data will be carried out every week. The monitoring equipment uncertainty levels, methods and the associated accuracy levels are presented in section B.7.1. Data records will be kept and archived electronically for two years after the end of the crediting period or the last issuance of CERs, whichever occurs later;

2.7 Data Assessment and Reporting

The record data will be daily analysed by the Biogas Supervisor. If detected any inconsistency regarding monitoring parameter data, it will be reported in a log-book and the LFG Plant Supervisor along with the Biogas coordinator will provide corrective actions, according to internal operational procedures.

Daily consolidated data will be sent by the LFG Plant Supervisor to the Biogas coordinator through electronic reports. The data of the monitored parameters will be storage using internal system network.

The data will be compiled and assessed to produce the required quantification and validation. The periodic monitoring report will contain the data required for the verification of the CERs. The records of regular maintenance performed will also be a component of the verification reports.

3 Corrective actions

The staff will log all corrective actions and will report these in the monitoring report. In case when the corrective actions are considered necessary, these actions will be implemented according to internal procedures.

4 Procedures for monitoring personnel training

The PP will conduct a training and quality control program to ensure that the good management practices are carried out and implemented by all project operating personnel in terms of record-keeping, equipment calibration, overall maintenance, and procedures for corrective action.

5 Emergency procedures

As a precautionary measure, regularly backups will be carried out to avoid data loss due to power outages. The Biogas coordinator will check daily the records. In addition, an emergency plan will be developed including other types of emergencies such as fire and work accidents.

6 Calibration

All the measurement instruments will be subject to regular calibration as per manufacturer's specifications or, in the absence of official standards and when applicable, the calibration frequency will be defined by the PP based on good practices in the market. Regular cross-check and calibration will be made by the operators and all applicable procedures will be supervised by Estre Ambiental S.A internal audit. The Biogas coordinator will be responsible for checking the equipment's proper working conditions, as well as checking and storing up the calibration certificates and records. The calibration frequencies for the measuring equipment are presented in section B.7.1. Calibration certificates will be kept for all the equipment during the crediting period and two years after.

SECTION C. Duration and crediting period

C.1. Duration of project activity

C.1.1. Start date of project activity

>>

Project starting date: 01/07/2013.

The starting date of the project activity will be the forecast date of purchasing the main equipment, according to feasibility study.

C.1.2. Expected operational lifetime of project activity

>>

25 years and 0 months

C.2. Crediting period of project activity

C.2.1. Type of crediting period

>>

Renewable (first)

C.2.2. Start date of crediting period

>>

The crediting period will start on 01/01/2014 or on the date of the registration of the CDM project activity (whichever is later).

C.2.3. Length of crediting period

>>

7 years (renewable for two times) and 0 months

SECTION D. Environmental impacts
D.1. Analysis of environmental impacts
>>
An analysis of the environmental impacts was done for the landfill gas project aiming:

1. Prevent the pollution of water sources, considering the use of surface and groundwater in region.
2. Provide soil conservation.
3. Minimize air pollution.
4. Ensure welfare of entrepreneurs and neighbourhood.
5. Minimize impacts to flora and fauna of the region.

For the construction and operation of the landfill gas project, the applicable laws will be followed:

- Law 6.938/1991 (National Environmental Policy)
- Law 9.605/1998 (Environmental Crimes).
- Law 4.771/1965 (Forestry Code)
- Law 9.985/2000 (National System of Nature Conservation Units - SNUC, criteria and standards for creation, implantation and management of conservation areas, including those ones related to Environmental Protection Areas – EPA, Areas of Ecologic Interests (*Áreas de Relevante Interesse Ecológico -ARIEs*), Private Reserves of Nature Heritage (*Reservas Particulares de Patrimônio Natural - RPPN*).
- CONAMA Resolution 302 and 303/2002 (Permanent Protection Areas – APP).
- CONAMA Resolution 001/86 (Environmental Impact Assessment)
- CONAMA Resolution 396/2008 (Groundwater legislation)

According to Brazilian legislation mentioned above is required an environmental impact assessment to the present project activity and the possible environmental impacts were analyzed by the Companhia Ambiental do Estado de São Paulo - CETESB (responsible agency to issue environmental licences in São Paulo State). The project activity has satisfied all the requirements for implementation of the landfill gas project and the CGR Piratininga received from CETESB the Installation License nº. 7002805. A summary of the environmental impacts and mitigation measures are explained in the section D.2.

There will be no transboundary impacts resulting from this project activity. All the relevant impacts occur within Brazilian borders and have been mitigated to comply with the environmental requirements for project's implementation.

D.2. Environmental impact assessment
>>
For the project activity, which has the objective to capture, flare and generate electricity through the use of LFG produced in the landfill, it is not necessary to develop an EIA (Environmental Impact Assessment). However, as the project boundary includes the project landfill, an environmental impact analysis (EIA) analysed by *CETESB* was carried out considering the landfill characteristics. Thus, CGR Piratininga has obtained all pertinent Licenses for the operation.

A summary of the environmental impacts and mitigation measures are explained in the Table 16 and in the Table 17 are showed the positive impacts due to the implementation of project activity.

Table 16 - Environmental Impacts and mitigation measures

IMPACT	POTENCIAL FACTOR	MITIGATION MEASURES
Atmospheric Pollution	• Dust emission from civil works.	• Wetting, calculated explosions for lower emissions of dust and vegetation surround.

	• Gas emissions from fossil combustion of vehicles and equipment. • Odour and biogas emissions from landfill.	• Maintenance of vehicles and equipment. • Vegetation surround, drainage of leachate, daily coverage of waste, deodorizer, maintenance of waste water treatment plant (WWTP) and biogas drainage and flare using passive capture system.
Superficial and ground water pollution.	• Leachate generation. • Wastewater emissions containing oil and grease. • Ground leachate generation. • Runoff water with particulate material.	• Subsurface drainage and treatment at the WWTP. • Oil/water separator - API and treatment at the WWTP. • Waterproofing with geomembrane and drainage • Sand separator before discharged into the rivers or natural drainage.
Soil destabilization. Siltation	• Cut and filling of soil. • Leaching of soils.	• Pluvial drainage, reutilization of soil and revegetation. • Preservation of coverage, dike and reutilization of soils.
Noise Pollution	• Noise emissions from civil works, vehicular traffic and equipment.	• Vegetation surround and calculated explosions for lower noise emissions, signalization and planning schedules. • Maintenance of vehicles and equipment.
Sanitary risks	• Vectors (insects, rats) proliferation	• Daily coverage of waste
Traffic alteration and risk of accidents.	• Increase of vehicular traffic. • Waste transport.	• Improvement of access via, signalization and paving. • Construction of alternatives via, maintenance of vehicles and training of drivers.
Landscape reconfiguration and landscape alteration	• Suppression of vegetation	• Planning of vegetation removal, replanting of forest and heterogeneous reforestation
Global environmental collapse	• Destabilization of landfill with rupture.	• Proper design project, rigorous execution and geotechnical monitoring ,

Table 17 - Positive Impacts

IMPACT	POTENCIAL FACTOR	MITIGATION MEASURES
Traffic of vehicles improvement	• Implantation and improvement of access via	• Positive impact
Increase of per capita income and stimulation of economy in the region. Increase of tax revenues	• Generation of direct and indirect jobs using local labour. • Purchase of materials and services in the region.	• Positive impact
Organization of use and occupation of land.	• Regular use and occupation of land, avoiding situations of invasion and disordered occupation.	• Positive impact

Moreover, it was developed a monitoring plan to verify and monitor in the proper frequency, the effective implantation of mitigation measures proposed.

The monitoring plan consists of the following specifics monitoring plans:

- Monitoring plan of air quality

- Monitoring plan of superficial waters
- Monitoring plan of ground waters
- Monitoring plan of noise
- Monitoring plan of landfill stability
- Monitoring plan of flora and fauna
- Monitoring plan of unit operations
- Monitoring plan of environmental-society conditions.
- Monitoring plan of construction site
- Monitoring plan of earthworks
- Monitoring plan of leachate drainage
- Monitoring plan of landfill gas drainage
- Monitoring plan of waste water and leachate treatment
- Monitoring plan of water supply
- Monitoring plan of vector transmission of diseases
- Monitoring plan of environmental education
- Monitoring of closure plan

SECTION E. Local stakeholder consultation

E.1. Solicitation of comments from local stakeholders

>>

According to the Resolutions Number 1[23], 4[24] and 7[25] of the Brazilian Designed National Authority (CIMGC – Comissão Interministerial de Mudança Global do Clima / *Interministerial Commission on Global Climate Change*), project participants shall send letters to local stakeholders 15 days before the start of the validation period, in order to receive comments. It includes:

- Name and type of the activity project;
- PDD (translated to Portuguese), made available through a website;
- Description of the project's contribution to the sustainable development, also made available through a website.

Letters were sent on 05/04/2012 to the following stakeholders involved and affected by the project activity:

- *Prefeitura municipal de Piratininga* / Municipal Administration of *Piratininga*;
- *Câmara dos vereadores de Piratininga* / Legislation Chamber of *Piratininga*;
- *Coordenadoria de Meio Ambiente de Piratininga* / Municipal Secretary Environmental of *Piratininga* City;
- Secretaria do Meio Ambiente do Estado de São Paulo/ Environmental secretary of São Paulo State;
- *Fórum Brasileiro das Organizações Não Governamentais e Movimentos Sociais para o Meio Ambiente e o Desenvolvimento - FBOMS* / Brazilian Forum of Non-Governmental Organizations and Social Movements for Environment and Development;
- *Ministério Público do Estado do* São Paulo / Paraná Pr*osecutor's Office;*
- *Ministério Público Federal* / Federal Prosecutor's Office.
- Local associations;
    - Aciflora;
    - Vidagua;
    - Instituto Ambiental Brasil

[23] http://www.mct.gov.br/upd_blob/0002/2736.pdf (Art. 3º, II)
[24] http://www.mct.gov.br/upd_blob/0011/11780.pdf (Artº 5°, unique paragraph)
[25] http://www.mct.gov.br/upd_blob/0023/23744.pdf, accessed on July 21st, 2008.

E.2. Summary of comments received
>>
No comments were received.

E.3. Report on consideration of comments received
>>
No comments were received.

SECTION F. Approval and authorization
>>
The Letter of Approval (LoA) from the Party is currently not available.

- - - - -

Appendix 1: Contact information of project participants

Organization name	Estre Ambiental S.A
Street/P.O. Box	Av. Juscelino Kubitschek, 1.830 – Torre 1 - 2º e 3º andar
Building	Edifício São Luiz
City	São Paulo
State/Region	SP
Postcode	-
Country	Brasil
Telephone	+55 (11) 3709-2300
Fax	-
E-mail	demetrios.christofidis@estre.com.br
Website	www.estre.com.br
Contact person	Demetrios Christofidis Jr
Title	Superintendent
Salutation	Sr.
Last name	Christofidis
Middle name	
First name	Demetrios
Department	Strategy and new business
Mobile	-
Direct fax	-
Direct tel.	-
Personal e-mail	-

Appendix 2: Affirmation regarding public funding

Not applicable. There is no public funding involved in the project activity.

Appendix 3: Applicability of selected methodology

All the information about the applicability of selected methodology is described in Section B.2. above.

Appendix 4: Further background information on ex ante calculation of emission reductions

The baseline study and monitoring methodology was developed by:

Econergy Brasil Ltda, São Paulo, Brazil
Telephone: +55 (11) 3555-5700
Contact person: Mr. Francisco do Espirito Santo Filho
Email: francisco.santo@econergy.com.br

Econergy Brasil Ltda is not a Project Participant.

The table below shows the key elements used for estimate the emissions of the emission reductions.

1. Key Parameters

Year landfilling operations will start	2013
Projected year for landfill closure - estimated based on current filling rate	2037
GWP for methane (UNFCCC and Kyoto Protocol decisions)	21
Methane concentration in LFG (% by volume) typical assumption for baseline scenario	50
LFG collection efficiency (%)	75
Flare efficiencies (%) operational data from flare manufacturer	99
Electricity consumption from the grid due to the project activity (MWh/year)	648
Electricity consumption from the diesel generator due to the project activity (MWh/year)	0
Unit price of electricity sold to the grid (R$/MWh)	103.06
Combined margin emission factor for electricity displacement (tCO_2/MWh) calculated based on the "Tool to calculate the emission factor for an electricity system".	0.1988
Installed capacity of Power Plant (MW)	6.0
Load factor (%)	94.00
Price per MW installed (R$/MWe)	2,391,687.73
Operational lifetime of the project activity (years)	25
LFG destruction rate	20%

2. Waste disposal and composition of the solid waste disposed in the landfill

The forecast amount of waste disposal in project activity is presented below:

Table 18 - Forecast amount of waste disposal in the landfill[26]

Year	Waste disposal (tonnes/yr)
2013	319,790
2014	319,790
2015	319,790
2016	320,666
2017	319,790
2018	319,790
2019	319,790
2020	320,666
2021	319,790
2022	319,790
2023	319,790
2024	320,666
2025	319,790
2026	319,790
2027	319,790
2028	320,666
2029	319,790
2030	319,790
2031	319,790
2032	320,666
2033	319,790
2034	319,790
2035	319,790
2036	320,666
2037	319,790

Table 19 - Composition of solid waste disposed in the landfill

Wood and wood products	4.07%
Pulp, paper and cardboard (other than sludge)	9.99%
Food, food waste, beverages and tobacco (other than sludge)	48.70%
Textiles	7.91%
Garden, yard and park waste	1.15%
Glass, plastic, metal, other inert waste	28.18%
TOTAL	**100.0%**

[26] The forecast amount of waste disposal in the landfill was based on waste disposal flow spreadsheet (CGR Piratininga waste disposal flow 2012 08 24 FES.xlsx)

3. Emission factors

The table below shows the Brazilian emission factors according to determination of the Brazilian DNA. More information is available at the Brazilian DNA website.

Combined Margin Emission Factor 2011 (tCO_2/MWh)		
1st crediting Period		**0.1988**
Build Margin - 2011		0.1056
Operating Margin 2011	January	0.2621
	February	0.2876
	March	0.2076
	April	0.1977
	May	0.2698
	June	0.341
	July	0.3076
	August	0.3009
	September	0.2734
	October	0.3498
	November	0.3565
	December	0.3495
	2010	0.2920

Source: Brazilian DNA[27]

Appendix 5: Further background information on monitoring plan

All the information about the monitoring plan were described in section B.7.1 and B.7.2

Appendix 6: Summary of post registration changes

It was left blank intentionally.

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[27] Emission factor from Brazilian DNA: http://www.mct.gov.br/index.php/content/view/333605.html#ancora accessed on 04/07/2012

History of the document

Version	Date	Nature of revision
04.1	11 April 2012	Editorial revision to change version 02 line in history box from Annex 06 to Annex 06b.
04.0	EB 66 13 March 2012	Revision required to ensure consistency with the "Guidelines for completing the project design document form for CDM project activities" (EB 66, Annex 8).
03	EB 25, Annex 15 26 July 2006	
02	EB 14, Annex 06b 14 June 2004	
01	EB 05, Paragraph 12 03 August 2002	Initial adoption.
Decision Class: Regulatory **Document Type:** Form **Business Function:** Registration		