UBERLÂNDIA LANDFILLS I AND II

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PROJECT DETAILS

1.1 Summary Description of the Project and its Implementation Status

The Project consists of a collection, transport and treatment system for landfill gas with production of electricity for self-consumption and incorporation to the national grid. Since the landfill gas major constituent is methane, whose GHG potential is 21 to 25 times the CO2, the Project reduces the emission of GHG into the atmosphere by means of methane destruction in high temperature flare and electricity generation, and of displacement of electricity generated from fossil fuel sources.

Uberlândia Landfill comprises two adjoining solid waste disposal sites (SWDS), named Landfill I and Landfill II, both owned by Limpebrás Resíduos Ltda. (Project Participant). The Landfill I started operating in July 1995 and stopped receiving waste in September 2010. The Landfill II started operating in October 2010 with approximately 18 years of lifetime. In this Project the two landfills were considered as a sole SDWS, since the area surrounding and including them, is owned and operated by Limpebrás Resíduos Ltda. and they are physically near enough to permit the joint operation. In fact, only a 27 m width road used exclusively for the landfilling operation separates the two sites, and the gas station and power plant of the Project are installed on the roadside between the Landfill I and Landfill II. The LFG is collect through vertical wells drilled in the waste mass or built during the waste landfilling (applicable for the Landfill II only) and is transported through a pipeline system connected to blowers towards the gas use section, where energy production and flare combustion sections are located. Entering the gas use section, the LFG collected is treated from humidity and other impurities to be sent to the electricity generation sets and/or to the enclosed flare. The LFG preferably flows to the power house; therefore, the major part of the LFG collected is turned into electric energy. The enclosed flare section aims to safely combust the surplus of gas in case the LFG flow exceeds the maximum utilization capacity of the power house or it is in maintenance. Both uses leads to a complete destruction of the methane present in the LFG. The electric energy produced from LFG is set both for the self consumption of the plant and the supply to the grid. The current Project total installed capacity of project activity is 2.852 MW.

The Project’s infrastructure construction started in May 2011 and the first LFG collection wells were drilled in the Landfill I by July 2011. The LFG aspiration and use for electricity generation and combustion in the enclosed flare started to be installed in August 2011. The flare combustion section became operational in January 2012, with 1 enclosed flare of 2,500 Nm^3/h of capacity. The power plant was commissioned in February 2012 with 1 engine of 1.426 MW of installed capacity; it started operating in March 2012. In October 2012, a second 1.426 MW engine was added to the power plant which came to operate with 2.852 MW of total installed capacity from 09/10/2012 on. Also in October 2012, the Project started to drill and connect LFG collection wells in the Landfill II. The project activity got registered under CDM in 04/09/2012 with the reference number 7110. No previous CDM verification was conducted to this Project. This monitoring report refers to pre-CDM registration emission.

In the monitoring period, from 01/03/2012 to 03/09/2012 (both dates included), the Project achieved 40,093 tCO_2e.

1.2 Sectoral Scope and Project Type

Sectoral scope 1 - Energy generation from renewable energy sources

Sectoral scope 13 – Waste handling and disposal.

The Project is not a grouped project.

1.3 Project Proponent

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1.4 Other Entities Involved in the Project

Not applicable.

1.5 Project Start Date

01-March-2012. It refers to the start up of the plant.[1]

1.6 Project Crediting Period

This monitoring report refers to pre-CDM emission reduction. The crediting period is described below.

Start: 01-March-2012 (date included)

End: 03-September-2012 (date included)

Length: 6 months (187 days)

1.7 Project Scale and Estimated GHG Emission Reductions or Removals

Indicate the scale of the project (project or large project) and the estimated annual GHG emission reductions or removals for the project crediting period.

Project Scale	
Project	X
Large project	

Year	Estimated GHG emission reductions or removals (tCO_2e)
Year...	43,275
Total estimated ERs	43,275
Total number of crediting years	1 (187 days)

[1] It refers to the date when the Project started generating electricity using the collected landfill gas and selling it. The electricity selling contract will be provided as evidence.

Average annual ERs	43,275

1.8 Description of the Project Activity

-

1.9 Project Location

The Project is located in Uberlândia city, in the Minas Gerais state in Brazil. The geographical coordinates of the Uberlândia Landfill are:

Latitude 18.878361° S

Longitude 48.318583° W

The figures below present the detailed location of the landfill:

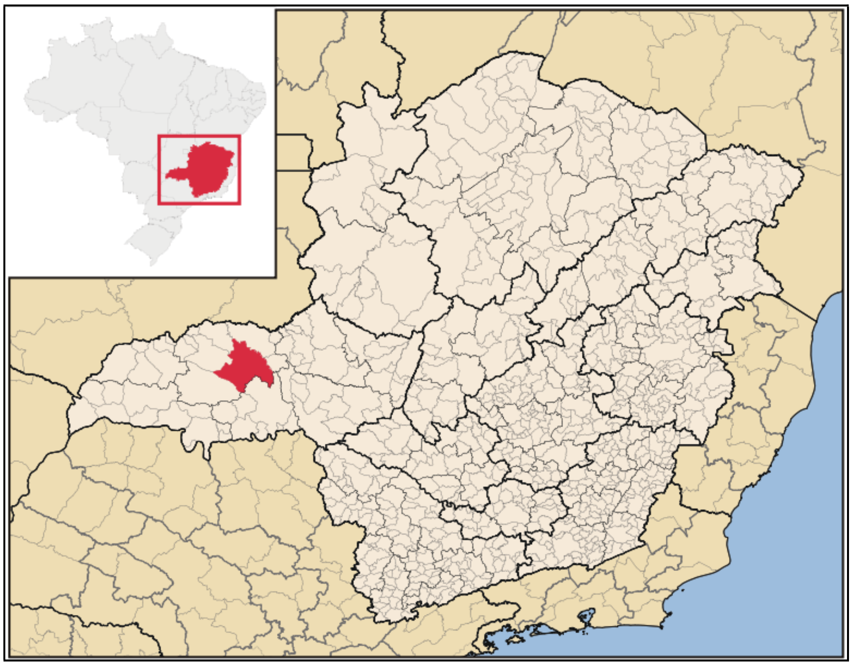

Figure 1: Location of Minas Gerais State and Uberlândia.

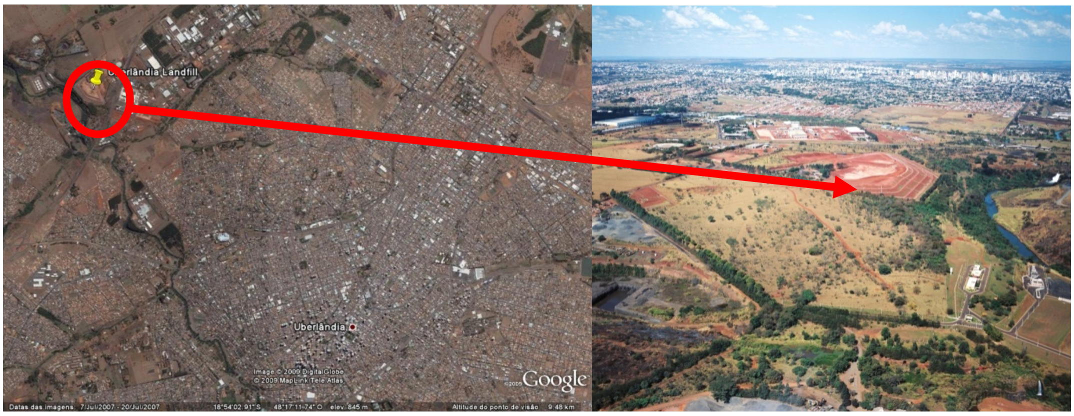

Figure 2: Location of the Landfill inside Uberlândia.

1.10 Conditions Prior to Project Initiation

The scenario existing prior to the implementation of the Uberlândia landfills I and II project activity at the Uberlândia Landfill was the operation of the landfill with uncontrolled emission of the LFG (landfill gas) generated to the atmosphere, i.e. the LFG generated due to the decomposition of the organic matter was vented through the vertical wells installed at the landfill's area. At the top of some wells, the LFG was partially burned to address safety and odour issues.

No equipment or machinery was installed nor was any other system in operation at the landfill.

1.11 Compliance with Laws, Statutes and Other Regulatory Frameworks

-

1.12 Ownership and Other Programs

1.12.1 Project Ownership

The Uberlândia Landfill is managed by Limpebrás Resíduos Ltda., a private company constituted in July 2008 with the specific objective of executing the concession contract signed between Limpebrás Engenharia Ambiental and the Municipality of Uberlândia in March 31st 2008, as a result of the public biding nº 843/2007, for the implementation and operation of Uberlândia's landfill amplification and provision of other correlated services, including the landfill gas exploitation for energy improvement purposes. Both Limpebrás Resíduos Ltda. and Limpebrás Engenharia Ambiental belong to the Limpebrás Group.

Asja Brasil Serviços para o Meio Ambiente Ltda.is a limited company created in August 2005 as part of Asja Group, whose main office is established in Italy. The group has projected, built and operated more than 30 plants similar to the proposed Project in Italy, and has also similar plants in China, Argentina, Albania and Brazil. As Asja Brasil Serviços para o Meio Ambiente Ltda. (Brazil) the group operates the “Exploitation of the biogas from Controlled Landfill in Solid Waste Management Central – CTRS / BR.040” project activity located in Belo Horizonte, Minas Gerais state.

Energas Geracao de Energia Ltda. is a limited company created in March 3rd 2011, composed by Limpebrás Resíduos Ltda. and Asja Brasil Serviços para o Meio Ambiente Ltda. with the specific objective of exploiting the landfill gas of the Uberlandia Landfills I and II through this Project activity[2].

1.12.2 Emissions Trading Programs and Other Binding Limits

Emissions reductions or removals generated by the Project are not within the scope of any Brazilian program or national cap. A letter from the program operator stating that the specific GHG emission reductions generated by the project are not within the scope of other emission trading programs or other binding limits will be provided to Designated Operational Entity and to VCS registry administrator.

1.12.3 Other Forms of Environmental Credit

The Project has not received another form of GHG-related environmental credit, and no GHG emission reductions for the monitoring period has been issued under the CDM program or other approved GHG program.

1.12.4 Participation under Other GHG Programs

This Project was registered under the CDM in 04-September-2012 with the reference number 7110 and crediting period equal to 7 years (equal to 84 months) renewable twice, from 04-September-2012 to 03-September-2019 (first period). With respect to non-overlapping periods, this project seeks to claim emission reductions prior to the CDM registration date.

This Project was also registered under the Gold Standard in 09-July-2013 with the reference ID GS3434. With respect to non-overlapping periods, this project seeks to claim emission reductions prior to the Gold Standard registration date.

[2] A copy of the constitution contract of Energas Geracao de Energia Ltda. will be provided as evidence of right of use.

1.12.5 Projects Rejected by Other GHG Programs

Not applicable.

1.13 Additional Information Relevant to the Project

Eligibility Criteria

CDM methodology ACM0001 is applicable because the main objective of the Project is to capture the landfill gas produced in the Uberlândia Landfills turning it into an active system. In the baseline scenario all the landfill gas resulted from the waste decomposition would be released in the atmosphere through the passive venting drains without any previous treatment. The Project made in investment in installing a new landfill gas capture system in the existing landfill. Also, the Project installed a flare and electricity generation equipments to convert the landfill gas in electricity and to destroy methane in a controlled manner.

Leakage Management

According with Version 12 of ACM0001, no leakage effects are accounted for under this methodology.

Commercially Sensitive Information

No financial estimation was excluded from the public version of CDM Project Design Document. However commercial proposals and contracts evidencing the CAPEX of the project activity have been excluded.

Sustainable Development

Not applicable.

Further Information

Not applicable.

2 APPLICATION OF METHODOLOGY

2.1 Title and Reference of Methodology

Uberlândia landfills I and II applies the following methodology and tools:

- Version 12.0.0 of ACM0001 – "Flaring or use of landfill gas";
- Version 4.0.0 of the "Combined tool to identify the baseline scenario and demonstrate additionality";
- Version 6.0.1 of the "Emissions from solid waste disposal sites";
- Version 01 of the "Tool to calculate baseline, project and/or leakage emissions from electricity consumption";
- Version 01 of the "Tool to determine project emissions from flaring gases containing methane";
- Version 2.0.0 of the "Tool to determine the mass flow of a greenhouse gas in a gaseous stream".

In accordance with the Tool to calculate baseline, project and/or leakage emissions from electricity consumption, the following tool is applied:

- Version 2.2.1 of the "Tool for calculation of emission factor for an electricity system".

2.2 Applicability of Methodology

-

2.3 Project Boundary

-

2.4 Baseline Scenario

-

2.5 Additionality

-

2.6 Methodology Deviations

Not applicable.

3 ESTIMATED GHG EMISSION REDUCTIONS AND REMOVALS

3.1 Baseline Emissions

Baseline Emissions

Version 12 of *ACM0001* states that greenhouse gas baseline emissions during a given year "y" (BE_y) are estimated according with the equation **(1)** below and comprises the following sources:

(A) Methane emissions from the SWDS in the absence of the project activity;

(B) Electricity generation using fossil fuels or supplied by the grid in the absence of the project activity;

(C) Heat generation using fossil fuels in absence of the project activity; and

(D) Natural gas used from the natural gas network in the absence of the project activity.

$$BE_y = BE_{CH4,y} + BE_{EC,y} + BE_{HG,y} + BE_{NG,y} \quad \textbf{(1)}$$

Where:

BE_y	=	Baseline emissions in year *y* (tCO_{2e}/yr)
$BE_{CH4,y}$	=	Baseline emissions of methane from the SWDS in year *y* (tCO_{2e}/yr)
$BE_{EC,y}$	=	Baseline emissions associated with electricity generation in year y (tCO_2/yr)
$BE_{HG,y}$	=	Baseline emissions associated with heat generation in year *y* (tCO_2/yr)
$BE_{NG,y}$	=	Baseline emissions associated with natural gas use in year *y* (tCO_2/yr)

As the Uberlândia landfills I and II does not include heat generation ($BE_{HG,y}$=0) and/or natural gas use ($BE_{NG,y}$=0), the equation is updated to:

$$BE_y = BE_{CH4,y} + BE_{EC,y} \quad \textbf{(2)}$$

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

Baseline emissions of methane from the SWDS are determined as follows, based on the amount of methane that is captured under the project activity and the amount that would be captured and destroyed in the baseline. In addition, the effect of methane oxidation that is present in the baseline and absent in the project is taken into account:

$$BE_{CH4,y} = (1 - OX_{top\_layer}) * (F_{CH4,PJ,y} - F_{CH4,BL,y}) * GWP_{CH4} \quad \textbf{(3)}$$

Where:

$BE_{CH4,y}$	=	Baseline emissions of methane from the SWDS in year *y* (tCO_{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); for this Project it is considered to be 0 (zero), as per the *ACM0001* in most circumstances where the LFG is captured and used this effect is considered to be very small, as the operators of the SWDS have in most cases an incentive to main a high methane concentration in

		the LFG, therefore the effect is neglected as a conservative assumption
$F_{CH4,PJ,y}$	=	Amount of methane in the LFG which is flared and/or used in the project activity in year *y* (tCH_4/yr)
$F_{CH4,BL,y}$	=	Amount of methane in the LFG that would be flared in the baseline in year *y* (tCH_4/yr)
GWP_{CH4}	=	Global Warming Potential of CH_4 (tCO_2/tCH_4)

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

According to the methodology *ACM0001*, during the crediting period, $F_{CH4,PJ,y}$ is determined as the sum of the quantities of methane flared and used in power plant(s), boiler(s), air heater(s), kiln(s) and natural gas distribution network, as follows:

$$F_{CH4,PJ,y} = F_{CH4,flared,y} + F_{CH4,EL,y} + F_{CH4,HG,y} + F_{CH4,NG,y} \quad \textbf{(4)}$$

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* (tCH_4/yr)
$F_{CH4,EL,y}$	=	Amount of methane in the LFG which is used for electricity generation in year *y* (tCH_4/yr)
$F_{CH4,HG,y}$	=	Amount of methane in the LFG which is used for heat generation in year *y* (tCH_4/yr)
$F_{CH4,NG,y}$	=	Amount of methane in the LFG which is sent to the natural gas distribution network in year *y* (tCH_4/yr)

As the project does not have heat generation ($F_{CH4,HG,y} = 0$), neither sends LFG to the natural gas distribution network ($F_{CH4,NG,y} = 0$), the equation (4) is updated to:

$$F_{CH4,PJ,y} = F_{CH4,flared,y} + F_{CH4,EL,y} \quad \textbf{(5)}$$

The working hours of the power plant are monitored and no emission reduction will be claimed for methane destruction during non-working hours.

Amount of methane used for electricity generation ($F_{CH4,EL,y}$)

$F_{CH4,EL,y}$ is determined using the *"Tool to determine the mass flow of a greenhouse gas in a gaseous stream"*. The following requirements apply:

- The gaseous stream the tool shall be applied to is the LFG delivery pipeline to each item of electricity generation equipment. $F_{CH4,EL,y}$ is then calculated as the sum of mass flows to each item of electricity generation equipment;
- CH_4 is the greenhouse gases for which the mass flow should be determined;
- The flow of the gaseous stream should be measured on continuous basis;

- The simplification offered for calculation the molecular mass of the gaseous stream is valid (equation 3 and 17 in the tool); and

- The mass flow should be summed to a yearly unit basis (t CH_4/yr).

Application of "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" (for determination of $F_{CH4,EL,y}$)

The option chosen for the calculation of the $F_{CH4,EL,y}$, according to the Table 1 of the tool, is the **Option A**, since the measurement of both flow of gaseous stream and volumetric fraction are on **dry basis**.

Therefore, it is necessary to demonstrate that the gaseous stream is dry to use this option. There are two ways to do this:

a) Measure the moisture content of the gaseous stream ($C_{H2O,t,db,n}$) and demonstrate that this is less or equal to 0.05 kg H2O/m^3 dry gas; or

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

For this project activity, the option (b) applies, as for security purposes the project participants installed a temperature probe at the hotter point of the LFG pipeline, just after the blowers, in order to continuously monitor this parameter. If the temperature reaches T_t = 60ºC the plant operation stops. No emission reductions will be claimed when the plant is stopped.

According to the *"Tool to determine the mass flow of a greenhouse gas in a gaseous stream"*, the mass flow of greenhouse gas *i* ($F_{i,t}$) is determined as follows:

$$F_{i,t} = V_{i,t,db} * v_{i,t,db} * \rho_{i,t} \quad \textbf{(6)}$$

With

$$\rho_{i,t} = \frac{P_t \times MM_i}{R_u \times T_t} \quad \textbf{(7)}$$

Where:

$F_{i,t}$	=	Mass flow of greenhouse gas *i* (CO_2, CH_4, N_2O, SF_6 or a PFC) 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 the gaseous gas *i* in the stream in a time interval *t* on a dry basis (m³ gas CH_4/m³ dry gas)
$\rho_{i,t}$	=	Density of the gaseous gas *i* in the stream in time interval *t* (kg CH_4/m³ CH_4)
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 (Pa.m^3/kmol.K)
T_t	=	Temperature of the gaseous stream in time interval *t* (K)

As described above, CH_4 is the greenhouse gas for which the mass flow shall be determined.

Amount of methane destroyed by flaring ($F_{CH4,flared,y}$)

$F_{CH4,flared,y}$ is determined as the difference between the amount of methane supplied to the flare(s) and any methane emissions from the flares(s), as the equation below:

$$F_{CH4,flared,y} = F_{CH4,sent\_flare,y} - (PE_{flare,y} / GWP_{CH4}) \quad \textbf{(8)}$$

Where:

$F_{CH4,flared,y}$	=	Amount of methane in the LFG which is destroyed by flaring in year *y* (tCH_4/yr)
$F_{CH4,sent\_flare,y}$	=	Amount of methane in the LFG which is sent to the flare in the year *y* (tCH_4/yr)
$PE_{flare,y}$	=	Project emissions from flaring of the residual gas stream in year *y* (tCO_2e/yr)
GWP_{CH4}	=	Global warming potential of CH4 (tCO_2e/ tCH_4)

$F_{CH4,sent\_flare,y}$ is 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).

The same options applied in the calculation of $F_{CH4,EL,y}$ are made for $F_{CH4,sent\_flare,y}$, as the measurement of both flow of gaseous stream and volumetric fraction are at **dry basis** and a temperature probe is installed at the hotter point of the LFG pipeline, just after the blowers, in order to continuously monitor this parameter, so the plant operation stops in case the temperature reaches T_t = 60°C. Therefore, the amount of methane sent to the flare(s) is calculated as per formulae **(6)** and **(8)**.

$PE_{flare,y}$ is 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.

Application of "Tool to determine project emissions from flaring gases containing methane" (for determination of $PE_{flare,y}$)

Since in this Project an **enclosed flare** is installed, the temperature in the exhaust gas of the flare is measured to determine whether the flare is operating or not.

According to the tool, for enclosed flares, either of the following two options can be used to determine the flare efficiency:

- To use a 90% default value. Continuous monitoring of compliance with manufacturer's specification of flare (temperature, flow rate of residual gas at the inlet of the flare) must be performed. If in a specific hour any of the parameters are out of the limit of manufacturer's specifications, a 50% default value for the flare efficiency should be used for the calculations for this specific hour.

- Continuous monitoring of the methane destruction efficiency of the flare (flare efficiency).

For the Project, a **90% default value for the flare efficiency** is used.

This tool involves the following seven steps:

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

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

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

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

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

STEP 6: Determination of the hourly flare efficiency

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

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

Step not applicable, since the methane combustion efficiency of the flare is not be continuously monitored.

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

Step not applicable, since the methane combustion efficiency of the flare is not be continuously monitored

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

Step not applicable, since the methane combustion efficiency of the flare is not be continuously monitored.

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

Step not applicable, since the methane combustion efficiency of the flare is not be continuously monitored

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

The residual gas moisture would not be significant in this Project because several treatment units are foreseen in order to reduce significantly the landfill gas moisture content; therefore the measured flow rate of the residual gas shouldn't be corrected to dry basis to be comparable with the measurement of methane that is undertaken on a dry basis.

$$TM_{RG,\,h} = FV_{RG,\,h} \times fv_{CH_4,\,RG,\,h} \times \rho_{CH_4,\,n} \qquad \textbf{(9)}$$

Where:

$TM_{RG,\,h}$	=	Mass flow rate of methane in the residual gas in the hour *h* (kg/h)
$FV_{RG,\,h}$	=	Volumetric flow rate of the residual gas in dry basis at normal conditions in hour *h* (m^3/h)
$fv_{CH4,\,RG,\,h}$	=	Volumetric fraction of methane in the residual gas on dry basis in hour *h*
$\rho_{CH4,\,n}$	=	Density of methane at normal conditions (0.716 kg/m^3)

STEP 6: Determination of the hourly flare efficiency

Following the methodology allowed options, the Project Proponents decided to adopt a default value for the flare efficiency.

Therefore, the flare efficiency in the hour h ($\eta_{flare,h}$) is:

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

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

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

  Continuous monitoring of compliance with manufacturer's specification of flare (temperature, flow rate of residual gas at the inlet of the flare) will be performed. In case of parameters out of the limit of manufacturer's specifications in a specific hour, a 50% default value for the flare efficiency is used for the calculations for this specific hour.

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:

$$PE_{flare,\,y} = \sum_{h=1}^{8760} TM_{RG,\,h} \times \left(1 - \eta_{Flare,\,h}\right) \times \frac{GWP_{CH_4}}{1000} \qquad \textbf{(10)}$$

Where:

$PE_{flare,\,y}$	=	Project emissions from flaring of the residual gas stream in year *y* (tCO_{2e})
$TM_{RG,\,h}$	=	Mass flow rate of methane in the residual gas in the hour *h* (kg/h)

$\eta_{flare,h}$ = Flare efficiency in the hour *h*

GWP_{CH4} = Global Warming Potential (tCO_{2e}/tCH_4) valid for the commitment period (tCO_{2e}/tCH_4)

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

According to the methodology *ACM0001*, to determine the amount of methane that would have been captured and destroyed (by flaring) in the baseline due to regulatory or contractual requirements, or to address safety and odour concerns (collectively referred to as *requirement* in this step), the appropriate case should be identified and the corresponding instruction followed.

Table 2: Cases for determining methane captured and destroyed in the baseline

Situation at the start of the project activity	Requirement to destroy methane	Existing LFG Capture system
Case 1	No	No
Case 2	Yes	No
Case 3	No	Yes
Case 4	Yes	Yes

In the Uberlândia Landfills I and II methane would be partially destroyed through lighting the top of some wells of passive venting system exclusively to address safety and odour concerns. There are no regulatory or contractual requirements related to the capture and/or destruction of methane generated in the landfill.

However, the Version 12 of *ACM0001* establishes that, when applying the *Step A.2*, the capture and destruction of methane in the baseline "*due to regulatory or contractual requirements, or to address safety and odour concerns*" should be "*collectively referred to as requirement*". Therefore, according to the methodology the purpose of the passive venting system used in the Project (addressing safety and odour concerns) is referred to as a requirement, for what the Case 3 is not applicable.

So, as the Uberlândia Landfills I and II would have a LFG capture system (passive system) and partially destroy methane through lighting the top of some wells of the passive venting system to address safety and odour concerns, the **Case 4** is identified as the appropriate case and is followed.

Case 4: Requirement to destroy methane exists and LFG capture system exists

$$F_{CH4,BL,y} = \max\{F_{CH4,BL,R,y}\ ;\ F_{CH4,BL,sys,y}\} \quad \textbf{(11)}$$

Where:

$F_{CH4,BL,R,y}$ = Amount of methane in the LFG which is flared in the baseline due to a requirement in year *y* (tCH_4/yr)

$F_{CH4,BL,sys,y}$ = 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 (tCH_4/yr)

According to the methodology, for the Case 4, $F_{CH4,BL,R,y}$ and $F_{CH4,BL,sys,y}$ shall be determined according to the respective procedures for Case 2 and Case 3.

According to Case 2 procedures:

- If the requirement does not specify the amount or percentage of LFG that should be destroyed but requires the installation of a capture system, without requiring the captured LFG to be flared then:

$$F_{CH4,BL,R,y} = 0 \quad \textbf{(12)}$$

According to Case 3 procedures:

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

$$F_{CH4,BL,sys,y} = F_{CH4,hist,y} \quad \textbf{(13)}$$

In determining $F_{CH4,hist,y}$ it is assumed that the fraction of LFG that was recovered in the year prior to the implementation of the project activity will be the same fraction recovered under the project activity:

$$F_{CH4,hist,y} = \frac{F_{CH4,BL,x-1}}{F_{CH4,x-1}} \cdot F_{CH4,PJ,y} \quad \textbf{(14)}$$

Where:

$F_{CH4,hist,y}$	=	Historical amount of methane in the LFG which is captured and destroyed (tCH_4/yr)
$F_{CH4,BL,x-1}$	=	Historical amount of methane in the LFG which is captured and destroyed in the year prior to the implementation of the project activity (tCH_4/yr)
$F_{CH4,x-1}$	=	Amount of methane in the LFG generated in the SWDS in the year prior to the implementation of the project activity, estimated using the actual amount of waste disposed in the landfill as per the Version 6.0.1 of the "*Emissions from solid waste disposal sites*" (tCH_4/yr)
$F_{CH4,PJ,y}$	=	Amount of methane in the LFG which is flared and/or used in the project activity in year y (tCH_4/yr)

$F_{CH4,BL,x-1}$ can be evaluated as a fraction of $F_{CH4,x-1}$, therefore:

$$F_{CH4,BL,x-1} = MD_{BL} \cdot F_{CH4,x-1} \quad \textbf{(15)}$$

Where:

$F_{CH4,BL,x-1}$	=	Historical amount of methane in the LFG which is captured and destroyed in the year prior to the implementation of the project activity (tCH_4/yr)
MD_{BL}	=	Methane destruction efficiency in the baseline (-)
$F_{CH4,x-1}$	=	Amount of methane in the LFG generated in the SWDS in the year prior to the implementation of the project activity, estimated using the actual amount of waste disposed in the landfill as per the Version 6.0.1 of the "*Emissions from solid waste disposal sites*" (tCH_4/yr)

According to the study "*Reducing the uncertainty of methane recovered (R) in GHG inventories from waste sector and of adjustment factor (AF) in landfill gas projects under CDM*"[3], 154 Brazilian municipal solid waste landfills were analyzed, and those which have available historic data (from reliable sources, as Brazilian Ministry of Cities, Brazilian Ministry of Environment and from landfill managers) had their methane destruction efficiency in the baseline (MD_{BL}) calculated, following the methodology *ACM0001*. Then, an average of this value was found among those landfills, in order to contribute for better estimating MD_{BL} in landfill gas destruction projects in Brazil, under the CDM. Project participants decided to use this study in order to contribute for better calculation of the $F_{CH4,hist,y}$ parameter.

As per this study, a collection efficiency of 75% was attributed to the passive systems, what the authors acknowledge to be a conservative approach, not reflecting the reality of existent passive systems commonly used in Brazil, and the sampled average MD_{BL} for those projects was 0.0176 and weighted average MD_{BL} was 0.0040 or, respectively, 1.76% and 0.40% (Table 19, in Appendix 4 of the related PDD). Regarding that the use of the sampled average MD_{BL} from the cited study is more conservative, for Uberlândia landfills I and II a methane destruction efficiency of 1.76% will be used for estimating the $F_{CH4,BL,x-1}$.

Therefore, the equation **(15)** is updated to:

$$F_{CH4,BL,x-1} = 1.76\% \ . \ F_{CH4,x-1} \qquad \textbf{(16)}$$

The equation **(17)** is then updated to:

$$F_{CH4,hist,y} = \frac{1.76\% \ . \ F_{CH4,x-1} \ . \ F_{CH4,PJ,y}}{F_{CH4,x-1}} \qquad \textbf{(17)}$$

Or

$$F_{CH4,hist,y} = 1.76\% \ . \ F_{CH4,PJ,y} \qquad \textbf{(18)}$$

Since the amount of methane in the LFG which is flared in the baseline ($F_{CH4,BL,y}$) shall be the major value, between those given in equations **12** (= 0) and **13** ($F_{CH4,BL,sys,y} = F_{CH4,hist,y}$), it is then determined that:

$$F_{CH4,BL,y} = 1.76\% \ . \ F_{CH4,PJ,y} \qquad \textbf{(19)}$$

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

According to the methodology, the baseline emissions associated with electricity generation in y ($BE_{EC,y}$) shall be calculated using the "*Tool to calculate baseline, project and/or leakage emissions from electricity consumption*".

Application of the tool "Tool to calculate baseline, project and/or leakage emissions from electricity consumption"(for determination of $BE_{EC,y}$)

The tool is applicable because the "Scenario A: Electricity consumption from the grid." applies to the sources of electricity for this Project and correspond to the sources of electricity generated

[3] Article presented at the *3rd International Workshop on Uncertainty in Greenhouse Gas Inventories* http://ghg.org.ua/fileadmin/user_upload/book/Proceedengs_UncWork.pdf; accessed in 06/06/2011.

identified in the selection of the most plausible baseline scenario. The general approach is used and the formula is:

$$BE_{EC,y} = \sum_{k} EC_{BL,k,y} \times EF_{EL,k,y} \times \left(1 + TDL_{k,y}\right) \quad \textbf{(20)}$$

Where:

$BE_{EC,y}$	=	Baseline emissions associated with electricity generation in the project activity in year *y* (tCO_2/yr)
$EC_{BL,k,y}$	=	Net amount of electricity generated using LFG in the project activity in year *y* (MWh/yr)
$EF_{EL,k,y}$	=	Emission factor for electricity generation for source *k* in year *y* (tCO_2/MWh)
$TDL_{k,y}$	=	Average technical transmission and distribution losses for providing electricity to source *k* in year *y.* A 20% default value has been used.
k	=	Sources of electricity generated identified in the baseline

The **Option A1** was chosen for the calculation of the $EF_{EL,k,y}$.

Option A1: Calculate the combined margin emission factor of the applicable electricity system, using the procedures in the approved version 2.2.1 of the "*Tool to calculate the emission factor for an electricity system*" ($EF_{EL,k,y} = EF_{grid,CM,y}$).

Determination of $EF_{EL,k,y}$ in equation ***(20)*** *- Application of "Tool to calculate the emission factor for an electricity system"*

$EF_{EL,k,y}$ is calculated according with the *Version 2.2.1 of the Tool for calculation of emission factor for an electricity system* ($EF_{grid,CM,\ y}$ in the tool). The tool considers the determination of the emissions factor for the grid to which the project activity is connected as the core data to be determined in the baseline scenario.

The Emission Factor is calculated as the *Combined Margin (CM)*, comprised by two components: the *Built Margin (BM)* and the *Operation Margin (OM)*. The BM evaluates the contribution of the power plants which would have been built if the project plant would not have been implemented. The OM evaluates the contribution of the power plants which would have been dispatched in the absence of the project activity.

The CM calculation must be based in data from an official source, preferable the dispatch authority. The capacity additions and the values generated from the power plants registered as CDM project activities must be excluded from the calculation. The calculation of the emission factor will be in charge of the CIMGC – Comissão Interministerial de Mudança Global do Clima (Brazilian DNA).

The OM values are presented in an hourly basis and the values are updated every month. The BM values are updated every year.

According with the Tool, *"If the DNA of the host country has published a delineation of the project electricity system and connected electricity systems, these delineations should be used"*. The

CIMGC published Resolução nº 8[4], which makes official the use of a single Electric Grid for CDM project activities applying the tool.

The steps 1 to 5: from the most recent version from the tool were applied by the CIMGC and the results were made available in their web-site.

Step 6: Calculate the combined margin emissions factor

The combined margin emissions factor was based on the following choice of method, and is calculated as follows:

(a) Weighted average CM

$$EF_{grid,CM,y} = EF_{grid,OM,y} * w_{OM} + EF_{grid,BM,y} * w_{BM} \quad \textbf{(21)}$$

Where:

$EF_{grid,CM,y}$ = Emission factor for the Brazilian electric grid in year *y* (tCO_2/MWh)

$EF_{grid,OM,y}$ = Operating margin CO_2 emission factor in year *y* (tCO_2/MWh)

$EF_{grid,BM,y}$ = Build margin CO_2 emission factor in year *y* (tCO_2/MWh)

w_{OM} = Weighting of operating margin emissions factor (%)

w_{BM} = Weighting of build margin emissions factor (%)

According with the *Tool*, values adopted for w_{OM} and w_{BM} were equal to 0.5 for each one during the 1st crediting period and 0.25 and 0.75, respectively, for the 2nd and 3rd crediting periods.

3.2 Project Emissions

Project emissions are calculated as follows:

$$PE_y = PE_{EC,y} + PE_{FC,y} \quad \textbf{(22)}$$

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)

The project does not consume fossil fuels for purpose other than electricity generation, therefore $PE_{FC,y} = 0$.

$PE_{EC,y}$ is determined using the *"Tool to calculate baseline, project and/or leakage emissions from electricity consumption"*.

[4] CIMGC – Comissão Interministerial de Mudança Global do Clima; "Resolução nº 8, de 26 de maio de 2009, que adota, para fins de atividade de projeto de MDL, um único sistema como definição de sistema elétrico do projeto no Sistema Interligado Nacional", available at http://www.mct.gov.br/; acessed in 08/09/2011.

Application of the "Tool to calculate baseline, project and/or leakage emissions from electricity consumption" (for determination of $PE_{EC,y}$)

As the same of the $BE_{EC,y}$, the tool is applicable because the "Scenario A: Electricity consumption from the grid." applies to the sources of electricity for this Project.

The general formula is:

$$PE_{EC,y} = \sum_{j} EC_{PJ,j,y} \times EF_{EL,j,y} \times \left(1 + TDL_{j,y}\right) \quad \textbf{(23)}$$

Where:

$PE_{EC,y}$	=	Project emissions from electricity consumption in the year y (tCO_2/yr)
$EC_{PJ,j,y}$	=	Quantity of electricity consumed by the project electricity consumption source *j* in year *y* (MWh/yr)
$EF_{EJ,j,y}$	=	Emission factor for electricity generation for source *j* in year *y* (tCO_2/MWh)
$TDL_{j,y}$	=	Average technical transmission and distribution losses for providing electricity to source *j* in year *y.* A 20% default value has been used.
j	=	Sources of electricity consumption in the project activity.

For the calculation of the EF, Option A1: "Calculate the combined margin emission factor of the applicable electricity system, using the procedures in the approved version 2.2.1 of the "*Tool to calculate the emission factor for an electricity system*"" applies. The calculations and considerations done for the $EF_{EL,k,y}$ shall be considered, only regarding that, for project emissions from electricity consumption, $EF_{grid,CM,y} = EF_{EL,j,y}$.

3.3 Leakage

According with Version 12 of ACM0001, no leakage effects are accounted for under this methodology.

3.4 Estimated Net GHG Emission Reductions and Removals

Emission Reductions will be calculated according with the equation below:

$$ER_y = BE_y - PE_y \quad \textbf{(24)}$$

Where:

ER_y	=	Emission reductions in year *y* (tCO_2e)
BE_y	=	Baseline emissions in year *y* (tCO_2e)

PE_y = Project emissions in year *y* (tCO_2e)

4 MONITORING

4.1 Data and Parameters Available at Validation

Parameters used exclusively for ex-ante estimation in the registered PDD were excluded from this monitoring report for simplicity. None of them are necessary for the present monitoring report. They are: η_{PJ} (Efficiency of the LFG capture system that will be installed in the project activity), $BE_{CH4,SWDS,y}$ (Baseline emissions occurring in the year y generated from waste disposal at a SWDS during a time period ending in the year y), $\rho_{CH4,n}$ (Density of methane gas at normal conditions), $\varphi_{default}$ (Default value for the model correction factor to account for model uncertainties), **OX** (Oxidation factor (reflecting the amount of methane from SWDS that is oxidized in the soil or other material covering the waste), **F** (Fraction of methane in the SWDS gas (volume fraction)), $DOC_{f,default}$ (Default value for the fraction of degradable organic carbon (DOC) in MSW that decomposes in the SWDS), $MCF_{default}$ (Methane correction factor), DOC_j (Fraction of degradable organic carbon in the waste type j (weight fraction)), k_j (Decay rate for the waste type j), 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), W_x (Total amount of waste disposed in a SWDS in year x), $p_{n,j,x}$ (Weight fraction of the waste type j in deposited waste), **z** (Number of samples collected during the year x).

Data / Parameter	OX_{top_layer}
Data 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 *“Emission from solid waste disposal sites”*
Value applied	0
Justification of choice of data or description of measurement methods and procedures applied	As per *ACM0001* version 12, in most circumstances where the LFG is captured and used this effect was considered to be very small, as the operators of the SWDS have in most cases an incentive to main a high methane concentration in the LFG. For this reason, this effect is neglected as a conservative assumption.
Purpose of the data	Calculation of baseline emissions.
Comments	Applicable to Step A of ACM0001 version 12.

Data / Parameter	$F_{CH4,hist,y}$
Data unit	t CH_4 / yr
Description	Historical amount of methane in the LFG which is captured and destroyed

<table>
<tr><td>Source of data</td><td>According to the study “Reducing the uncertainty of methane recovered (R) in GHG inventories from waste sector and of adjustment factor (AF) in landfill gas projects under CDM”.</td></tr>
<tr><td>Value applied</td><td>$F_{CH4,hist,y}$ = 1.76% * $F_{CH4,PJ,y}$
The $F_{CH4,hist,y}$ value for each year is shown in the table:
<table>
<tr><th>Month</th><th>$F_{CH4,hist,y}$ [t CH_4/yr]</th><th>Month</th><th>$F_{CH4,hist,y}$ [t CH_4/yr]</th></tr>
<tr><td>2012 Mar</td><td>5.43</td><td>2012 Jul</td><td>5.25</td></tr>
<tr><td>2012 Apr</td><td>5.52</td><td>2012 Ago</td><td>5.33</td></tr>
<tr><td>2012 May</td><td>5.09</td><td>2012 Sep</td><td>0.59</td></tr>
<tr><td>2012 Jun</td><td>4.96</td><td></td><td></td></tr>
</table>
Please refer to the emission reductions calculation spreadsheet, attached as a document, to see the hourly values.</td></tr>
<tr><td>Justification of choice of data or description of measurement methods and procedures applied</td><td>Calculated as per the version 12 of ACM0001 and described in the section E.1 of this document.
$F_{CH4,hist,y}$ is compared with the $F_{CH4,BL,R,y}$ as required by the version 12 of ACM0001 in order to calculate the $F_{CH4,BL,y}$.</td></tr>
<tr><td>Purpose of the data</td><td>Calculation of baseline emissions.</td></tr>
<tr><td>Comments</td><td>Applicable to Case 3 of Step A.2 of ACM0001 version 12.</td></tr>
</table>

Data / Parameter	**GWP_{CH4}**
Data unit	t CO_{2e}/t CH_4
Description	Global warming potential of CH_4
Source of data	IPCCC
Value applied	• Up to the year 2012: 21
Justification of choice of data or description of measurement methods and procedures applied	Decisions under UNFCCC and the Kyoto Protocol (a value of 21 is to be applied for the first commitment period of the Kyoto Protocol).
Purpose of the data	Calculation of baseline emissions.
Comments	-

Data / Parameter	**R_u**
Data unit	Pa.m^3/kmol.K
Description	Universal ideal gases constant
Source of data	“*Tool to determine the mass flow of a greenhouse gas in a gaseous stream”* version 02.0.0 and “*Tool to determine project emissions from flaring gases containing methane*” version 01

Value applied	8,314.472
Justification of choice of data or description of measurement methods and procedures applied	Physical constant
Purpose of the data	Calculation of baseline emissions.
Comments	-

Data / Parameter	**MM_i**
Data unit	kg/kmol
Description	Molecular mass of greenhouse gas *i*
Source of data	"*Tool to determine the mass flow of a greenhouse gas in a gaseous stream*" version 02.0.0
Value applied	(see table below)
Justification of choice of data or description of measurement methods and procedures applied	Physical constant.
Purpose of the data	Calculation of baseline emissions.
Comments	For this Project, only CH4 is analyzed.

Compound (*i*)	Structure	Molecular mass (kg / kmol)
Carbon dioxide	CO_2	44.01
Methane	CH_4	16.04
Nitrous oxide	N_2O	44.02
Sulphur hexafluoride	SF_6	146.06
Perfluoromethane	CF_4	88.00
Perfluoroethane	C_2F_6	138.01
Perfluoropropane	C_3F_8	188.02
Perfluorobutane	C_4F_{10}	238.03
Perfluorocyclobutane	$c\text{-}C_4F_8$	200.03
Perfluoropentane	C_5F_{12}	288.03
perfluorohexano	C_6F_{14}	338.04

4.2 Data and Parameters Monitored

Data / Parameter	**$F_{CH4,BL,R,y}$**
Data unit	t CH_4/yr
Description	Amount of methane in the LFG which is flared in the baseline due

	to a requirement in year *y*
Source of data	Information of the host country's regulatory requirements relating to LFG, contractual requirements, or requirements to address safety and odour concerns.
Description of measurement methods and procedures applied	$F_{CH4,BL,R,y}$ will be compared with the $F_{CH4,hist,y}$ as required by the version 12 of *ACM0001* in order to calculate the $F_{CH4,BL,y}$.
Frequency of monitoring/recording	Monitored annually.
Value applied:	0
Monitoring equipment	Not applicable. Type, accuracy class, serial number and calibration frequency do not apply.
QA/QC procedures applied	Internal audits are going to be performed in order to ensure correct monitoring of this parameter
Purpose of data	Calculation of baseline emissions.
Calculation method	Not applicable.
Comments	Applicable to Case 2 of Step A.2 of *ACM0001* version 12.

Data / Parameter	$\rho_{reg,y}$
Data unit	Dimensionless
Description	Fraction of LFG that is required to be flared due to a requirement in year y
Source of data	Default
Description of measurement methods and procedures applied	Information of the host country's regulatory requirements relating to LFG, contractual requirements, or requirements to address safety and odour concerns.
Frequency of monitoring/recording	0
Value applied:	Not applicable. Type, accuracy class, serial number and calibration frequency do not apply.
Monitoring equipment	Monitored annually.
QA/QC procedures applied	Not applicable.

Purpose of data	Internal audits are going to be performed in order to ensure correct monitoring of this parameter.
Calculation method	Calculation of baseline emissions or baseline net GHG removals by sinks.
Comments	Applicable to Case 2 of Step A.2 of ACM0001 version 12.

Data / Parameter	**$PE_{flare,y}$**
Data unit	tCO_{2e}
Description	Project emissions from flaring of the residual gas stream in year y
Source of data	Calculated as per the *"Tool to determine project emissions from flaring gases containing methane".*
Description of measurement methods and procedures applied	Not applicable.
Frequency of monitoring/recording	Calculated for each hour using hourly aggregated data. Aggregated also monthly and yearly for reporting purposes.
Value applied:	As an illustrative representation of the values of this parameter in the monitoring period, data were aggregated monthly as shown in the table below: **Month** / **$PE_{flare,y}$ (tCO_2e)** 2012 Mar / 99.86 2012 Apr / 111.24 2012 May / 83.54 2012 Jun / 32.33 2012 Jul / 16.67 2012 Ago / 13.67 2012 Sep / 0.00 Please refer to the emission reductions calculation spreadsheet, attached as a document, to see the hourly values.
Monitoring equipment	Not applicable. Type, accuracy class, serial number and calibration frequency do not apply.
QA/QC procedures applied	Internal audits are going to be performed in order to ensure correct monitoring of this parameter.

Purpose of data	Calculation of baseline emissions.
Calculation method	Please refer to the Section 4.1 of this document.
Comments	Archive data will be kept minimum two years after the end of the crediting period.

Data / Parameter	**Operation of the energy plant**
Data unit	Hr
Description	Operation of the energy plant
Source of data	Engine's working hours counter meters
Description of measurement methods and procedures applied	Data is processed and registered by the PLC. For this monitoring period, only the Engine 2 was operating.
Frequency of monitoring/recording	Monitoring frequency: continuous Recording frequency: every two minutes Aggregation frequency: hourly, daily, monthly
Value applied:	As an illustrative representation of the values of this parameter in the monitoring period, data were aggregated monthly as shown in the table below:
Monitoring equipment	Engine's working hour counter meters. Type, accuracy class, serial number and calibration frequency for the hour counter meter do not apply. Engine 1: Type JGC 420 GS-L.L; Serial number 1024802 Engine 2: Type JGC 420 GS-L.L; Serial number 1024794
QA/QC procedures applied	Not applicable.
Purpose of data	Calculation of baseline emissions.

Month	Working hours of Engine 2 [h]
2012 Mar	687
2012 Apr	703
2012 May	668
2012 Jun	688
2012 Jul	709
2012 Ago	714
2012 Sep	71

Calculation method	Not applicable.
Comments	This is monitored to ensure methane destruction is claimed for methane used in electricity plant when it is operational.

Data / Parameter	$PE_{EC,y}$
Data unit	tCO_2
Description	Project emissions from electricity consumption by the project activity during the year y
Source of data	Calculated as per the "*Tool to calculate baseline, project and/or leakage emissions from electricity consumption*".
Description of measurement methods and procedures applied	Not applicable.
Frequency of monitoring/recording	Calculated hourly as it depends on the $EC_{PJ,j,y}$ and $EF_{EL,j,y}$.
Value applied:	As an illustrative representation of the values of this parameter in the monitoring period, data were aggregated monthly as shown in the table below: <table><tr><th>Month</th><th>PE_{EC,y} (tCO₂)</th><th>Month</th><th>PE_{EC,y} (tCO₂)</th></tr><tr><td>2012 Mar</td><td>0.4</td><td>2012 Jul</td><td>0.4</td></tr><tr><td>2012 Apr</td><td>0.1</td><td>2012 Ago</td><td>0.4</td></tr><tr><td>2012 May</td><td>1.0</td><td>2012 Sep</td><td>0.0</td></tr><tr><td>2012 Jun</td><td>0.3</td><td></td><td></td></tr></table>Please refer to the emission reductions calculation spreadsheet, attached as a document, to see the hourly values.
Monitoring equipment	Not applicable. Type, accuracy class, serial number and calibration frequency do not apply.
QA/QC procedures applied	Internal audits are going to be performed in order to ensure correct monitoring of this parameter
Purpose of data	Calculation of project emissions.
Calculation method	Please refer to the Section 4.2 of this document.
Comments	Archive data will be kept minimum two years after the end of the crediting period.

Data / Parameter	$V_{t,db}$
Data unit	m^3 dry gas/h

Description	Volumetric flow of the gaseous stream in time interval *t* on a dry basis
Source of data	Flow meter
Description of measurement methods and procedures applied	Instant flow is continuously measured by a flow meter, one for the flare's feeding pipeline and one for each electricity generation equipment pipeline. Automatic measurement of the landfill gas temperature and pressure are made by probes connected to the flow meter. The flow is measured continuously in Nm^3/h and data is aggregated hourly to summarize the Nm^3 of LFG being delivered to the flaring and electricity generation sections, then monthly and yearly for reporting purposes. According to the Tool to determine the mass flow of a greenhouse gas in a gaseous stream, 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 by demonstrating that (one of the two options): a)The moisture content of the gaseous stream is less of equal to 0.05 kg H_2o/m^3 dry gas; or b)The temperature of the gaseous stream (T_t) is less than 60°C (333.15 K) at the flow measurement point. In the Project, the plant is design not to operate under temperatures greater than 60°C for security purposes; it is done through a temperature sensor installed at the hotter point of LFG pipeline, after the blowers. For flare, $\mathbf{V_{t,db} = FV_{RG,h}}$. For this monitoring period, only the Flare and Engine 2 were operating.
Frequency of monitoring/recording	Monitoring frequency: continuous Recording frequency: every two minutes Aggregation frequency: hourly, daily, monthly
Value applied:	As an illustrative representation of values of this parameter in the monitoring period, data was aggregated monthly as shown in the table below:

Month	**$V_{t,db}$ [Nm^3]**	
	Flare line	**Engine 2 line**
2012 Mar	94,610	782,184
2012 Apr	100,112	745,308
2012 May	75,391	714,328
2012 Jun	23,196	826,926
2012 Jul	2,191	959,979
2012 Ago	5,328	966,743

	2012 Sep | - | 107,464 Please refer to the emission reductions calculation spreadsheet, attached as a document, to see the hourly values.
Monitoring equipment	The monitoring equipments are listed below: Flare 1 line (23/01/2012 ~ 03/12/2012) Brand & Type: FCI ST 51 Accuracy: +/- 1% Serial number: 411848 Engine 2 line (23/01/2012 ~03/12/2012) Brand & Type: FCI ST 51 Accuracy: +/- 1% Serial number: 411850
QA/QC procedures applied	According to the manufacture' specifications, the flow meter requires external calibration every 18 months. Flare line Brand and Serial nº of equipment | Calibration date | Calibration validity | Calibration certificate nº (name of company) FCI 411848 | 13/09/2011 | 12/09/2012 | - (FCI)(1) (1) The calibration certificate does not have a specific identification number. Engine 2 line Brand and Serial nº of equipment | Calibration date | Calibration validity | Calibration certificate nº (name of company) FCI 411850 | 13/09/2011 | 12/09/2012 | - (FCI)(1) (1) The calibration certificate does not have a specific identification number.
Purpose of data	Calculation of baseline emissions or baseline net GHG removals by sinks.
Calculation method	Not applicable.
Comments	This parameter will be monitored in Option A of the tool.

Data / Parameter	$v_{i,t,db}$
Data unit	m^3 gas *i*/m^3 dry gas
Description	Volumetric fraction of greenhouse gas *i* in a time interval *t* in a dry basis
Source of data	Continuous gas analyzer
Description of measurement methods and procedures applied	According to the *Tool to determine the mass flow of a greenhouse gas in a gaseous stream*, 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 by demonstrating that (one of the two options): a)The moisture content of the gaseous stream is less of equal to 0.05 kg H_2o/m^3 dry gas; or b)The temperature of the gaseous stream (T_t) is less than 60°C (333.15 K) at the flow measurement point. In the Project, the plant is design not to operate under temperatures greater than 60°C for security purposes; it is done through a temperature sensor installed at the measured lines. For this Project, only CH_4 is analyzed. Therefore, $\mathbf{v_{i,t,db} = fv_{CH4,RG,h}}$.
Frequency of monitoring/recording	Monitoring frequency: continuous Recording frequency: every two minutes Aggregation frequency: hourly, daily, monthly
Value applied:	As an illustrative representation of the values of this parameter in the monitoring report period data were aggregated monthly, as shown in the table below: (see table below) Please refer to the emission reductions calculation spreadsheet, attached as a document, to see the hourly values.
Monitoring equipment	Brand: Siemens Type: Ultramat 23 Accuracy: +/-1% for the CH_4 and 0.5% for the O_2 Serial Number: N1B8759
QA/QC procedures applied	The supplier of the methane analyzer recommends calibrating the instrument every six or twelve months depending on the application. However, it has been decided to perform the calibration on a more frequent basis in order to get a more conservative measure. The methane analyzer is calibrated every month by a trained plant operator and supervised by the Project Manager (PM). The plant operator applies the calibration procedure suggested by the manufacturer which is documented within the Plant Maintenance Manual. The internal calibration is registered on the respective form: “Formulario de calibração analisador fixo de biogás” – FO

Month	$\mathbf{v_{CH4,t,db}}$ **(%)**
2012 Mar	49.93
2012 Apr	52.75
2012 May	52.21
2012 Jun	46.83
2012 Jul	43.86
2012 Ago	44.05
2012 Sep	43.53

	CAL/002. The plant operator and the PM have been trained in order to be qualified to carry out the calibration procedure correctly. All the training certificates are available at the plant. The process for calibration is performed by use of gas cylinders which are purchased from a certified gas supplier. The cylinders have a quality certificate that assures the quality of the calibration gases. Calibrated gases cylinders' certificate numbers are listed below:

Period of use	Type of gas mixture	Cylinder nº	Calibration date (validity)	Certificate nº (name of company)
30/08/2012 ~ 17/11/2014	60% CH_4 and 40% CO_2	EID 5018	25/11/2011 (36 months or 24/11/2014)	3199/11 (Linde)
30/08/2012 ~ 17/11/2014	100% N_2	EHR 2155	23/11/2011 (36 months or 22/11/2014)	- (Linde)

When installed Ultramat 23 had been calibrated by its manufacturer, so the equipment was duly calibrated when it started operating. During the monitoring period Ultramat 23 was calibrated in the following dates:

• 10/03/2012 • 05/04/2012 • 03/05/2012 • 01/06/2012	• 01/07/2012 • 31/07/2012 • 30/08/2012

Purpose of data	Calculation of baseline emissions.
Calculation method	Not applicable
Comments	Data will be archived electronically during the crediting period and two years after.

Data / Parameter	T_t
Data unit	°C
Description	Temperature of the gaseous stream in time interval *t*
Source of data	Temperature sensor
Description of measurement methods and procedures applied	Data is processed and registered by the PLC.

Frequency of monitoring/recording	Monitoring frequency: continuous Recording frequency: every two minutes Aggregation frequency: hourly, daily, monthly
Value applied:	As an illustrative representation of the values of this parameter in the monitoring period data were aggregated monthly as shown in the table below: <table><tr><th>Month</th><th>T_t (°C)</th></tr><tr><td>2012 Mar</td><td>29.49</td></tr><tr><td>2012 Apr</td><td>28.27</td></tr><tr><td>2012 May</td><td>27.06</td></tr><tr><td>2012 Jun</td><td>27.70</td></tr><tr><td>2012 Jul</td><td>28.12</td></tr><tr><td>2012 Ago</td><td>27.99</td></tr><tr><td>2012 Sep</td><td>29.69</td></tr></table>Please refer to the emission reductions calculation spreadsheet, attached as a document, to see the hourly values calculated.
Monitoring equipment	Measured continuously with temperature sensor installed at the hottest point of the LFG pipeline, just after the blowers, to assure that the applicability condition related to the gaseous stream flow temperature being below 60°C is met. (23/01/2012 ~ 03/10/2012) Brand & Type: Ecil Pt-100 Accuracy: 0.15 ºC + 0.002*T Serial number: 1129.541344
QA/QC procedures applied	External calibration is applied to this equipment annually. <table><tr><th>Brand and Serial nº of equipment</th><th>Calibration date</th><th>Calibration validity</th><th>Calibration certificate nº (name of company)</th></tr><tr><td>Ecil 1129.541344</td><td>20/10/2011</td><td>19/10/2012</td><td>7862/11 (Ecil)</td></tr></table>
Purpose of data	Calculation of baseline emissions.
Calculation method	Not applicable.
Comments	As all parameters are converted to normal conditions during the monitoring process, this parameter is needed exclusively to ensure the gaseous stream is dry (applicability condition).

Data / Parameter	P_t
Data unit	Pa

Description	Pressure of the gaseous stream in time interval *t*
Source of data	Not applicable.
Description of measurement methods and procedures applied	Not applicable.
Frequency of monitoring/recording	Not applicable.
Value applied:	Not applicable.
Monitoring equipment	Not applicable.
QA/QC procedures applied	Not applicable.
Purpose of data	Not applicable.
Calculation method	Not applicable.
Comments	As all parameters will be converted to normal conditions during the monitoring process, this parameter is not needed to be monitored.

Data / Parameter	$fv_{CH4,RG,h}$
Data unit	-
Description	Volumetric fraction of methane in the residual gas on dry basis in the hour *h*
Source of data	See parameter $v_{i,t,db}$.
Description of measurement methods and procedures applied	See parameter $v_{i,t,db}$.
Frequency of monitoring/recording	See parameter $v_{i,t,db}$.
Value applied:	See parameter $v_{i,t,db}$.
Monitoring equipment	See parameter $v_{i,t,db}$.
QA/QC procedures applied	See parameter $v_{i,t,db}$.
Purpose of data	Calculation of baseline emissions.
Calculation method	See parameter $v_{i,t,db}$.
Comments	See parameter $v_{i,t,db}$.

Data / Parameter	$FV_{RG,h}$

Data unit	m^3/h
Description	Volumetric flow rate of the residual gas in dry basis at normal conditions in the hour *h*
Source of data	See parameter $\mathbf{V}_{t,db}$ for Flare line.
Description of measurement methods and procedures applied	See parameter $\mathbf{V}_{t,db}$ for Flare line.
Frequency of monitoring/recording	See parameter $\mathbf{V}_{t,db}$ for Flare line.
Value applied:	See parameter $\mathbf{V}_{t,db}$ for Flare line.
Monitoring equipment	See parameter $\mathbf{V}_{t,db}$ for Flare line.
QA/QC procedures applied	See parameter $\mathbf{V}_{t,db}$ for Flare line.
Purpose of data	Calculation of baseline emissions.
Calculation method	See parameter $\mathbf{V}_{t,db}$ for Flare line.
Comments	See parameter $\mathbf{V}_{t,db}$ for Flare line.

Data / Parameter	$\mathbf{T}_{flare}$
Data unit	°C
Description	Temperature in the exhaust gas of the enclosed flare
Source of data	Type S thermocouple
Description of measurement methods and procedures applied	Data is processed and registered by the PLC.
Frequency of monitoring/recording	Monitoring frequency: continuous Recording frequency: every two minutes Aggregation frequency: hourly, daily, monthly
Value applied:	As an illustrative representation of the values of this parameter in the monitoring period data were aggregated monthly as shown in the table below:

Month	T_{flare} (°C)
2012 Mar	248.83
2012 Apr	342.50
2012 May	246.46
2012 Jun	92.62
2012 Jul	20.41
2012 Ago	25.98

	2012 Sep — 18.55 Please refer to the emission reductions calculation spreadsheet, attached as a document, to see the hourly values.
Monitoring equipment	(23/01/2012 ~ 03/10/2012) Brand: Ecil Type: Thermocouple that withstands temperatures up to 1,600°C Accuracy: +/-1.5ºC or 0.25% of the temperature (the one which is greater) Serial number: 1126.527878
QA/QC procedures applied	External calibration is applied to this equipment annually. **Brand and serial nº of equipment** / **Calibration date** / **Calibration validity** / **Calibration certificate nº (name of company)** Ecil 1126.527878 / 20/10/2011 / 19/10/2012 / 7866/11 (Ecil)
Purpose of data	Calculation of baseline emission.
Calculation method	Not applicable.
Comments	Archive data will be kept minimum two years after the end of the crediting period.

Data / Parameter	$EC_{BL,k,y}$
Data unit	MWh/yr
Description	Net amount of electricity generated using LFG in year *y*
Source of data	Electricity meter
Description of measurement methods and procedures applied	Data measured continuously with an electricity meter specifying the total amount of electricity exported in the time interval.
Frequency of monitoring/recording	Monitoring frequency: continuous Recording and aggregation frequency: monthly (CEMIG's invoices emission frequency)
Value applied:	Values measured by the electricity meter in kWh and aggregated to MWh for reporting purposes only.

Month	$EC_{BL,k,y}$ (MWh)
2012 Mar	925.80
2012 Apr	944.29
2012 May	895.78
2012 Jun	929.15
2012 Jul	935.39
2012 Ago	938.73

	2012 Sep 95.27
Monitoring equipment	<u>Main Electricity Meter</u> **Brand and type:** Schneider ION 8600C **Accuracy:** +/- 0.2% **Serial nº of equipment:** PT-1104A085-1 **Calibration frequency:** not applicable **Calibration date:** 16/11/2011 **Calibration certificate nº:** CCM-210/2011 <u>Standby Electricity Meter</u> **Brand and type:** Schneider ION 8600C **Accuracy:** +/- 0.2% **Serial nº of equipment:** PT-1103B220-01 **Calibration frequency:** not applicable **Calibration date:** 16/11/2011 **Calibration certificate nº:** CCM-211/2011
QA/QC procedures applied	Electricity meter belongs to CEMIG, which is responsible for its maintenance and for continuously checking the measured data to verify that the equipment works properly and is accurate, otherwise CEMIG provides external calibration.
Purpose of data	Calculation of baseline emissions.
Calculation method	Not applicable.
Comments	Data will be archived electronically during the crediting period and two years after.

Data / Parameter	$\mathbf{EF_{EL,k,y}}$
Data unit	tCO_2/MWh
Description	Emission factor for electricity generation for source *k* in year *y*
Source of data	The data used to calculate the grid emission factor was taken from the Brazilian DNA[5].
Description of measurement methods and procedures applied	Not applicable.
Frequency of monitoring/recording	Annually.
Value applied:	In this Project, $\mathbf{EF_{EL,k,y} = EF_{grid,CM,y}}$. 2012: 0.3593 tCO_2/MWh
Monitoring equipment	Not applicable. Type, accuracy class, serial number and calibration frequency do not apply.

[5] http://www.mct.gov.br (Accessed in 03/06/2016).

QA/QC procedures applied	Internal Audits are going to be performed in order to ensure correct monitoring of this parameter.
Purpose of data	Calculation of baseline emissions.
Calculation method	Please refer to the Section 4.1 of this document.
Comments	-

Data / Parameter	$TDL_{k,y}$
Data unit	-
Description	Average technical transmission and distribution losses for providing electricity to source k in year *y*
Source of data	According to the "*Tool to calculate baseline, project and/or leakage emissions from electricity consumption*", scenario A applies to the project as the source of electricity consumption and, since no recent, accurate and reliable data were available, the option to choose a default value of 20% was chosen
Description of measurement methods and procedures applied	Not applicable.
Frequency of monitoring/recording	Annually.
Value applied:	$TDL_{k,y} = TDL_{j,y}$ 20%
Monitoring equipment	Not applicable. Type, accuracy class, serial number and calibration frequency do not apply.
QA/QC procedures applied	Internal Audits are going to be performed in order to ensure correct monitoring of this parameter.
Purpose of data	Calculation of baseline emissions.
Calculation method	Please refer to the Section 4.1 of this document.
Comments	Archive data will be kept minimum two years after the end of the crediting period.

Data / Parameter	$EC_{PJ, j, y}$
Data unit	MWh
Description	Quantity of electricity consumed by the project electricity consumption source *j* in year *y*
Source of data	Electricity meter
Description of measurement methods	Data measured continuously with an electricity meter specifying the total amount of electricity exported in the time interval.

and procedures applied	
Frequency of monitoring/recording	Monitoring frequency: continuous Recording and aggregation frequency: monthly (CEMIG's invoices emission frequency)
Value applied:	Values measured by the electricity meter in kWh and aggregated to MWh for reporting purposes only. <table><tr><th>Month</th><th>$EC_{PJ,j,y}$ (MWh)</th></tr><tr><td>2012 Mar</td><td>0.89</td></tr><tr><td>2012 Apr</td><td>0.27</td></tr><tr><td>2012 May</td><td>2.39</td></tr><tr><td>2012 Jun</td><td>0.80</td></tr><tr><td>2012 Jul</td><td>1.03</td></tr><tr><td>2012 Ago</td><td>0.89</td></tr><tr><td>2012 Sep</td><td>0.01</td></tr></table>
Monitoring equipment	Main Electricity Meter **Brand and type:** Schneider ION 8600C **Accuracy:** +/- 0.2% **Serial nº of equipment:** PT-1104A085-1 **Calibration frequency:** not applicable **Calibration date:** 16/11/2011 **Calibration certificate nº:** CCM-210/2011 Standby Electricity Meter **Brand and type:** Schneider ION 8600C **Accuracy:** +/- 0.2% **Serial nº of equipment:** PT-1103B220-01 **Calibration frequency:** not applicable **Calibration date:** 16/11/2011 **Calibration certificate nº:** CCM-211/2011
QA/QC procedures applied	Electricity meter belongs to CEMIG, which is responsible for its maintenance and for continuously checking the measured data to verify that the equipment works properly and is accurate, otherwise CEMIG provides external calibration.
Purpose of data	Calculation of project emissions.
Calculation method	Not applicable.
Comments	Data will be archived electronically during the crediting period and two years after

Data / Parameter	$EF_{grid,CM,y}$
Data unit	tCO_2/MWh
Description	Combined margin emissions factor required to evaluate CO_2

	emissions due to the power consumption of the project activity imported from the National Grid
Source of data	The data used to calculate the grid emission factor was taken from the Brazilian DNA[6].
Description of measurement methods and procedures applied	Please see parameter $\mathbf{EF_{EL,k,y}}$.
Frequency of monitoring/recording	Please see parameter $\mathbf{EF_{EL,k,y}}$.
Value applied:	For this Project, $\mathbf{EF_{grid,CM,y} = EF_{EL,k,y} = EF_{EL,j,y}}$. Please see parameter $\mathbf{EF_{EL,k,y}}$.
Monitoring equipment	Please see parameter $\mathbf{EF_{EL,k,y}}$.
QA/QC procedures applied	Please see parameter $\mathbf{EF_{EL,k,y}}$.
Purpose of data	Calculation of project emissions.
Calculation method	Please see parameter $\mathbf{EF_{EL,k,y}}$.
Comments	Please see parameter $\mathbf{EF_{EL,k,y}}$.

Data / Parameter	$\mathbf{TDL_{j,y}}$
Data unit	-
Description	Average technical transmission and distribution losses for providing electricity to source *j* in year *y*
Source of data	According to the "*Tool to calculate baseline, project and/or leakage emissions from electricity consumption*", scenario A applies to the project as the source of electricity consumption and, since no recent, accurate and reliable data were available, the option to choose a default value of 20% was chosen.
Description of measurement methods and procedures applied	See parameter $\mathbf{TDL_{k,y}}$.
Frequency of monitoring/recording	See parameter $\mathbf{TDL_{k,y}}$.
Value applied:	$\mathbf{TDL_{j,y} = TDL_{k,y}}$ 20%
Monitoring equipment	See parameter $\mathbf{TDL_{k,y}}$.
QA/QC procedures applied	See parameter $\mathbf{TDL_{k,y}}$.
Purpose of data	Calculation of project emissions.
Calculation method	See parameter $\mathbf{TDL_{k,y}}$.

[6] http://www.mct.gov.br (Accessed in 03/06/2016).

Comments	See parameter **$TDL_{k,y}$**.

4.3 Monitoring Plan

According to ACM0001, direct monitoring is conducted on the LFG captured, destroyed by flare and used for power generation.

An operative manual of the project is available. This Management Manual has the applicative documents of the monitoring plan (description of the project and responsibilities, operative procedures for measurements and handlings of data and details about internal audits, etc.).

Operators collect necessary data for the monitoring plan and the Project Manager verifies the correct application of the operative procedures written in the manual.

The monitoring plan is described below:

1 DATA MONITORED

The monitoring procedures include:

- Landfill gas flow into flare
- Landfill gas flow into power plant
- Methane content in the landfill gas
- Temperature of exhaust gas from flaring
- Electricity imported from the power grid
- Electricity exported to the power grid
- Power plant working hours
- Emissions from flaring
- Emission Factors
- $TDL_{k/j,y}$ = Average technical transmission and distribution losses for providing electricity to source *k/j* in year *y*
- Information of the host country's regulatory requirement relating to LFG, contractual requirements, or requirements to address safety and odour concerns

All equipment of the plant are connected through a Programmable Logic Control (PLC) that permits the operator quick check of the main working parameters through a user-friendly interface.

2 DATA COLLECTED, FREQUENCY AND QUALITY CONTROL

Landfill gas flow:

- fed to the flares
- fed to the electricity generation devices

Landfill gas flow is measured by means of a flow meter. One flow meter is installed for each LFG destroying device.

In order to normalize the flow measured by the flow meter to standard temperature and pressure, the temperature and pressure of LFG are measured by temperature and pressure sensors already included in the flow meter equipment.

Flow meters are subjected to regular maintenance and testing regime to ensure accuracy according to manufacturer's specifications.

Methane content in the landfill gas

Methane content in the landfill gas is measured by a gas analyzer with an infrared ray system analysis (Siemens – Ultramat 23), with a scale range of 0-100%Vol.

The CH_4 analyzer is calibrated according to its calibration protocol.

The gas analyzer is subject to regular maintenance and testing regime to ensure accuracy according to manufacturer's specifications and accuracy is checked at least every six month during the plant normal operation.

Temperature of exhaust gas

Project owners measure and control the temperature of the exhaust gas with a thermocouple installed in the upper section of the flare, at 80% of the flare's height, in order to determine the efficiency of the flare.

The default value of flare efficiency is correlated with the value of temperature of the exhaust gas. Flare efficiency is considered:

- 0% if the temperature in the exhaust gas of the flare is below 500 °C for more than 20 minutes during the hour h.

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

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

The enclosed flare is equipped with an extra thermocouple at the bottom part of chamber (height of main combustion occurrence). Data from this equipment can be used to assess whether the flare was correctly operating or not in case of failure of thermocouple installed at the top of flare.

Thermocouple is calibrated every year using a reference thermocouple, in case of failure in calibration the thermocouple will be replaced.

Electricity imported from and exported to power grid

Electricity imported and exported by power grid is measured by electricity meters owned by the local administrator of the grid – CEMIG (Companhia Energética de Minas Gerais), which is responsible for the maintenance of this equipment. Both amounts of electricity can be verified in official electricity bills emitted by the local administrator of the grid.

Power Plant Working Hours

Engines' working hour meters are connected to the PLC and so this parameter is continuously monitored and hourly reported.

Emissions from flaring

Project emissions from flaring of the residual gas stream in year y (tCO_{2e}) are determined by the procedure described in the *"Tool to determine project emissions from flaring gases containing methane"*. Please refer to the section E.1 of this document.

Emission Factor

Since "ex post" option has been chosen in the Operating Margin calculations applying the "*Tool to calculate the emission factor for an electricity system*", the emission factor is determined for the year in which the project activity displaces grid electricity, requiring the emissions factor to be updated annually during monitoring. If the data required to calculate the emission factor for year y is usually only available later than six months after the end of year y, alternatively the emission factor of the previous year (y-1) may be used. If the data is usually only available 18 months after the end of year y, the emission factor of the year proceeding the previous year (y-2) may be used. The same data vintage (y, y-1 or y-2) will be used throughout all crediting periods.

TDL

Project emissions from consumption of electricity are calculated based on the quantity of electricity consumed, an emission factor for electricity generation and TDL, a factor to account for transmission losses.

The Average technical transmission and distribution losses for providing electricity to the Project in year y is monitored annually. In the absence of data from the relevant year, most recent figures should be used, but not older than 5 years.

TDL_y should be estimated for the distribution and transmission networks of the electricity grid of the same voltage as the connection where the proposed CDM project activity is connected to. The technical distribution losses should not contain other types of grid losses (e.g. commercial losses/theft). The distribution losses can either be calculated by the project participants or be based on references from utilities, network operators or other official documentation.

Internal Audits are going to be performed in order to ensure correct monitoring of this parameter.

Information of the host country's regulatory requirement relating to LFG, contractual requirements, or requirements to address safety and odour concerns

The regulatory requirement relating to LFG valid in the host country, contractual requirements, or requirements to address safety and odour concerns are monitored annually, in order to define the amount of methane in the LFG that would have been flared in the baseline, as per equation (11) in the section E.1 of this document.

Possible failure: No electrical power

When there is no electrical power the blower of the biogas plant cannot operate, so no landfill gas stream is available.

The flow meter detects no landfill gas stream and does not count any CO_{2e}. No special actions are possible to avoid this.

3 MONITORING EQUIPMENT AND INSTALLATION

All measurement equipments are maintained and managed on general technical standards. The Management Manual determines the quality control regime for each key that includes regular maintenance and calibration. The measurement and recording are done in an accurate and transparent manner.

In order to determine the quantity of ERs generated during the project activity the following equipment are installed. (Figure 3)

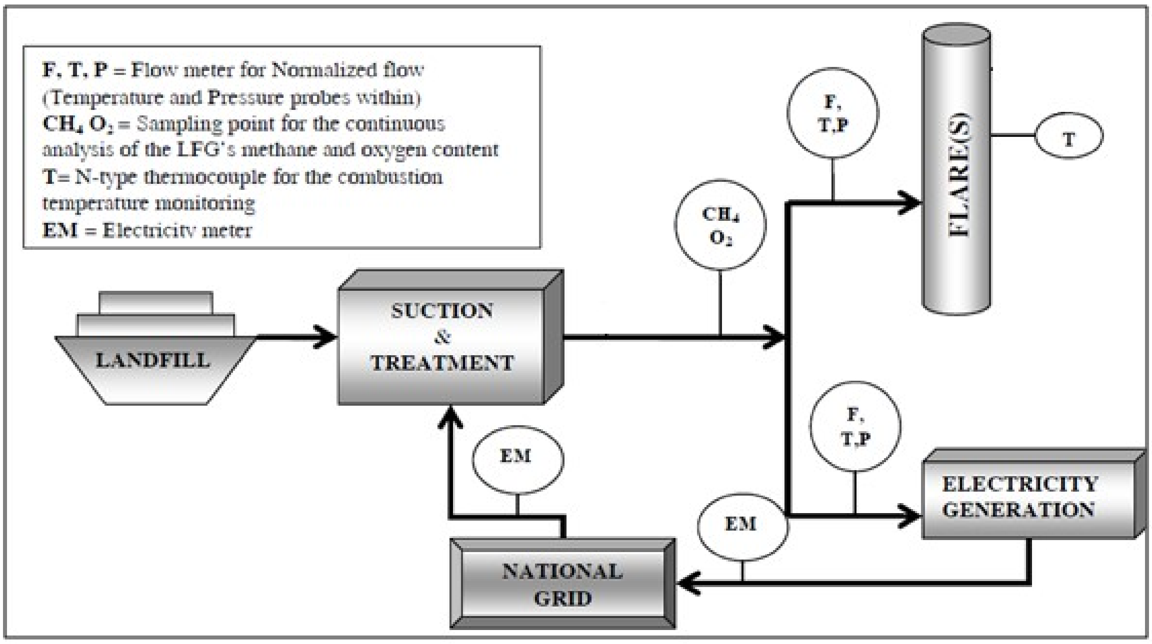

Figure 3: Monitoring points.

4 CALCULATION OF THE AMOUNT OF ERs

The greenhouse gas emission reduction achieved by the project activity during a given year "y" (ER_y) is calculated by using the formula as given in methodology *ACM0001* and in the related tools and showed in the section E of this document.

5 MONITORING ORGANIZATION

To assure a correct monitoring, the personnel are trained on the following subjects:

- General knowledge about the equipment used in the landfill
- Reading and recording data
- Calibration methodology
- Emergency situation

Chosen trainees have a good understanding of the processes and installation of the technology for the landfill gas extraction. And the personnel are trained before the plant enters into operation (Figure 4).

A guidebook about landfill gas extraction and utilization in English and Portuguese is also available. The guidebook has:

- Operating manual
- Maintenance instructions
- Description of the main parts of the equipment

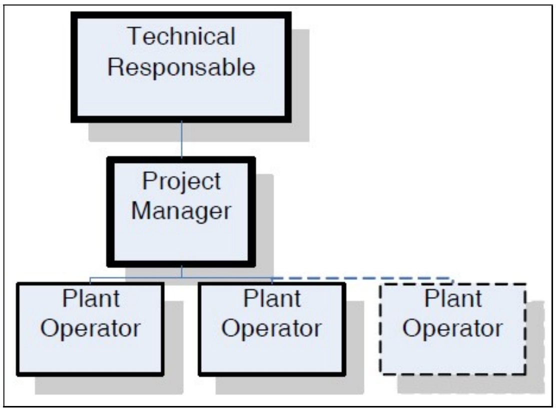

Figure 4: Organization Chart.

6 CALIBRATION

All measurement instruments are subject to regular calibration. The calibration procedures in the “Management Manual” define the management, checks and calibration intervals of the equipment used for process control.

PM is responsible for the management of the pieces of equipment needing regular calibration for the biogas installations.

The regular check and calibration are entrusted to the operators. The PM is responsible for checking the equipment’s proper working order, as well as checking and storing up the calibration certificates and records. Calibration documents are kept for all equipment until two years after the end of the crediting period.

7 DATA MANAGEMENT SYSTEM

The PLC receives continuously the value of the parameters monitored on-site and automatically generates spreadsheets that are archived. The information archived is aggregated hourly, monthly and yearly in a standard format for reporting purposes.

The quality control system ensures that all the necessary documents (such as operation manual, drawings, maintenance and calibration instructions, etc.) are available and stored in a proper manner. Monitored data and monitoring sheets are copied to the Project Proponent's digital server every six months. All data, including calibration records and Monitoring Reports, will be kept until 2 years after the end of the crediting period.

8 AUDIT REVIEW

Internal audits are performed by an auditor not involved in the daily operation of the biogas plant in order to assess the implementation of the Monitoring Plan and to prepare the Monitoring Report

5 SAFEGUARDS

5.1 No Net Harm

Extensive evaluation on the environmental and socio-economic impacts associated with the Project and respective mitigation measures was made when obtaining the environmental license, and regular report on the environmental and socio-economic parameters monitoring is provided to the environmental agency. Also, this Project was registered under the Gold Standard in 09-July-2013 with the reference ID GS3434.

5.2 Environmental Impact

Extensive evaluation on the environmental and socio-economic impacts associated with the Project and respective mitigation measures was made when obtaining the environmental license, and regular report on the environmental and socio-economic parameters monitoring is provided to the environmental agency.

5.3 Local Stakeholder Consultation

Not applicable.

5.4 Public Comments

Not applicable.

6 ACHIEVED GHG EMISSION REDUCTIONS AND REMOVALS

6.1 Data and Parameters Monitored

Data / Parameter	$F_{CH4,BL,R,y}$
Data unit	t CH_4/yr
Description	Amount of methane in the LFG which is flared in the baseline due to a requirement in year *y*
Value applied:	0
Comments	Applicable to Case 2 of Step A.2 of *ACM0001* version 12.

Data / Parameter	$\rho_{reg,y}$
Data unit	Dimensionless
Description	Fraction of LFG that is required to be flared due to a requirement in year y
Value applied:	Not applicable. Type, accuracy class, serial number and calibration frequency do not apply.
Comments	Applicable to Case 2 of Step A.2 of *ACM0001* version 12.

Data / Parameter	$PE_{flare,y}$
Data unit	tCO_{2e}
Description	Project emissions from flaring of the residual gas stream in year y
Value applied:	As an illustrative representation of the values of this parameter in the monitoring period, data were aggregated monthly as shown in the table below: (see table below) Please refer to the emission reductions calculation spreadsheet, attached as a document, to see the hourly values.
Comments	Archive data will be kept minimum two years after the end of the crediting period.

Month	$PE_{flare,y}$ (tCO_2e)
2012 Mar	99,86
2012 Apr	111,24
2012 May	83,54
2012 Jun	32,33
2012 Jul	16,67
2012 Ago	13,67
2012 Sep	0,00

Data / Parameter	**Operation of the energy plant**
Data unit	Hr
Description	Operation of the energy plant
Value applied:	As an illustrative representation of the values of this parameter in the monitoring period, data were aggregated monthly as shown in the table below:
Comments	This is monitored to ensure methane destruction is claimed for methane used in electricity plant when it is operational.

Month	Working hours of Engine 2 [h]
2012 Mar	687
2012 Apr	703
2012 May	668
2012 Jun	688
2012 Jul	709
2012 Ago	714
2012 Sep	71

Data / Parameter	**$PE_{EC,y}$**
Data unit	tCO_2
Description	Project emissions from electricity consumption by the project activity during the year y
Value applied:	As an illustrative representation of the values of this parameter in the monitoring period, data were aggregated monthly as shown in the table below:
Comments	Archive data will be kept minimum two years after the end of the crediting period.

Month	$PE_{EC,y}$ (tCO_2)	Month	$PE_{EC,y}$ (tCO_2)
2012 Mar	0.4	2012 Jul	0.4
2012 Apr	0.1	2012 Ago	0.4
2012 May	1.0	2012 Sep	0.0
2012 Jun	0.3		

Please refer to the emission reductions calculation spreadsheet, attached as a document, to see the hourly values.

Data / Parameter	$V_{t,db}$
Data unit	m^3 dry gas/h
Description	Volumetric flow of the gaseous stream in time interval *t* on a dry basis
Value applied:	As an illustrative representation of values of this parameter in the monitoring period, data was aggregated monthly as shown in the table below:
Comments	This parameter will be monitored in Option A of the tool.

Month	$V_{t,db}$ [Nm^3]	
	Flare line	Engine 2 line
2012 Mar	94,610	782,184
2012 Apr	100,112	745,308
2012 May	75,391	714,328
2012 Jun	23,196	826,926
2012 Jul	2,191	959,979
2012 Ago	5,328	966,743
2012 Sep	-	107,464

Please refer to the emission reductions calculation spreadsheet, attached as a document, to see the hourly values.

Data / Parameter	$v_{i,t,db}$
Data unit	m^3 gas *i*/m^3 dry gas
Description	Volumetric fraction of greenhouse gas *i* in a time interval *t* in a dry basis
Value applied:	As an illustrative representation of the values of this parameter in the monitoring report period data were aggregated monthly, as shown in the table below:

Month	$v_{CH4,t,db}$ (%)
2012 Mar	49.93
2012 Apr	52.75
2012 May	52.21
2012 Jun	46.83
2012 Jul	43.86
2012 Ago	44.05
2012 Sep	43.53

Please refer to the emission reductions calculation spreadsheet,

	attached as a document, to see the hourly values.
Comments	Data will be archived electronically during the crediting period and two years after.

Data / Parameter	T_t
Data unit	°C
Description	Temperature of the gaseous stream in time interval *t*
Value applied:	As an illustrative representation of the values of this parameter in the monitoring period data were aggregated monthly as shown in the table below: <table><tr><th>Month</th><th>T_t (°C)</th></tr><tr><td>2012 Mar</td><td>29.49</td></tr><tr><td>2012 Apr</td><td>28.27</td></tr><tr><td>2012 May</td><td>27.06</td></tr><tr><td>2012 Jun</td><td>27.70</td></tr><tr><td>2012 Jul</td><td>28.12</td></tr><tr><td>2012 Ago</td><td>27.99</td></tr><tr><td>2012 Sep</td><td>29.69</td></tr></table>Please refer to the emission reductions calculation spreadsheet, attached as a document, to see the hourly values calculated.
Comments	As all parameters are converted to normal conditions during the monitoring process, this parameter is needed exclusively to ensure the gaseous stream is dry (applicability condition).

Data / Parameter	P_t
Data unit	Pa
Description	Pressure of the gaseous stream in time interval *t*
Value applied:	Not applicable.
Comments	As all parameters will be converted to normal conditions during the monitoring process, this parameter is not needed to be monitored.

Data / Parameter	$fv_{CH4,RG,h}$
Data unit	-

Description	Volumetric fraction of methane in the residual gas on dry basis in the hour *h*
Value applied:	See parameter $\mathbf{v_{i,t,db}}$.
Comments	See parameter $\mathbf{v_{i,t,db}}$.

Data / Parameter	$\mathbf{FV_{RG,h}}$
Data unit	m^3/h
Description	Volumetric flow rate of the residual gas in dry basis at normal conditions in the hour *h*
Value applied:	See parameter $\mathbf{V_{t,db}}$ for Flare line.
Comments	See parameter $\mathbf{V_{t,db}}$ for Flare line.

Data / Parameter	$\mathbf{T_{flare}}$
Data unit	°C
Description	Temperature in the exhaust gas of the enclosed flare
Value applied:	As an illustrative representation of the values of this parameter in the monitoring period data were aggregated monthly as shown in the table below: (see table below) Please refer to the emission reductions calculation spreadsheet, attached as a document, to see the hourly values.
Comments	Archive data will be kept minimum two years after the end of the crediting period.

Month	T_{flare} (°C)
2012 Mar	248.83
2012 Apr	342.50
2012 May	246.46
2012 Jun	92.62
2012 Jul	20.41
2012 Ago	25.98
2012 Sep	18.55

Data / Parameter	$\mathbf{EC_{BL,k,y}}$
Data unit	MWh/yr
Description	Net amount of electricity generated using LFG in year *y*
Value applied:	Values measured by the electricity meter in kWh and aggregated to MWh for reporting purposes only.

	<table><tr><th>Month</th><th>$EC_{BL,k,y}$ (MWh)</th></tr><tr><td>2012 Mar</td><td>925.80</td></tr><tr><td>2012 Apr</td><td>944.29</td></tr><tr><td>2012 May</td><td>895.78</td></tr><tr><td>2012 Jun</td><td>929.15</td></tr><tr><td>2012 Jul</td><td>935.39</td></tr><tr><td>2012 Ago</td><td>938.73</td></tr><tr><td>2012 Sep</td><td>95.27</td></tr></table>
Comments	Data will be archived electronically during the crediting period and two years after .

Data / Parameter	$EF_{EL,k,y}$
Data unit	tCO_2/MWh
Description	Emission factor for electricity generation for source *k* in year *y*
Value applied:	In this Project, $EF_{EL,k,y} = EF_{grid,CM,y}$. 2012: 0.3593 tCO_2/MWh
Comments	-

Data / Parameter	$TDL_{k,y}$
Data unit	-
Description	Average technical transmission and distribution losses for providing electricity to source k in year *y*
Value applied:	$TDL_{k,y} = TDL_{j,y}$ 20%
Comments	Archive data will be kept minimum two years after the end of the crediting period.

Data / Parameter	$EC_{PJ, j, y}$
Data unit	MWh
Description	Quantity of electricity consumed by the project electricity consumption source *j* in year *y*
Value applied:	Values measured by the electricity meter in kWh and aggregated to MWh for reporting purposes only. <table><tr><th>Month</th><th>$EC_{PJ, j, y}$ (MWh)</th></tr><tr><td>2012 Mar</td><td>0.89</td></tr></table>

	2012 Apr — 0.27 2012 May — 2.39 2012 Jun — 0.80 2012 Jul — 1.03 2012 Ago — 0.89 2012 Sep — 0.01
Comments	Data will be archived electronically during the crediting period and two years after

Data / Parameter	$\mathbf{EF_{grid,CM,y}}$
Data unit	tCO_2/MWh
Description	Combined margin emissions factor required to evaluate CO_2 emissions due to the power consumption of the project activity imported from the National Grid
Value applied:	For this Project, $\mathbf{EF_{grid,CM,y} = EF_{EL,k,y} = EF_{EL,j,y}}$. Please see parameter $\mathbf{EF_{EL,k,y}}$.
Comments	Please see parameter $\mathbf{EF_{EL,k,y}}$.

Data / Parameter	$\mathbf{TDL_{j,y}}$
Data unit	-
Description	Average technical transmission and distribution losses for providing electricity to source *j* in year *y*
Value applied:	$\mathbf{TDL_{j,y} = TDL_{k,y}}$ 20%
Comments	See parameter $\mathbf{TDL_{k,y}}$.

6.2 Baseline Emissions

The data used to calculate the grid emission factor was taken from publicly information available in the Brazilian DNA's website[7] for the year 2012, as demonstrated in the Tables 3 below.

Table 3: Combined emission factor calculation for 2012

$EF_{CM} = (EF_{OM} \times W_{OM}) + (EF_{BM} \times W_{BM})$					
EMISSION FACTOR (tCO_2/MWh)					
YEAR	EF_{OM}	EF_{BM}	W_{OM}	W_{BM}	EF_{CM}

[7] http://www.mct.gov.br/index.php/content/view/74689.html (accessed in 03/062016).

2012	0.5176	0.2010	0.50	0.50	0.3593

For other calculations applying actual values, please refer to the emission reductions spreadsheet, attached as a document, to see the values calculated and/or aggregated every one hour.

The Baseline emissions of methane from the SWDS, the Baseline emissions associated with electricity generation in the project activity are calculated in the Table 4 below. For hourly calculation, please refer to the emission reductions calculation spreadsheet attached as a document.

Table 4: Baseline emissions

Month	**$F_{CH4,flared,y}$**	**$F_{CH4,EL,y}$**	**$F_{CH4,PJ,y}$**	**$F_{CH4,BL,y}$**	**GWP_{CH4}**	**BE_{CH4}**	**$BE_{EC,y}$**
	(tCH_4)	**(tCH_4)**	**(tCH_4)**	**(tCH_4)**	**-**	**(tCO_{2e})**	**(tCO_{2e})**
2012 Mar	27.88	280.14	308.03	5.42	21	6,354	399
2012 Apr	32.45	280.66	313.11	5.51	21	6,459	407
2012 May	25.53	263.19	288.72	5.08	21	5,956	386
2012 Jun	6.10	275.40	281.50	4.95	21	5,807	400
2012 Jul	0.00	298.20	298.20	5.25	21	6,151	403
2012 Aug	1.35	301.29	302.64	5.33	21	6,243	404
2012 Sep	0.00	33.27	33.27	0.59	21	686	41
Total						**37,656**	**2,440**

6.3 Project Emissions

The Project emission for electricity consumption was calculated in the Table 5 below.

Table 5: Project emissions for electricity consumption from the national grid

Project emission for electricity consumption from the national grid				
Month	**$EC_{PJ,j,y}$ (kWh)**	**$EF_{grid,CM,y}$(tCO_2/MWh)**	**$TDL_{j,y}$ (-)**	**$PE_{EC,y}$ (tCO_2e)**
2012 Mar	891.45	0.3593	0.2	0.4
2012 Apr	271.76	0.3593	0.2	0.1
2012 May	2,392.91	0.3593	0.2	1.0
2012 Jun	797.33	0.3593	0.2	0.3
2012 Jul	1,032.51	0.3593	0.2	0.4
2012 Aug	885.84	0.3593	0.2	0.4
2012 Sep	8.96	0.3593	0.2	0.0
Total				**2.7**

6.4 Leakage

According with Version 12 of ACM0001, no leakage effects are accounted for under this methodology.

6.5 Net GHG Emission Reductions and Removals

Year	Baseline emissions or removals (tCO_2e)	Project emissions or removals (tCO_2e)	Leakage emissions (tCO_2e)	Net GHG emission reductions or removals (tCO_2e)
2012	40,096	3	0	40,093
Total	40,096	3	0	40,093