MONITORING REPORT FORM (CDM-MR) *
Version 01 - in effect as of: 28/09/2010

CONTENTS

* as contained within the document entitled "Guidelines for completing the monitoring report form (CDM-MR)" (EB 54 meeting report, annex 34).

MONITORING REPORT
Version 1 and date 07/10/2011

Exploitation of the biogas from controlled landfill in solid waste management central – CTRS / BR.040

3464
Monitoring period No.1 (04/06/2011 - 30/09/2011)

SECTION A. General description of the project activity

A.1. Brief description of the project activity: >>

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Purpose of the project activity and the measures taken to reduce greenhouse gas emissions

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 times the CO2, the Project reduces the emission of GHG into the atmosphere by means of methane destruction in high temperature flares and of displacement of electricity generated from fossil fuel sources.

Brief description of the installed technology and equipments

The LFG is collect through vertical wells drilled in the waste mass 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 then sent to the electricity generation sets and/or to the enclosed flares. 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 Project total installed capacity of project activity is 5.704 MW having four engines of 1.426 MW individual capacities. The details of the technology have been explained in section A.4 of this report.

Relevant dates for the project activity

The landfill began accepting waste in 1975. By the end 2006, more than 17,400,000 m3 of solid urban waste have been filled over the landfill. The maximum landfill height is about 64 meters. The lifetime of the landfill was 32 years, ending on December 2007.

The Project's infrastructure construction started in December 2008 and the first landfill gas collection wells were drilled by the beginning of 2009.

The landfill gas aspiration and flare combustion plant was installed in 12/09/2009 and it is operational since 29/10/2009. Combustion plant was initially composed by 2 enclosed flares of 2,500 Nm^3/h of capacity each one.

The electricity generation plant was commissioned in the second fortnight of November and start operating in 30/11/2010.

In 04/06/2011 one of the enclosed flares installed in the combustion plant was definitively turned off, because it had been idle since the generation plant started operating.

CDM validation was contracted in 19/10/2008 and completed in 24/02/2010. The project activity accomplished its CDM registration in 04/06/2011 with the reference number 3464.

Total emission reductions achieved in this monitoring period

In the monitoring period, from 04/06/2011 to 30/09/2011 (both dates included), the Project achieved 82,860 tCO_{2e}.

A.2. Project Participants

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Name of Party Involved (host)	Private and/or public entity(ies) project participants	Kindly indicate if the Party involved wishes to be considered as project participant (Yes / No)
Brazil (host)	• Consórcio Horizonte Asja (Private entity) • Asja Brasil Serviços para o Meio Ambiente Ltda. (Private entity) • Aria.biz S.A. (Private entity)	No

Consórcio Horizonte Asja is a joint venture between Asja Brasil Serviços para o Meio Ambiente Ltda. and Aria.biz S.A..

A.3. Location of the project activity:

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The Project is locate in CTRS / BR.040 Landfill, to be found on highway BR.040, section Belo Horizonte – Sete Lagoas, near km 531, Jardim Filadélfia neighbourhood in Belo Horizonte city, Minas Gerais state, Brazil.

CTRS / BR.040 landfill is located, according to Google Earth, at the following coordinates:

- Latitude S: 19.9159°
- Longitude W: 44.0181°

The pictures below present the detailed location of the landfill:

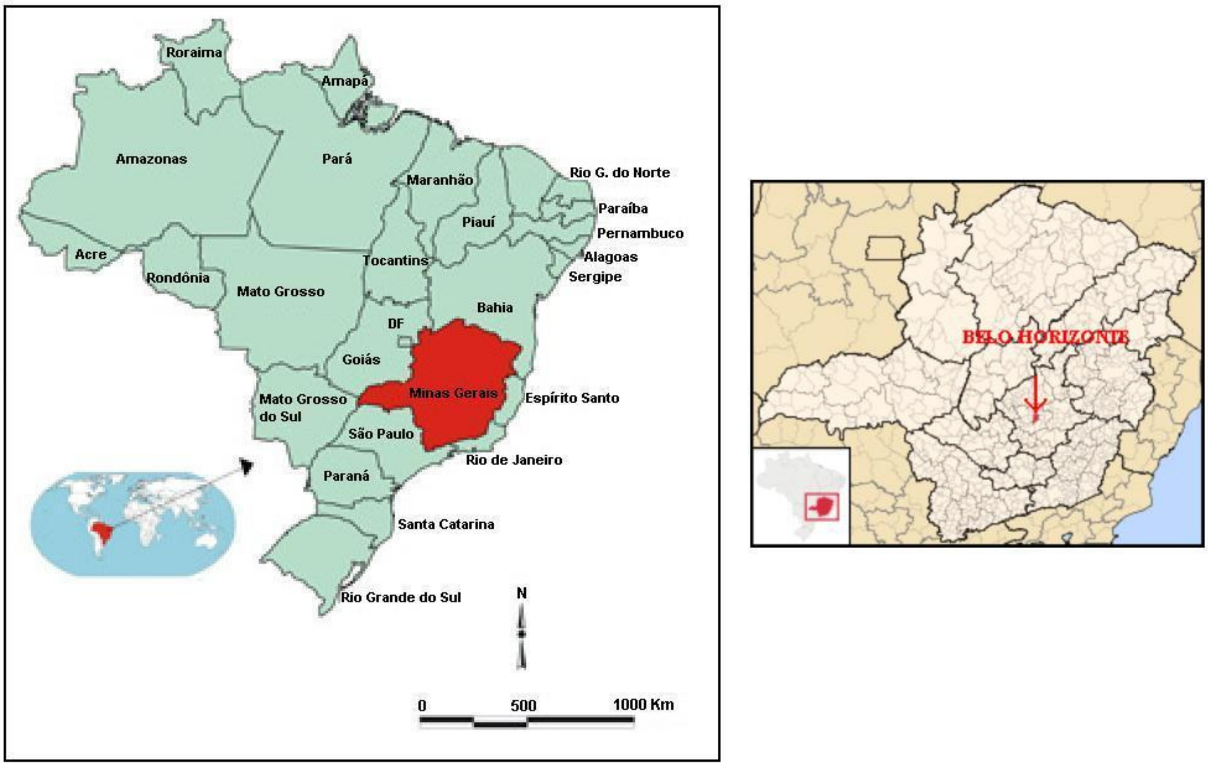

Figure 1: Project location.

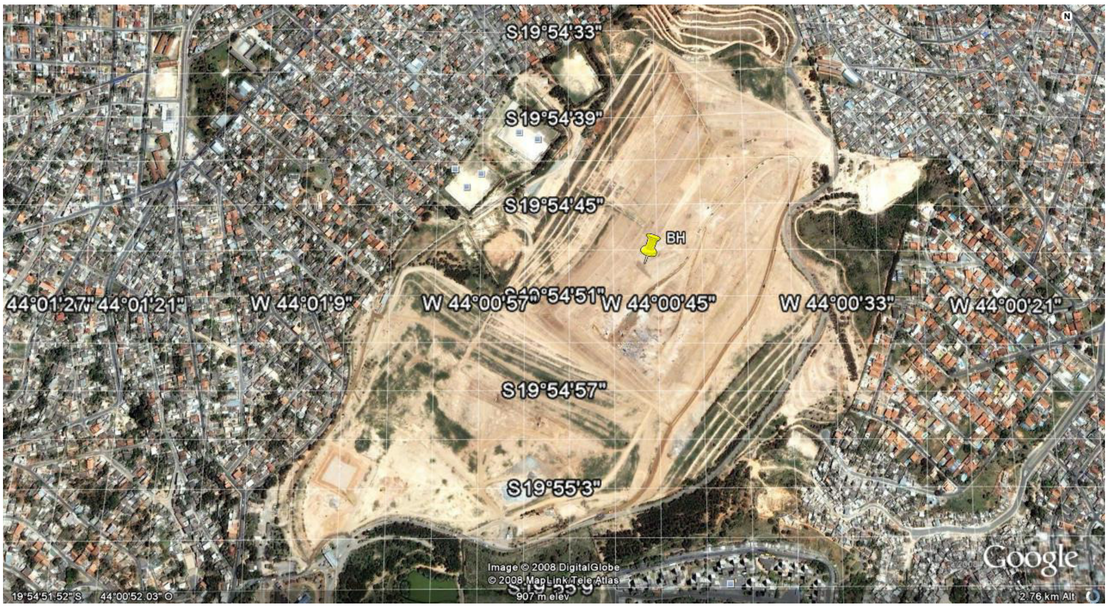

Figure 2: CTRS / BR.040 landfill location. (Source: Google Earth)

A.4. Technical description of the project

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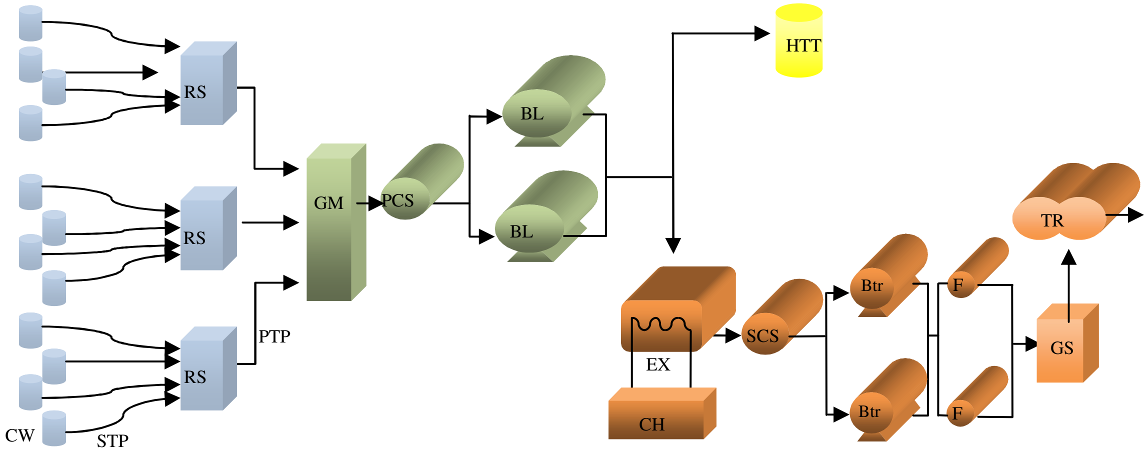
<u>Biogas plant general layout</u>

Consórcio Horizonte Asja is responsible for all the design, construction, operation and maintenance process. The technology to be employed by the Project includes landfill gas collecting, pre-treatment, power generation and flare combustion systems. The following sections are recognized in the plant:

A. Biogas Collection / Conveying Section;
B. Biogas Suction and Control Section;
C. Treatment, Electricity Generation and Flare Combustion Section.

These sections are generically showed in Figure 3 below and described subsequently.



Collection Section	Suction and Control Section	Electricity generation and Torch Section
CW: Capture Well **STP**: Biogas Secondary Transport Pipelines **RS:** Regulation Substation **PTP:** Biogas Primary Transport Pipelines	**GM**: General Intake Manifold **PCS**: Primary Condensate Separator (Cyclonic) **BL**: Multistage Blowers	**EX**: Pipe bundle Heat Exchanger **CH**: Chiller **SCS**: Secondary Condensate Separator **Btr**: Boosters **F**: Dry filters **GS**: Generation Set **TR**: Transformer **HTT**: High Temperature Torch

Figure 3: Schematic situation of a landfill with active gas recovery.

A. Biogas Collection / Conveying Section

The Project drilled 165 vertical wells in the field (boreholes with an average diameter of 100 cm to a maximum depth of 50 meters down from ground level) and installed leachate pumps in some wells in order to remove the leachate and keep them empty to ensure a regular outflow of biogas. Each well was fitted with a well head consisting of a carbon steel pipe, complete with a flanged side section bearing a butterfly valve that enables the well to be connected or cut from the vacuum system. The well head then was equipped with threaded pipe unions (to pumps and control floats) being one of them used for gas sampling and physical and chemical measuring of gas characteristics.

The biogas conveying system main components installed is: HDPE pipelines from well heads to substations of regulation; substations of regulation; HDPE pipelines from substations of regulation to the lines manifolds; HDPE pipelines from lines manifolds to the suction station.

The substation of regulation is made of galvanised steel and is fitted with an inlet for each pipe coming from a single biogas well; the biogas capacity at each entry point from the relative well can be regulated with a hand wheel valve, and a central barrel is provided for condensate separation. Each substation

receives the LFG of many wells and is responsible for grouping the flows and transferring them to the line manifolds through a pipeline. Similarly, the lines manifolds receive the LFG from many substation of regulation, transferring the flow to the suction section.

B. Biogas Suction and Control Section

Through the pipelines the LFG extracted from the landfill reaches a carbon steel which collects the biogas from the 2 lines manifolds in a separator/coalescer filter for a first separation of the condensate. Two multistage turbo blowers specially engineered for this particular application was installed in parallel to ensure trouble-free operation even in the event of a failure occurring in one of the machines. The analytical instruments installed includes a CH_4 (methane) and O_2 (oxygen) analyzer. Moreover, a management and alarm device for the most important parameters (pressure, temperature, capacity, frequency, etc.) related to plant operation was also installed.

The biogas analysis and control system of the plant main goals are:

- Monitor the biogas extracted from the wells, to determine its quality, quantity, pressure and temperature;
- Control the flow of biogas by means of an inverter that regulates blower's working regime changing the feeding electricity's frequency and thus the rotation speed of the blower's electrical motors; and
- Detect any type of malfunctioning and give out an alarm if any hazardous situation occurs (e.g. high oxygen content in the LFG).

The instrumental system is able to control all chemical and physical parameters of biogas as well as to control the main equipments of the plant both for the feeding the flares and for the generating section. All data from analyzers and various instruments on the lines are acquired in a control system PLC (Programmable Logic Controller) that control all the automatic operations of the plant (inverter operation to adjust blower's performance in order to keep constant pressure in engine's feeding line, oxygen content, etc.).

The gas engine-generator sets have an own local control and regulation system supplied together with the sets from the engine supplier. The system governs all regulation and control processes needed for correct sets running.

C. Treatment, Electricity Generation and Flare Combustion Section

After the blowers the LFG line is divided in two parallel lines, one towards the electricity generation section and the other towards the flare combustion section.

The electricity generation section comprises the LFG treatment system and the generation sets. Such treatment system consists in a series of gas/water & glycol tube nest heat exchangers, through which the LFG passes, that can cool the LFG to a temperature lower than 10 °C, by means of a set of chillers. The condensate formed is then separated by a coalescer filter, situated downstream of the tube nest, therefore a sizeable share of the impurities (sulphurated, aromatic, halogenated compounds) trapped in the condensate itself are eliminated from the LFG stream. Afterwards, biogas passes through a dry filter (barrels made on site in carbon steel fitted with polyester filters) in order to remove solid impurities from the gas flow as well as a share of the micro-contaminants that would be harmful to the electric energy generating sets. The gas coming from the treatment section is conveyed, through a mild pressure line, to internal combustion-engine generating sets.

The flare section was equipped with two high temperature enclosed flares to ensure the complete and safe destruction of the LFG captured. All equipments utilized to monitor the flare's combustion efficiency in continuous were installed according to the "Tool to determine project emissions from flaring gases containing methane" i.e. flow meter on the inlet pipeline and a thermocouple temperature probe and an exhaust gas sampling point to measure unburned methane and oxygen content in the exhaust gases, both thermocouple and sampling point was installed at 80% of torch's height.

A.5. Title, reference and version of the baseline and monitoring methodology applied to the project activity:

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The complete reference of the applied baseline and monitoring methodology applied in the project activity has been summarized below.

Sectoral Scope: The Project is categorized in the Sectoral Scope 13 – Waste Handling and Disposal.

Tools: the Project applies the following methodology and related Tools:

- Version 11 of ACM0001 – *"Consolidated baseline and monitoring methodology for landfill gas project activities"*;
- Version 05.2 of the *"Tool for the demonstration and assessment of additionality";*
- Version 01 of the *"Tool to determine project emissions from flaring gases containing methane"*;
- Version 01 of the "*Tool to calculate baseline, project and/or leakage emissions from electricity consumption"*;
- Version 02 of the *"Tool to calculate the emission factor for an electricity system";*
- Version 02 of the *"Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion"*;
- Version 05 of the "*Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site".*

A.6. Registration date of the project activity:

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04/06/2011.

A.7. Crediting period of the project activity and related information (start date and choice of crediting period):

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Crediting period from 04/06/2011 to 03/06/2021.

Choice of crediting period: fixed for 10 years (120 months).

A.8. Name of responsible person(s)/entity(ies):

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The monitoring report was completed by Consórcio Horizonte Asja (Project Participant).

CONSÓRCIO HORIZONTE ASJA
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SECTION B. Implementation of the project activity

B.1. Implementation status of the project activity

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The Project's infrastructure construction started in December 2008 and the first landfill gas collection wells were drilled by the beginning of 2009. The landfill gas aspiration and flare combustion plant, composed by 2 enclosed flares of capacity of 2,500 Nm^3/h each one, was installed in 12/09/2009 and it

is operational since 29/10/2009. The electricity generation plant was commissioned in the second fortnight of November and start operating in 29/11/2010. From this day on the major part of LFG is converted into energy and so the flare combustion section became super estimated; for this reason one of the enclosed flares (Flare 2) was turned off in 04/06/2011.

The project activity accomplished its CDM registration in 04/06/2011 with the reference number 3464.

The first CDM/CER period for verification is from 04/06/2011 to 30/09/2011, both dates included.

Events such planned and forced outages for change of equipments did not require corrective actions, since no emission reduction was claimed for the moments on which the plant was out of service. All changes of equipments were done using calibrated and certified devices and do not have impacts on the GHG emission reductions calculation.

All equipment exchanges during the present monitoring report are resumed on the table below; anyway, more detailed information was presented for each specific on the Section D.2.

None of mentioned events impacts any applicability conditions stated in the Version 11 of ACM0001 – *"Consolidated baseline and monitoring methodology for landfill gas project activities"*.

Table 1: Exchange of equipments during the monitoring period.

Changes date (dd/mm/yyyy)	Position at the plant	Old equipments serial number	New equipments serial number
04/06/2011	Flow meter – Flare 2 line	Rosemount Annubar 285 78150	N/A*
04/06/2011	Differential pressure sensor – Flare 2 line	ABB 264 DS 6409016455	N/A*
04/06/2011	Relative pressure probe – Flare 2 line	SMAR U305231	N/A*
04/06/2011	Temperature probe – Flare 2 line	Ecil 1037.157694	N/A*
04/06/2011	Thermocouple – Flare 2 (80% height)	Ecil 0950.064322	N/A*
04/06/2011	Relative Pressure Probe – Energy line	ABB 6410003214	SMAR U305352
04/06/2011	Temperature Probe – Energy line	Ecil 0913.999002	Ecil 1037.157655
04/06/2011	Temperature Probe – Main line	Ecil 1003.073042	Ecil 1028.138141
04/06/2011	Thermocouple – Flare 1 (80% height)	Ecil 0950.064338	Ecil 0950.064353

* Flare 2 was definitively turned off in 04/06/2011 because it had been idle since the engines started operating, in 30/11/2010.

Important clarifications:

- Calibrations are performed by an external certified company;
- All calibration frequency starts counting based on the installation date of the equipment and following the manufacturer specifications.

B.2. Revision of the monitoring plan

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Not applicable. No revision of the monitoring plan was requested until now.

B.3. Request for deviation applied to this monitoring period

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Not applicable. No deviation was applied until now.

B.4. Notification or request of approval of changes

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Not applicable. Notification or request of approval of changes was made until now.

SECTION C. Description of the monitoring system

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According to version 11 of ACM0001 – *"Consolidated baseline and monitoring methodology for landfill gas project activities"*, 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 is the applicative document of the monitoring plan (description of the project and responsibilities, operative procedures for measurements and handlings of data and details about internal audits, etc.).

1. <u>Parameters monitored</u>

The following parameters are monitored and logged in accordance to the Monitoring Plan:

- Landfill gas collected from project wells;
- Landfill gas flow into flares;
- Landfill gas flow into power plant;
- Methane content in the landfill gas;
- Temperature of exhaust gas from flaring;
- Methane and oxygen content in the exhaust gas from flaring;
- Electricity imported from the power grid;
- Electricity exported to the power grid;
- Power plant working hours;
- Emissions from flaring;
- Local and national regulatory framework;
- Carbon emission factor from the grid;
- TDLy = average technical transmission and distribution losses for providing electricity to the Project in the year y; and
- MDproject,y = amount of methane destroyed by the project activity during the year y of the project activity (tCH_4).

The equipments in the plant are connected through a Programmable Logic Control (PLC) that permits the operator to quickly check the main working parameters through a user-friendly interface. The process parameters are continuously sampled and stored in the data logger of the plant. Then information registered is automatically aggregated per hour in a standard form used for reporting purposes.

All measurements instruments are subject to regular checks and calibrations whose procedures are described in detail in the Managing Manual of the plant. All procedures comply with manufacturer's instructions or specifications of methodology applied.

The PM (Project Manager) is responsible for the general management of the plant, including controlling equipments subjected to regular checks and calibration, in order not to surpass the frequencies established for each QA/QC procedure, and for checking the equipment's proper working order, as well as checking and storing up the calibration certificates and records.

Calibrations performed internally, by the plant's operators themselves, are registered in specific forms for each activity and calibrations performed by external companies receive calibration certificates. Both forms and certificates are stored in the plant.

Description of how parameters are properly monitored is found below.

1.1. Landfill gas collected from project wells, flowed into flares and into power plant

Instant flows collected from the project wells, sent to the flares and to the power plant are measured by flow meters installed in each line, as represented in the Figure 4 below. Flows are normalized according to landfill gas temperature and pressure automatically measured by probes connected to each flow meter, so PLC continuously monitors the Nm^3/h flowing into the plant.

These data is hourly aggregated to summarize the Nm^3 of LFG being collected from the wells, being delivered to each flare and being sent to the power plant. Emission reduction generated by the Project is calculated based on hourly aggregated data.

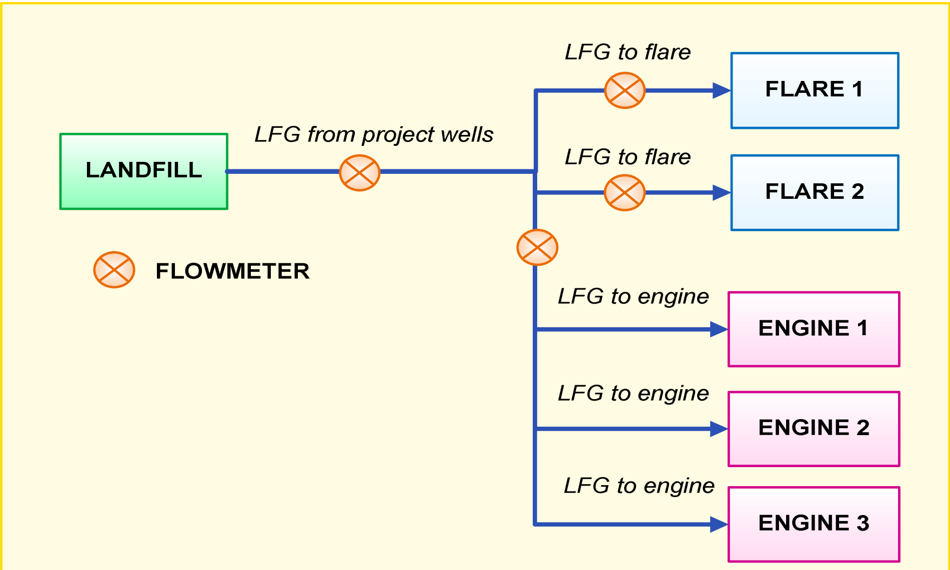

Figure 4: Flow meters' position in the landfill gas plant.

To limit the time of operation with no flow signal in case of failure, the flow meter will be exchanged as soon as possible. Despite this quick exchange, the plant would operate for a short time without continuous flow signal, which will be solved by attributing the average flow of the last 7 days to the this time span. This procedure will permit calculating the quantity of CO_2 reduced. Flow measurement equipments are reliable and flow meters failures are unusual.

1.2. Methane content in the landfill gas

Methane content of the landfill gas is continuously measured with an infrared ray system analyzer (Siemens – Ultramat 23) and data sampled is stored in the data logger of the plant and aggregated per hour.

The gas analyzer is subject to regular maintenance according to manufacturer's instructions, and calibration records are kept available in the plant.

To limit the time of operation with no gas analyzer in case of failure, this analyzer will be replaced with another instrument as soon as possible. Despite this quick exchange, the plant would operate for a short time without CH_4 signal. To determine the CH_4 content during this time span, the average CH_4 content of the last 7 days will be used.

1.3. Temperature of exhaust gas from flaring

The temperature of the exhaust gas is continuously measured with a thermocouple installed in upper section of each flare, at 80% of flare's height. Data is registered in continuous base by the PLC and aggregated per hour.

As required by methodology, the flare efficiency is correlated with the temperature of the exhaust gas, and is only calculated if temperature of exhaust gas is higher that 500°C for more than 40 minutes during the hour considered. All calculations are made by the software (PLC) that in a conservative approach imposes a maximum flare efficiency of 99.999%, i.e. flare efficiency range is 0 to 0.99999.

In case of failure of thermocouple, the instrument will be replaced with another of equal characteristics as soon as possible in order to limit the time of operation with no data registered. Despite this quick exchange, the plant would operate for a short time without temperature signal. To determine the exhaust gas temperature during this time span, the average value of the last 7 days will be used.

1.4. Methane and oxygen content in the exhaust gas from flaring

The quantity of methane and oxygen emitted by the flares is measured by continuous analyzer (Siemens – Ultramat 23) equipped with a sampling probe for collection of exhaust gas samples installed in the upper section of each flare, at 80% of flare's height. Data is registered in continuous base by the PLC and aggregated per hour.

The gas analyzer is subject to regular maintenance according to manufacturer's instructions, and calibration records are kept available in the plant.

To limit the time of operation with no gas analyzer in case of failure, this analyzer will be replaced with another instrument as soon as possible. Despite this quick exchange, the plant would operate for a short time without CH_4 and O_2 signal. To determine the CH_4 and O_2 content during this time span, the average CH_4 and O_2 content of the last 7 days will be used.

1.5. Electricity imported from the power grid

Electricity imported from the national grid during the monitoring period and was measured by an electricity meter owned by the local electricity supplier – CEMIG (Companhia Energética de Minas Gerais). The quantity of electricity imported is determined monthly through the bills issued by the supplier company (every month) and values are recorded in a specific controlling form.

Electricity meter's management and maintenance are made by CEMIG. Project Proponents are not allowed to work on it.

When there is no electrical power the blower of the biogas plant cannot operate, therefore no landfill gas stream is available. The flow meter detects no landfill gas stream and does not count any CO_{2e} emission reduction. No special actions are possible to avoid this.

1.6. Electricity exported to the power grid

Electricity produced from landfill gas and exported to the national grid is continuously measured by an electricity meter whose management and maintenance are made by the buyer company – CEMIG (Companhia Energética de Minas Gerais). Project Proponents are not allowed to work on it. Amounts of electricity sold to the grid can be attested thanks to official electricity bills.

The power plant is able to supply the energy needed for the entire Project. However the power plant is dependent of availability of power grid, i.e. generating engines cannot work if no electricity is available in national grid and no emission reduction is produced in this case.

1.7. Power Plant Working Hours

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

1.8. Emissions from flaring

Project emissions from flaring of the residual gas stream in year y (tCO2e) are determined by the procedure described in the *"Tool to determine project emissions from flaring gases containing Methane"* for each flare. Please refer to the Section E.1 of this document.

1.9. Local and National Regulatory Framework

An external contractor keeps an updated legal data bank and sends to the Project Proponents weekly news about the latest developments in relation to national, regional and municipal environmental legislation.

1.10. Carbon emission factor from the grid

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 calculating 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.

For more information, please refer to Section E.1 of this document

1.11. TDLy

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.

TDLy 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.

1.12. MDproject y

Amount of methane destroyed by the Project during the year y (tCH_4).

The methane destroyed by the project activity is determined by monitoring the quantity of methane actually flared and used to generate electricity and the total quantity of methane captured and calculated, as described in Section E.1 of this document.

2. Monitoring equipments and installation

All measuring 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. In order to determine the quantity of ERs generated during the project activity the following equipments, represented in the Figure 5 below, are installed.

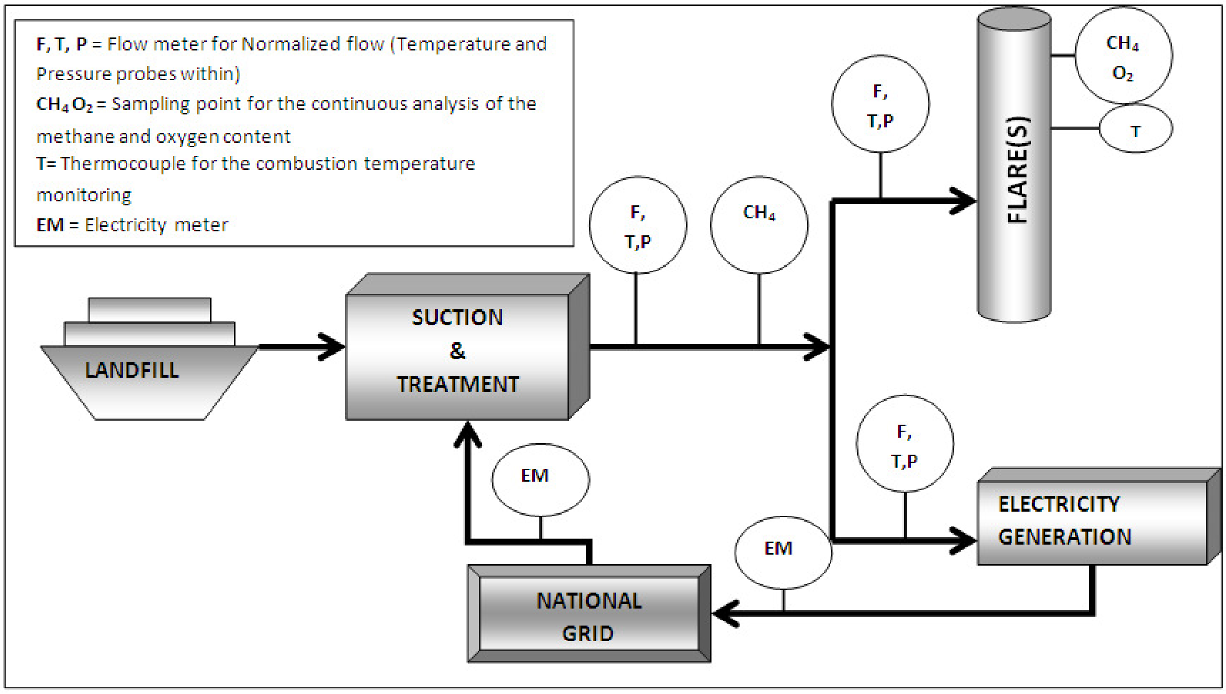

Figure 5: Monitoring points.

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; and
- Emergency situation.

The personnel had been trained before the plant entered in operation. Chosen trainees have a good understanding of the processes and installation of the technology for the landfill gas extraction. See Organization Figure 6 below.

A Management Manual describing all operation and calibration procedures in details is also available.

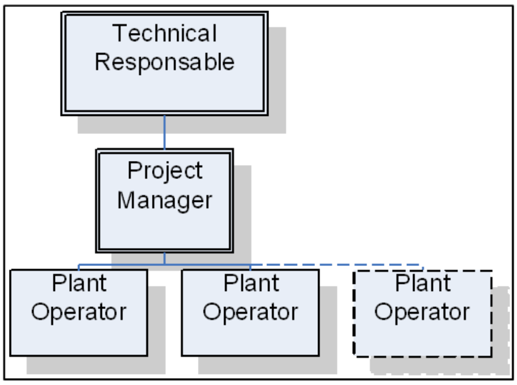

Figure 6: Organization chart.

The PLC continuously receives the value of the parameters monitored on-site and automatically generates spreadsheets that are archived. The information archived is hourly aggregated in a standard format for reporting purposes.
The quality control system ensures that all the necessary documents (such as operational manual, drawings, maintenance and calibration instructions, etc.) are available and stored in a proper manner.
Monitored data and Monitoring Sheets are daily copied to local extra HD and to Project Proponent's digital server every 6 months.
All data, including calibration records and Monitoring Reports, will be kept until 2 years after the end of the crediting period.

3. 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.
All the audit findings, including corrective actions, are recorded and available on-site at the time of verification.

SECTION D. Data and parameters

D.1. Data and parameters determined at registration and not monitored during the monitoring period, including default values and factors

Data / Parameter:	**Regulatory requirements relating to landfill gas**
Data unit:	-
Description:	Regulatory requirements relating to landfill gas
Source of data used:	Publicly available information of the Brazilian's regulatory requirements relating to landfill gas. The Designated National Authority (DNA) has been contacted to provide information.
Value(s) :	Brazilian government does not mandate to flare or collect the Landfill Gas (LFG) emitted from landfills (communication *Ofício nº058/2008/CIMGC*).
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	The information though recorded annually is not used to change the adjustment factor (AF) or directly the amount of methane that would have been destroyed/combusted during the year y in the absence of the project (MDBL,y) at renewal of the credit period because for this Project it has been chosen a fixed Crediting Period.
Additional comment:	An external contractor keeps an updated legal data bank and sends weekly news about the latest developments in relation to national, regional and municipal environmental legislation.

Data / Parameter:	**η PY**

Data unit:	%
Description:	Capture efficiency of the baseline passive venting system
Source of data used:	*2006 IPCC Guidelines for National Greenhouse Gas Inventories*
Value(s) :	37%
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	As per measurements made in 11 Dutch landfills, in the closed unlined period, Oonk and Boom (1995) measures efficiencies in between 10 and 80%, the average being 37%.
Additional comment:	Used to calculate Adjustment Factor.

Data / Parameter:	$\eta_{LFG,F}$
Data unit:	%
Description:	Landfill Gas (LFG) Flaring efficiency of the passive venting system's connected wells
Source of data used:	Version 01 of the *"Tool to determine project emissions from flaring gases containing methane"*;
Value(s) :	50%
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	It can be considered that lighted wells can burn methane less efficiently than an open flare. In the *"Tool to determine project emissions from flaring gases containing methane"* open flares are defined as devices where the residual gas is burned in an open air tip with or without any auxiliary fluid assistance, therefore it is conservative to adopt for these wells the open flare efficiency value which is equal to 50%.
Additional comment:	Used to calculate Adjustment Factor.

Data / Parameter:	$\mathbf{GWP_{CH4}}$
Data unit:	t CO_2e / t CH_4
Description:	Global Warming Potential (GWP) of methane
Source of data used:	ACM0001 version 11 *"Consolidated baseline and monitoring methodology for landfill gas project activities"*
Value(s) :	21
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Decisions under UNFCCC and the Kyoto Protocol (a value of 21 is to be applied for the first commitment period of the Kyoto Protocol).
Additional comment:	Parameter is fixed since for this Project Activity crediting period is fixed and the landfill is already closed.

Data / Parameter:	$\mathbf{N_{fw}}$
Data unit:	-
Description:	Number of wells lighted on in the baseline
Source of data used:	Survey data, see Annex 3 of *CDM Project Design Document* (CDM

	PDD) *"Baseline information"* for the Survey Report
Value(s) :	25
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	It has been measured that the average number of wells lighted on in the CTRS / BR.040 landfill in the survey period was 23; in the calculation it has been assumed a value of 25 to be more conservative. Moreover the ignited wells were conservatively considered to remain lighted all day long, for the whole year, not taking into account seasonal rains, windy days and the frequent quenching attested from the survey in order to act in the most conservative way. No other data source was available.
Additional comment:	Used to calculate Adjustment Factor.

Data / Parameter:	$\mathbf{N_{vw}}$
Data unit:	-
Description:	Total number of wells present on site that could be ignited
Source of data used:	Survey data, see Annex 3 of *CDM Project Design Document* (CDM PDD) *"Baseline information"* for the Survey Report
Value(s) :	123
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Attested from the Survey, see Report attached to CDM PDD with picture and drawings, no other data source were available.
Additional comment:	Used to calculate Adjustment Factor.

Data / Parameter:	$\mathbf{D_{CH4}}$
Data unit:	tCH_4/m^3CH_4
Description:	Methane Density
Source of data used:	-
Value(s) :	0.0007168
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	At standard temperature and pressure (0 degree Celsius and 1.013 bar) the density of methane is 0.0007168 tCH_4/m^3CH_4
Additional comment:	--

D.2. Data and parameters monitored

Data / Parameter:	$\mathbf{LFG_{total,y}}$
Data unit:	Nm^3
Description:	Total amount of landfill gas captured at normal Temperature and Pressure
Measured /Calculated /Default:	Measured
Source of data:	Flow meter
Value(s) of monitored parameter:	Instant flow is measured by a flow meter, normalized according to landfill gas temperature and pressure. Automatic measurement of

	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 Nm^3 of LFG being delivered to the plant. Calculation of emission reductions is made based on data aggregated every one hour. Please refer to the Hourly Report data sheet attached as a document.
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Baseline emission calculations.
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	The monitoring equipments are listed in the sheet below. For the calibration frequency, date of last calibration and validity please refer to "QA/QC procedures applied". <u>Flowmeter</u> Brand: Rosemount Type: Annubar 285 Accuracy: +/- 0.25% Serial Number: 78147 <u>Differential pressure sensor</u> Brand : ABB Type: 264 DS Accuracy: +/- 0.075% Serial Number: 6409016459 <u>Relative pressure probe</u> Brand: ABB Type: 264 HS Accuracy: +/- 0.075% Serial number: 6409016561 <u>Temperature probe</u> Brand: Ecil Type: Pt-100 Accuracy: ± 0.2% calculated to 100ºC±(0,1ºC+0,017) Serial number: 1028.138141
Measuring/ Reading/ Recording frequency:	Monitoring frequency: continuous Recording frequency: every two minutes Aggregation frequency: hourly, daily, monthly
Calculation method (if applicable):	Not applicable.
QA/QC procedures applied:	**<u>Flowmeter</u>** No calibration is required for this equipment, according to manufacturer specifications. **<u>Differential pressure sensor</u>** External calibration is applied to this equipment annually. (see table below) **<u>Relative pressure probe</u>** External calibration is applied to this equipment annually.

Brand and Serial nº of equipment	Calibration frequency	Calibration date and validity (dd/mm/yyyy)	Calibration certificate number
ABB 264 DS 6409016459	Annual	13/07/2011 – 12/07/2012	P00266

Brand and Serial nº of equipment	Calibration frequency	Calibration date and validity (dd/mm/yyyy)	Calibration certificate number
ABB 264 HS 6409016561	Annual	23/03/2011 – 22/03/2012	CAL 00141

Temperature probe

External calibration is applied to this equipment annually.

Brand and Serial nº of equipment	Calibration frequency	Calibration date and validity (dd/mm/yyyy)	Calibration certificate number
Ecil 1028.138141	Annual	31/03/2011 – 30/03/2012	2212/11

Data / Parameter:	$LFG_{flare,y}$
Data unit:	Nm^3
Description:	Amount of landfill gas flared
Measured /Calculated /Default:	Measured
Source of data:	Flow meter
Value(s) of monitored parameter:	Instant flow is measured by a flow meter normalized according to landfill gas temperature and pressure. Automatic measurement of temperature and pressure was made by probes connected to the flow meter. The flow is measured continuously in Nm^3/h and data is aggregated hourly to summarize Nm^3 of LFG being delivered to the plant. Calculation of emission reductions is made based on data aggregated every one hour. Please refer to the Hourly Report data sheet attached as a document.
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Baseline emission calculations.
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	The monitoring equipments are listed in the sheet below. For the calibration frequency, date of last calibration and validity please refer to "QA/QC procedures applied".

Flowmeter Brand: Rosemount Type: Annubar 285 Accuracy: ± 0.25% Serial Number: 78149	Differential pressure sensor Brand : ABB Type: 264 DS Accuracy: ± 0.075% Serial Number: 6409016458
Relative pressure probe Brand: ABB Type: 264 HS Accuracy: ± 0.075% Serial number: 6409016558	Temperature probe Brand: Ecil Type: Pt-100 Accuracy: ± 0.2% calculated to 100ºC ±(0,1ºC+0,017) Serial number: 1037.157644

Measuring/ Reading/ Recording frequency:	Monitoring frequency: continuous Recording frequency: every two minutes Aggregation frequency: hourly, daily, monthly
Calculation method (if applicable):	Not applicable
QA/QC procedures applied:	**<u>Flowmeter</u>** No calibration is required for this equipment, according to Rosemount recommendation.

<u>Differential pressure sensor</u>

External calibration is applied to this equipment annually.

Brand and Serial nº of equipment	Calibration frequency	Calibration date and validity (dd/mm/yyyy)	Calibration certificate number
ABB 264 DS 6409016458	Annual	13/07/2011 - 12/07/2012	CAL00263

<u>Relative pressure probe</u>

External calibration is applied to this equipment annually.

Brand and Serial nº of equipment	Calibration frequency	Calibration date and validity (dd/mm/yyyy)	Calibration certificate number
ABB 264 HS 6409016558	Annual	23/03/2011 - 22/03/2012	CAL00142

<u>Temperature probe</u>

External calibration is applied to this equipment annually.

Brand and Serial nº of equipment	Calibration frequency	Calibration date and validity (dd/mm/yyyy)	Calibration certificate number
Ecil 1037.157644	Annual	14/12/2010 - 13/12/2011	8618/10

Data / Parameter:	$LFG_{electricity,y}$
Data unit:	Nm^3
Description:	Amount of landfill gas combusted in power plant
Measured /Calculated /Default:	Mesured
Source of data:	Flow meter
Value(s) of monitored parameter:	Instant flow was measured by a flow meter, normalized according to landfill gas temperature and pressure. Automatic measurement of temperature and pressure was made by probes connected to the flow meter. The flow is measured continuously in Nm^3/h and data is aggregated hourly to summarize Nm^3 of LFG being delivered to the plant. Calculation of emission reductions is made based on data aggregated every one hour. Please refer to the Hourly Report data sheet attached as a document.
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Baseline emission calculations.

<table>
<tr><td>Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)</td><td>The monitoring equipments are listed in the sheet below. For the calibration frequency, date of last calibration and validity please refer to “QA/QC procedures applied”.

<table>
<tr><td>Flowmeter
Brand: Rosemount
Type: 285
Accuracy: ± 0.25%
Serial Number: 78151</td><td>Differential pressure sensor
Brand: ABB
Type:264 DS
Accuracy: ± 0.075%
Serial Number:
6409016454</td></tr>
<tr><td>Relative pressure probe
Brand: SMAR
Type: LD301M
Accuracy: ± 0.05%
Serial number: U305352</td><td>Temperature probe
Brand: Ecil
Type: Pt-100
Accuracy: ± 0.2% calculated to 100ºC ±(0,1ºC+0,017)
Serial number: 1037.157655</td></tr>
</table></td></tr>
<tr><td>Measuring/ Reading/ Recording frequency:</td><td>Monitoring frequency: continuous
Recording frequency: every two minutes
Aggregation frequency: hourly, daily, monthly</td></tr>
<tr><td>Calculation method (if applicable):</td><td>Not applicable</td></tr>
<tr><td>QA/QC procedures applied:</td><td>Flowmeter
No calibration is required for this equipment, according to Rosemount recommendation.

Differential pressure sensor
External calibration is applied to this equipment annually.
<table>
<tr><th>Brand and Serial nº of equipment</th><th>Calibration frequency</th><th>Calibration date and validity (dd/mm/yyyy)</th><th>Calibration certificate number</th></tr>
<tr><td>ABB 264 DS 6409016454</td><td>Annual</td><td>13/07/2011 - 12/07/2012</td><td>CAL00265</td></tr>
</table>
Relative pressure probe
External calibration is applied to this equipment annually.
<table>
<tr><th>Brand and Serial nº of equipment</th><th>Calibration frequency</th><th>Calibration date and validity (dd/mm/yyyy)</th><th>Calibration certificate number</th></tr>
<tr><td>SMAR U305352</td><td>Annual</td><td>12/05/2011 - 11/05/2012</td><td>U305352(1)</td></tr>
</table>
(1) For this equipment the provider does not give a calibration certificate number. It is necessary to watch at the serial number in the certificate to identify the equipment.

Temperature probe
External calibration is applied to this equipment annually.
<table>
<tr><th>Brand and Serial nº of equipment</th><th>Calibration frequency</th><th>Calibration date and validity (dd/mm/yyyy)</th><th>Calibration certificate number</th></tr>
<tr><td>Ecil 1037.157655</td><td>Annual</td><td>14/12/2010 - 13/12/2011</td><td>8616/10</td></tr>
</table></td></tr>
</table>

Data / Parameter:	$w_{CH4,y}$

Data unit:	m^3CH_4/ m^3LFG
Description:	Methane fraction in the landfill gas
Measured /Calculated /Default:	Measured
Source of data:	Continuous methane analyzer
Value(s) of monitored parameter:	Please refer to the Hourly Report data sheet attached as a document.
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Baseline emission calculations.
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	Brand: Siemens Type: Ultramat 23 Serial Number: ULT 01 - N1 X 6-991 For the calibration frequency, date of last calibration and validity please refer to "QA/QC procedures applied".
Measuring/ Reading/ Recording frequency:	Monitoring frequency: continuous Recording frequency: every two minutes Aggregation frequency: hourly, daily, monthly
Calculation method (if applicable):	Not applicable.
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 monthly basis in order to get a more conservative measure. The methane analyzer is every month calibrated 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: (1) "Formulario de calibração analisador fixo de biogás" – FO 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 number	Calibration date	Certificate number
18/10/2010 to current moment	60% CH_4 and 40% CO_2	EGE 8142	03/09/2010 (36 months)	2318/10
13/01/11 to current moment	100% N_2	EGE 8143	09/2010 (36months)	1125/11

During the monitoring period Ultramat 23 was calibrated in the

<table>
<tr><td></td><td>following dates:<table><tr><td>30/05/2011</td><td>25/07/2011</td><td>19/09/2011</td></tr><tr><td>28/06/2011</td><td>22/08/2011</td><td></td></tr></table></td></tr>
</table>

Data / Parameter:	Operation of the energy plant
Data unit:	Hours
Description:	Operation of the energy plant
Measured /Calculated /Default:	Measured
Source of data:	Engine’s working hour counter meters
Value(s) of monitored parameter:	Please refer to the Hourly Report data sheet attached as a document.
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Baseline emission calculations.
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	Engine’s working hour counter meters.
Measuring/ Reading/ Recording frequency:	Monitoring frequency: continuous Recording frequency: every two minutes Aggregation frequency: hourly, daily, monthly
Calculation method (if applicable):	Not applicable
QA/QC procedures applied:	Not applicable

<table>
<tr><td>Data / Parameter:</td><td>EL_{LFG}</td></tr>
<tr><td>Data unit:</td><td>MWh</td></tr>
<tr><td>Description:</td><td>Net amount of electricity generated using landfill gas</td></tr>
<tr><td>Measured /Calculated /Default:</td><td>Measured</td></tr>
<tr><td>Source of data:</td><td>Electricity meter</td></tr>
<tr><td>Value(s) of monitored parameter:</td><td>Values based on the Project invoices delivered to the energy buyer.
<table>
<tr><th>Period related</th><th>Reference number</th><th>Amount of electricity exported to the grid [MWh]</th></tr>
<tr><td rowspan="2">Jun*</td><td>Nº 000.000.029</td><td rowspan="2">2,477.9763*</td></tr>
<tr><td>Nº 000.000.030</td></tr>
<tr><td rowspan="2">July</td><td>Nº 000.000.034</td><td rowspan="2">2,523.769</td></tr>
<tr><td>Nº 000.000.035</td></tr>
<tr><td rowspan="2">August</td><td>Nº 000.000.037</td><td rowspan="2">2,602.653</td></tr>
<tr><td>Nº 000.000.038</td></tr>
<tr><td>September</td><td>Invoice not emitted till the date of completion of this report.</td><td>2793,885</td></tr>
</table></td></tr>
</table>

	*Calculated value of invoice sent to CEMIG subtracting the first three days of June 2011. The calculation is made from the total amount of energy sold in June divided by the total number of days in the month, and multiplying the daily average of June for 27 days.
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Baseline emission calculations.
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	Data measured continuously with an electricity meter specifying the total amount of electricity exported in the time interval. In accordance with the local energy concessionaire CEMIG specifications, the electricity meter do not need regular maintenance to ensure its accuracy. The initial calibration done by manufacturer are the following:
Measuring/ Reading/ Recording frequency:	Monitoring frequency: continuous Recording and aggregation frequency: monthly (CEMIG's invoices emission frequency)
Calculation method (if applicable):	Not applicable.
QA/QC procedures applied:	Electricity meter belongs to CEMIG, which is responsible for its maintenance.

Brand and Serial nº of equipment	Calibration frequency	Calibration date (dd/mm/yyyy)	Calibration certificate number
Schneider ION 8660 PT-0912A361-01	None	29/01/2010	038/2009

Data / Parameter:	EL_{PR}
Data unit:	MWh
Description:	Total amount of electricity imported to meet the requirements of the Project
Measured /Calculated /Default:	Measured
Source of data:	Electricity meter
Value(s) of monitored parameter:	In accordance with the local energy concessionaire – CEMIG specifications, the electricity meter do not need regular maintenance to ensure its accuracy.
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Project emission calculations.

Period related	Reference number	Amount of electricity imported from the grid [kWh]
Jun*	N°000802507	631*
July	N°001585876	277
August	N°000029978	258
September	Bill not emitted till the date of completion of this report.	685

*Calculated value for the 27 days of June 2011 using June's average daily value multiplied for the 27 days of project activity.

Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	Data measured continuously with an electricity meter specifying the total amount of electricity imported in that time interval. In accordance with the local energy concessionaire CEMIG specifications, the electricity meter do not need regular maintenance to ensure its accuracy. The initial calibration done by manufacturer are the following:

Brand and Serial nº of equipment	Calibration frequency	Calibration date (dd/mm/yyyy)	Calibration certificate number
Schneider ION 8660 PT-0912A361-01	None	29/01/2010	038/2009

Measuring/ Reading/ Recording frequency:	Monitoring frequency: continuous Recording and aggregation frequency: monthly (CEMIG's bill emission frequency)
Calculation method (if applicable):	Not applicable.
QA/QC procedures applied:	Electricity meter belongs to CEMIG, which is responsible for its maintenance.

Data / Parameter:	$CE_{Felecy,BL,y}$
Data unit:	tCO_2/MWh
Description:	Carbon Emission Factor for electricity
Measured /Calculated /Default:	Calculated
Source of data:	Official data from DNA.
Value(s) of monitored parameter:	0.3095 tCO_2/MWh
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Baseline emission calculations.
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	Not applicable.
Measuring/ Reading/ Recording frequency:	Annual.
Calculation method (if applicable):	Please refer to the Section E.1.
QA/QC procedures applied:	Internal audits are performed in order to ensure correct monitoring of this parameter. The audits will be performed each year through the verification of the parameters in the site of the government of Brazil. http://www.mct.gov.br/index.php/content/view/303076.html#ancora (Web site checked on 05/09/2011)

Data / Parameter:	$PE_{EC,y}$
Data unit:	tCO_2
Description:	Project emissions from electricity consumption by the project activity during the year y
Measured /Calculated	Calculated

/Default:	
Source of data:	Calculated as per the *"Tool to calculate baseline, project and/or leakage emissions from electricity consumption"*.
Value(s) of monitored parameter:	Total $PE_{EC,y}$ in the monitoring period is 0.687 $tCO2_e$.
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Project emission calculations.
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	Not applicable.
Measuring/ Reading/ Recording frequency:	Calculated for monitoring period as it depends on the $CEF_{elecy,BL},_y$ to be applied (the most recent available).
Calculation method (if applicable):	Please refer to the Section E.2 of this document.
QA/QC procedures applied:	Internal audits are going to be performed in order to ensure correct monitoring of this parameter.

Data / Parameter:	$TDL_{j,y}$
Data unit:	%
Description:	Average technical transmission and distribution losses for providing electricity to source j in year y
Measured /Calculated /Default:	Default
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.
Value(s) of monitored parameter:	20%
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Project emission calculations.
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	Not applicable.
Measuring/ Reading/ Recording frequency:	Monitored annually. Data will be archived electronically during the crediting period and two years after.
Calculation method (if applicable):	Not applicable.
QA/QC procedures applied:	Internal audits are performed in order to ensure correct monitoring of this parameter.

Data / Parameter:	$EF_{CM,y}$

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
Measured /Calculated /Default:	Calculated
Source of data:	Official data from DNA.
Value(s) of monitored parameter:	0.3095 tCO_2/MWh
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Project emission calculations.
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	Not applicable.
Measuring/ Reading/ Recording frequency:	Annually.
Calculation method (if applicable):	Please refer to Section E.1 of this document.
QA/QC procedures applied:	Internal audits are performed in order to ensure correct monitoring of this parameter

Data / Parameter:	$fv_{i,h}$
Data unit:	-
Description:	Volumetric fraction of component i in the residual gas in the hour h where i = CH_4, CO, CO_2, O_2,H_2, N_2
Measured /Calculated /Default:	Measured
Source of data:	Continuous gas analyzer
Value(s) of monitored parameter:	As a simplified approach, in this Project it is only measured the methane content of the residual gas and considered the remaining part as N_2. See parameter $w_{CH4,y}$
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Baseline emission calculations.
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	See parameter $w_{CH4,y}$
Measuring/ Reading/ Recording frequency:	See parameter $w_{CH4,y}$
Calculation method (if applicable):	Not applicable.
QA/QC procedures applied:	See parameter $w_{CH4,y}$

Data / Parameter:	$t_{O2,h}$
Data unit:	-
Description:	Volumetric fraction of O_2 in the exhaust gas of the flare in the hour h (only in case the flare efficiency is continuously monitored)
Measured /Calculated /Default:	Measured
Source of data:	Continuous gas extractive sampling analyzer with water and particulates removal devices.
Value(s) of monitored parameter:	Please refer to the Hourly Report data sheet attached as a document.
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Baseline emission calculations.
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	Brand: Siemens Type: Ultramat 23 Serial Number: ULT 02 - N1X6-992 For the calibration frequency, date of last calibration and validity please refer to "QA/QC procedures applied".
Measuring/ Reading/ Recording frequency:	Monitoring frequency: continuous Recording frequency: every two minutes Aggregation frequency: hourly, daily, monthly
Calculation method (if applicable):	Not applicable.
QA/QC procedures applied:	The supplier of the gas 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 monthly basis in order to get a more conservative measure. The gas analyzer is every month calibrated by a trained operator and the PM. The PM 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: (1) "Formulario de calibração analisador fixo de fumos" – FO CAL/003. 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 makes assures the quality of the calibration gases. Calibrated gases cylinders' certificate numbers are listed below:

Period of use	Type of gas mixture	Cylinder number	Calibration date	Certificate number
17/12/2010 to current moment	2587 vpm CH_4	EGE 8114	09/09/2010 (24months)	2391/10
13/01/2011 to current moment	100% N_2	EGE 8143	09/2010 (36months)	1125/11

	During the monitoring period the Ultramat 23 was calibrated in the following dates: 30/05/2011 · 25/07/2011 · 19/09/2011 28/06/2011 · 22/08/2011

30/05/2011	25/07/2011	19/09/2011
28/06/2011	22/08/2011	

Data / Parameter:	$fv_{CH4,FG,h}$
Data unit:	mg/m^3
Description:	Concentration of methane in the exhaust gas of the flares in dry basis at normal conditions in the hour h
Measured /Calculated /Default:	Measured
Source of data:	Continuous gas extractive sampling analyzer with water and particulates removal devices.
Value(s) of monitored parameter:	Please refer to the Hourly Report data sheet attached as a document.
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Baseline emission calculations.
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	Brand: Siemens Type: Ultramat 23 Accuracy: ± 1% CH_4 and 0.5% O_2 Serial Number: ULT 02 - N1X6-992 For the calibration frequency, date of last calibration and validity please refer to "QA/QC procedures applied".
Measuring/ Reading/ Recording frequency:	Monitoring frequency: continuous Recording frequency: every two minutes Aggregation frequency: hourly
Calculation method (if applicable):	Ultramat 23 reads ppm values. To convert from ppmv to mg/m3 value is multiplied by 0.716.
QA/QC procedures applied:	The supplier of the gas 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 monthly basis in order to get a more conservative measure. The gas analyzer is every month calibrated by a trained operator and the PM. The PM 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: (1) "Formulario de calibração analisador fixo de fumos" – FO CAL/003. 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 makes assures the quality of the calibration gases. Calibrated gases cylinders' certificate numbers are listed below:

Period of use	Type of gas mixture	Cylinder number	Calibration date	Certificate number
17/12/2010 to current moment	2587 vpm CH_4	EGE 8114	09/09/2010 (24months)	2391/10
13/01/2011 to current moment	100% N_2	EGE 8143	09/2010 (36months)	1125/11

During the monitoring period the Ultramat 23 was calibrated in the following dates:

30/05/2011	25/07/2011	19/09/2011
28/06/2011	22/08/2011	

Data / Parameter:	T_{flare}
Data unit:	ºC
Description:	Temperature in the exhaust gas of the enclosed flares
Measured /Calculated /Default:	Measured
Source of data:	Thermocouple
Value(s) of monitored parameter:	Please refer to the Hourly Report data sheet attached as a document.
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Baseline emission calculations.
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	Brand: Ecil Type: Thermocouple that withstands temperatures up to 1,600°C Serial number: 0950.064353 For the calibration frequency, date of last calibration and validity please refer to "QA/QC procedures applied".
Measuring/ Reading/ Recording frequency:	Monitoring frequency: continuous Recording frequency: every two minutes Aggregation frequency: hourly, daily, monthly
Calculation method (if applicable):	Not applicable.
QA/QC procedures applied:	External calibration is applied to this equipment annually.

Brand and Serial nº of equipment	Calibration frequency	Calibration date and validity (dd/mm/yyyy)	Calibration certificate number
Ecil 0950.064353	Annual	24/05/2011 - 23/05/2012	3504/11

Data / Parameter:	$PE_{flare,y}$
Data unit:	tCO_{2e}
Description:	Project emissions from flaring of the residual gas stream in year y
Measured /Calculated /Default:	Calculated
Source of data:	Calculated as per the *"Tool to determine project emissions from*

	flaring gases containing Methane".
Value(s) of monitored parameter:	Please refer to the Hourly Report data sheet attached as a document.
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Baseline emission calculations.
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	Not applicable.
Measuring/ Reading/ Recording frequency:	Calculated for each hour using hourly aggregated data. Aggregated also daily and monthly
Calculation method (if applicable):	Please refer to the Section E.1 of this document.
QA/QC procedures applied:	Internal audits are going to be performed in order to ensure correct monitoring of this parameter.

Data / Parameter:	$fv_{CH4,RG,h}$
Data unit:	m^3CH_4/ m^3LFG
Description:	Methane fraction in the landfill gas
Measured /Calculated /Default:	Measured
Source of data:	Gas analyzer
Value(s) of monitored parameter:	See parameter $w_{CH4,y}$
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Baseline emission calculations.
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	See parameter $w_{CH4,y}$
Measuring/ Reading/ Recording frequency:	See parameter $w_{CH4,y}$
Calculation method (if applicable):	See parameter $w_{CH4,y}$
QA/QC procedures applied:	See parameter $w_{CH4,y}$

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
Measured /Calculated /Default:	See parameter LFG_{Flare}
Source of data:	See parameter LFG_{Flare}
Value(s) of monitored parameter:	See parameter LFG_{Flare}

Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Baseline emission calculations.
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	See parameter LFG_{Flare}
Measuring/ Reading/ Recording frequency:	See parameter LFG_{Flare}
Calculation method (if applicable):	See parameter LFG_{Flare}
QA/QC procedures applied:	See parameter LFG_{Flare}

SECTION E. Emission reductions calculation

E.1. Baseline emissions calculation

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According to ACM0001 version 11 baseline emissions were calculated with the following formula:

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

Where:

BE_y	=	Baseline emissions in year y (tCO_{2e})
$MD_{project,y}$	=	The amount of methane that would have been destroyed/combusted during the year, in tones of methane (tCH_4) in project scenario
$MD_{BL,y}$	=	The amount of methane that would have been destroyed/combusted during the year in the absence of the project due to regulatory and/or contractual requirement, in tones of methane (tCH_4)
GWP_{CH4}	=	Global Warming Potential value for methane for the first commitment period is 21 tCO_{2e}/tCH_4
$EL_{LFG,y}$	=	Net quantity of electricity produced using LFG, which in the absence of the project activity would have been produced by power plants connected to the grid or by an onsite/off-site fossil fuel based captive power generation, during year y, in megawatt hours (MWh);
$CEF_{elecy,BL,y}$	=	CO_2 emissions intensity of the baseline source of electricity displaced, in tCO_{2e}/MWh.
$ET_{LFG,y}$	=	The quantity of thermal energy produced utilizing the landfill gas, which in the absence of the project activity would have been produced from onsite/offsite fossil fuel fired boiler, during the year y in TJ, for this Project is equal to 0 since no thermal energy will be produced
$CEF_{ther,BL,y}$	=	CO_2 emissions intensity of the fuel used by boiler to generate thermal energy which is displaced by LFG based thermal energy generation, in tCO_{2e}/TJ; for this Project is equal to 0 since no thermal energy will be produced

For this Project, since regulatory or contractual requirements do not specify $MD_{BL,y}$ and no historic data exists for LFG captured and destroyed, an “Adjustment Factor” (AF) was used and justified, taking into account the project context

(2)

$$MD_{BL,\ y} = MD_{project,\ y} \times AF$$

Calculation of AF

Baseline scenario consisted in a passive LFG venting system with partial LFG destruction by flaring since some of the wells were on occasion manually lighted on.

Therefore a specific system for collection and destruction of methane existed and according to ACM001 requirements, the ratio of the destruction efficiency of the baseline system to the destruction efficiency of the system used in the project has been used and the following procedure followed.

The procedure to calculate the "Adjustment Factor" AF involves the following tree steps:

Step 1: The calculation of the destruction efficiency of the system (ε_{BL});
Step 2: The calculation of the destruction efficiency of the system used in the project activity (ε_{PR});
Step 3: The calculation of the adjustment factor (AF=ε_{BL} / ε_{PR}).

Step 1: Calculating the destruction efficiency of the system (ε_{BL})

$$\varepsilon_{BL} = \frac{MD_{Hist}}{MG_{Hist}}; \quad \textbf{(3)}$$

Where:

ε_{BL}	=	Destruction efficiency of the baseline system (fraction)
MD_{Hist}	=	Amount of methane destroyed historically measured for the previous year before the start of project activity (tCH_4)
MG_{Hist}	=	Amount of methane generated historically for the previous year before the start of project activity, estimated using the actual amount of waste disposed in the landfill as per Version 05 of the *Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site* (tCH_4)

Since no measured data are available for the estimation of MD_{Hist}, the following approach was applied to determine this parameter as, per option b) of the cited methodology.

As there were no historical records of the amount of LFG collected and destroyed in the landfill's wells, a procedure for estimating the amount of landfill gas that would be captured in absence of the project activity was provided:

1. MD_{Hist} was a fraction of MG_{Hist} by the formula:

$$MD_{Hist} = \eta_{BL} \times MG_{Hist} \quad \textbf{(3.1)}$$

Where MG_{Hist} is the amount of methane generated historically for the previous year before the start of project activity; and:

2. The abovementioned η_{BL} is the overall destruction efficiency in the baseline and has been calculated with the following formula:

$$\eta_{BL} = \eta_{PV} \times \eta_{LFGF} \times \frac{N_{fw}}{N_{vwl}} \quad \textbf{(3.2)}$$

Where:

η_{PV}	=	Collection efficiency of passive venting systems in closed landfills. CTRS / BR.040 landfill has a passive venting system, which was way less efficient than the active systems because of the pressure: in the passive system landfill gas is emitted to the atmosphere due to variation of the barometric pressure. As per measurements made in 11 Dutch landfills, an average collection efficiency value of passive system is equal to 37%[1]
η_{LFGF}	=	Efficiency of methane destruction in open flares. It can be considered that lighted wells can burn methane less efficiently than an open flare, in the "*Tool to determine project emissions from flaring gases containing methane*" open flares are defined as devices where the residual gas is burned in an open air tip with or without any auxiliary fluid assistance, therefore it is conservative to adopt for these wells the open flare efficiency value which is equal to 50%.
$N_{fw=}$	=	Number of vertical wells actually burning the landfill gas collected in the passive system as from survey *"Baseline information"*, the average was 23, in this calculation we considered 25 wells lighted to be conservative. Moreover the ignited wells were conservatively considered to remain lighted all day long, for the whole year, not taking into account seasonal rains, windy days and the frequent quenching attested from the survey.
N_{vw}	=	Number of wells that could be ignited. As shown in *"Baseline information"* survey the total number of wells that could be lighted on was 123.

The calculation is therefore as follows:

$$\eta_{BL} = 37\% \times 50\% \times \frac{25}{123} = 3.8\%$$

As per formula (3.1)

$$MD_{Hist} = 3.8 \times MG_{Hist}$$

Therefore, according to the formula (3) the final baseline efficiency (ε_{BL}) value is:

$$\varepsilon_{BL} = \frac{MD_{Hist}}{MG_{Hist}} = 3.8 \times \frac{MG_{Hist}}{MG_{Hist}} = 3.8\ \%$$

Step 2: Calculation of the destruction efficiency of the system used in the project activity (ε_{PR})

According to the ACM0001, it has been selected the following:

Option-2:
The destruction efficiency of the system used in the project activity was estimated every year as follows:

$$\varepsilon_{PR,y} = \frac{MD_{project,y}}{MG_{PR,y}} \quad \textbf{(4)}$$

Where:

$\varepsilon_{PR,y}$	=	Destruction efficiency of the system used in the project activity for year *y* (fraction)
$MD_{project,y}$	=	Amount of methane destroyed by the project activity during the year *y* of the project activity (tCH_4)

[1] http://www.mnp.nl/ipcc/Archive/AR4FOD/ExpRevFOD/FODrev/FOD_AChapter10.doc

$MG_{PR,y}$ = Amount of methane generated during year y of the project activity

Step 3: Calculation of the adjustment factor (AF)

Since Option 2 has been used in Step 2 and the destruction efficiency of the system used in the Project (ε_{PR}) was estimated every year, then the *'Adjustment Factor'* (AF) also was calculated every year with the following formula:

$$AF_y = \frac{\varepsilon_{BL}}{\varepsilon_{PRy}} \quad \textbf{(5)}$$

Where:

AFy = Adjustment factor for year *y*, this factor was then used in equation **(2)** in place of AF

$MD_{project,y}$ was determined *ex post* by metering the actual quantity of methane captured and destroyed once the project activity was operational. The methane destroyed by the project activity ($MD_{project,y}$) during a year was determined by monitoring the quantity of methane actually flared/ destroyed on the energy generation sets and the total quantity of methane captured.

The measured quantities fed to the flares and/or to the generation set were compared annually with the total quantity of methane collected from the Project wells. The lowest value of the two was adopted as $MD_{project,y}$.

No emissions reductions were claimed for methane destruction during non operational hours and $MD_{Project}$ was calculated as:

$$MD_{project,\ y} = MD_{flare,\ y} + MD_{electricit\ y,\ y} + MD_{thermal,\ y} + MD_{PL,\ y} \quad \textbf{(6)}$$

Where:
$MD_{flared,y}$ = Quantity of methane destroyed by flaring (tCH_4)
$MD_{electricity,y}$ = Quantity of methane destroyed by generation of electricity (tCH_4).
$MD_{thermal,y}$ = Quantity of methane destroyed for the generation of thermal energy (tCH_4), for the proposed Project this is equal to 0
$MD_{PL,y}$ = Quantity of methane sent to the pipeline for feeding to the natural gas distribution network (tCH_4), for the proposed Project this is equal to 0
And

$$MD_{flared,y} = LFG_{flared,\ y} \times W_{CH4,\ y} \times D_{CH4} - \left(\frac{PE_{flare,\ y}}{GWP_{CH4}} \right) \quad \textbf{(7)}$$

Where:

$LFG_{flare,y}$ = Quantity of landfill gas fed to the flare(s) during the year measured in cubic meters (m^3)
$W_{CH4,y}$ = Average methane fraction of the landfill gas as measured during the year and expressed as a fraction (in $m^3\ CH_4$ / m^3 LFG)
D_{CH4} = Methane density expressed in tonnes of methane per cubic meter of methane (tCH_4/m^3CH_4)
$PE_{flare,y}$ = Project emissions from flaring of the residual gas stream in year y (tCO_2e)

Application of "Tool to determine project emissions from flaring gases containing methane"

For the Project enclosed flares are installed and continuous monitoring of the flare efficiency is made. 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
This step calculates the residual gas mass flow rate in each hour *h*, based on the volumetric flow rate and the density of the residual gas. The density of the residual gas is determined based on the volumetric fraction of all components in the gas.

$$FM_{RG,h} = \rho_{RG,n,h} \bullet FV_{RD,h} \qquad \textbf{(7.1)}$$

Where:

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

Where:

$$\rho_{RG,n,h} = \frac{P_n}{\frac{R_u}{MM_{RG,h}} \bullet T_n} \qquad \textbf{(7.2)}$$

Where:

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

and:

$$MM_{RG,h} = \sum_i (f_{vi,h} \bullet MM_i) \qquad \textbf{(7.3)}$$

Where:

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

MM_i	kg/kmol	Molecular mass of residual gas component *i*
i		The components CH_4, CO, CO_2, O_2, H_2, N_2

For this Project it has been chosen, as a simplified approach, to measure only the volumetric fraction of methane and consider the difference to 100% as being nitrogen (N_2).

STEP 2
Determine the mass fractions of carbon, hydrogen, oxygen and nitrogen in the residual gas, calculated from the volumetric fraction of each component *i* in the residual gas, as follows:

$$fm_{j,h} = \frac{\sum_i fv_{i,h} \bullet AM_j \bullet NA_{j,i}}{MM_{RG,h}} \qquad \textbf{(7.4)}$$

Where:

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

STEP 3
This step was applied in the Project since the methane combustion efficiency of the flare(s) has been continuously monitored.

Determine the average volumetric flow rate of the exhaust gas in each hour *h* based on a stoichiometric calculation of the combustion process, which depends on the chemical composition of the residual gas, the amount of air supplied to combust it and the composition of the exhaust gas, as follows:

$$TV_{n,FG,h} = V_{n,FG,h} \bullet FM_{RG,h} \qquad \textbf{(7.5)}$$

Where:

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

$$V_{n,FG,h} = V_{n,CO2,h} + V_{n,O2,h} + V_{n,N2,h} \qquad \textbf{(7.6)}$$

Where:

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

$V_{n,O2,h}$	m^3/kg residual gas	Quantity of O_2 volume free in the exhaust gas of the flare at normal conditions per kg of residual gas in the hour h

$$V_{n,O2,h} = n_{O2,h} \bullet MV_n \quad \textbf{(7.7)}$$

Where:

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

$$V_{n,N2,h} = MV_n \bullet \left\{ \frac{fm_{N,h}}{200AM_N} + \left(\frac{1 - MF_{O2}}{MF_{O2}} \right) \bullet \left[F_h + n_{O2,h} \right] \right\} \quad \textbf{(7.8)}$$

Where:

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

$$V_{n,CO2,h} = \frac{fm_{C,h}}{AM_C} \bullet MV_n \quad \textbf{(7.9)}$$

Where:

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

$$n_{O2,h} = \frac{t_{O2,h}}{[1 - (t_{O2,h} / MF_{O2})]} \bullet \left[\frac{fm_{C,h}}{AM_C} + \frac{fm_{N,h}}{2AM_N} + \left(\frac{1 - MF_{O2}}{MF_{O2}} \right) \bullet F_h \right] \quad \textbf{(7.10)}$$

Where:

Variable	SI Unit	Description
$n_{O2,h}$	kmol/kg residual gas	Quantity of moles O_2 in the exhaust gas of the flare per kg residual gas flared in hour *h*
$t_{O2,h}$	-	Volumetric fraction of O2 in the exhaust gas in the hour *h*
MF_{O2}	-	Volumetric fraction of O_2 in the air (0.21)
F_h	kmol/kg residual gas	Stoichiometric quantity of moles of O_2 required for a complete oxidation of one kg residual gas in hour *h*

$fm_{j,h}$	-	Mass fraction of element *j* in the residual gas in hour *h* (from equation 7.4)
AM_j	kg/kmol	Atomic mass of element *j*
j		The elements carbon (index C) and nitrogen (index N)

$$F_h = \frac{fm_{C,h}}{AM_C} + \frac{fm_{H,h}}{4AM_H} - \frac{fm_{O,h}}{2AM_O} \qquad \textbf{(7.11)}$$

Where:

Variable	**SI Unit**	**Description**
F_h	kmol O_2/kg residual gas	Stoichiometric quantity of moles of O_2 required for a complete oxidation of one kg residual gas in hour *h*
$fm_{j,h}$	-	Mass fraction of element *j* in the residual gas in hour *h* (from equation 7.4)
AM_j	kg/kmol	Atomic mass of element *j*
j		The elements carbon (index C), hydrogen (index H) and oxygen (index O)

STEP 4

This step was applied in the Project since the methane combustion efficiency of the flare(s) has been continuously monitored.

The mass flow of methane in the exhaust gas is based on the volumetric flow of the exhaust gas and the measured concentration of methane in the exhaust gas, as follows:

$$TM_{FG,h} = \frac{TV_{n,FG,h} \bullet fv_{CH4,FG,h}}{1000000} \qquad \textbf{(7.12)}$$

Where:

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

STEP 5

The quantity of methane in the residual gas flowing into the flare is the product of the volumetric flow rate of the residual gas ($FV_{RG,h}$), the volumetric fraction of methane in the residual gas ($fv_{CH4,RG,h}$) and the density of methane ($\rho_{CH4,n,h}$) in the same reference conditions (normal conditions and dry or wet basis).

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

$$TM_{RG,h} = FV_{RG,h} \bullet fv_{CH4,RG,h} \bullet \rho_{CH4,n} \qquad \textbf{(7.13)}$$

Where:

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

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

STEP 6
Since this Project installed enclosed flares and does a continuous monitoring, the flare efficiency in the hour *h* (η *flare,h*) is:

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

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

$$\eta_{flare,h} = 1 - \frac{TM_{FG,h}}{TM_{RG,h}} \quad \textbf{(7.14)}$$

Where:

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

STEP 7
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* (η *flare,h*), as follows:

$$PE_{flare,y} = \sum_{h=1}^{8760} TM_{RG,h} \bullet (1-\eta_{flare,h}) \bullet \frac{GWP_{CH4}}{1000} \quad \textbf{(7.15)}$$

Where:

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

$$MD_{electricity,y} = LFG_{electricity} \bullet W_{CH4,y} \bullet D_{CH4} \quad \textbf{(8)}$$

Where:

$MD_{electricity,y}$	=	Quantity of methane destroyed by generation of electricity, for this monitoring period is equal to 0
$LFG_{electricity,y}$	=	Quantity of landfill gas fed into electricity generator, for this monitoring period is equal to 0

Determination of $CEF_{elec,BL,y}$ *in equation (1) and (10) - Application of "Tool to calculate the emission factor for an electricity system"*

Since the baseline was electricity generated by plants connected to the grid the emission factor have been calculated according to "*Tool to calculate the emission factor for an electricity system*" version 2.

The data used to calculate the grid emission factor was taken from publicly available information in the Brazilian DNA' website[2]. The most recent complete data refers to 2010, which was applied for the whole monitoring period, as demonstrated in the Table 2 below.

Table 2: Emission Factor Calculations

COMBINED MARGIN EMISSION FACTOR - 2010					
$EF_{CM} = (EF_{OM} X W_{OM}) + (EF_{BM} X W_{BM})$					
EMISSION FACTOR (tCO_2/MWh)					
MONTH	EF_{OM}	EF_{BM}	W_{OM}	W_{BM}	***EF***
Jan	0.2111	0.1404	0.50	0.50	0.17575
Feb	0.2798	0.1404	0.50	0.50	0.2101
Mar	0.2428	0.1404	0.50	0.50	0.1916
Apr	0.2379	0.1404	0.50	0.50	0.18915
May	0.3405	0.1404	0.50	0.50	0.24045
Jun	0.4809	0.1404	0.50	0.50	0.31065
Jul	0.4347	0.1404	0.50	0.50	0.28755
Aug	0.6848	0.1404	0.50	0.50	0.4126
Sep	0.7306	0.1404	0.50	0.50	0.4355
Oct	0.732	0.1404	0.50	0.50	0.4362
Nov	0.7341	0.1404	0.50	0.50	0.43725
Dec	0.6348	0.1404	0.50	0.50	0.3876
FINAL	0,4787	0.1404	0.50	0.50	**0.3095**

* Using the last EF_{BM} available (2010)

The Combined Margin (CM) for the Project was calculated as the weighted average of the Build Margin (BM) and Operating Margin (OM), as follows:

$$CEF_{elec,BL,y} = EF_{EL,j,y} = CM_{2010} = (OM_{2010} \text{ x } 0.5) + (BM_{2010} \text{ x } 0.5) = \mathbf{0.3095\ tCO_2/MWh} \qquad \mathbf{(11)}$$

E.2. Project emissions calculation

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As per the ACM0001 version 11 Project Emissions was evaluated with the following formula:

$$PE_y = PE_{EC,y} + PE_{FC,y} \qquad \mathbf{(9)}$$

Where:

$PE_{EC,y}$ = Emissions from consumption of electricity in the Project. The project emissions from electricity consumption ($PE_{EC,y}$) have been calculated following the version 01 of "*Tool to calculate baseline, project and/or leakage emissions from electricity consumption*".

$PE_{FC,y}$ = Emissions from consumption of heat in the Project. For this Project is equal to 0 since no heat will be consumed.

Determination of $PE_{EC,y}$ *in equation (9) - Application of "Tool to calculate baseline, project and/or leakage emissions from electricity consumption"*

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[2] http://www.mct.gov.br/index.php/content/view/303076.html#ancora

The tool is applicable because the "Scenario A: Electricity consumption from the grid." applies to the sources of electricity for this Project and no baseline or leakage emissions have to be evaluated for this Project since no electricity is consumed in the baseline and no leakage have to be taken into account. The general formula is:

$$PE_{EC,y} = \sum_{y} EC_{PJ,j,y} \bullet EF_{EL,j,y} \bullet (1 + TDL_y) \quad \textbf{(10)}$$

Where:

$PE_{EC,y}$	=	Project emissions from electricity consumption in year *y* (tCO_2/y)
$EC_{PJ,j,y}$	=	Quantity of electricity consumed by the project electricity consumption source *j* in year *y* (MWh/y)
$EF_{EL,j,y}$	=	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,* for the Project the 20% default value has been used
j	=	Sources of electricity consumption in the project, in this case is only the National grid

For the calculation of the $EF_{EL,j,y,}$ the Scenario A applies to the Project as a grid energy consumer. Proceeding, the methodology Option A1 has been selected to "Calculate the combined margin emission factor of the applicable electricity system using the procedures in the approved version 2 of the "*Tool to calculate the emission factor for an electricity system*" ($EF_{EL,j,y} = CEF_{elec,BL,y}$)"

Therefore, Project emission for electricity consumption was calculated in the Table 3 below.

Table 3: Project *e*missions for electricity consumption from the national grid

Project emission for electricity consumption from the national grid					
Bill emission date	**Period**	$EC_{PJ,j,y}$	$EF_{EL,j,y}$	$TDL_{j,y}$	$PE_{EC,y}$
	(from-to)	**MWh**	**tCO_2/MWh**	**-**	**tCO_{2e}**
7/7/2011	01/06/2011 - 30/06/2011	0.631	0.3095	0.2	0.234
10/8/2011	01/07/2011 - 31/07/2011	0.277	0.3095	0.2	0.103
5/9/2011	01/08/2011 - 31/08/2011	0.258	0.3095	0.2	0.096
Invoice not emitted till the completion date of this report	01/09/2011 - 30/09/2011	0.685	0.3095	0.2	0.254
	Total				**0.687**

*Value calculated for 27 days of June.

Project emissions were conservatively considered to be 1 tCO_{2e}.

E.3. Leakage calculation

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No leakage effects need to be accounted under ACM0001 methodology.

E.4. Emission reductions calculation / table

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Emission reductions were calculated as follows:

ERy = BE - PEy **(12)**

Where:

ERy	=	Emission reductions in year y (tCO2e/y)
BEy	=	Baseline emissions in year y (tCO2e/y)
PEy	=	Project emissions in year y (tCO2e/y)

During the monitoring period accumulated baseline emissions was calculated in 82,861 tCO_{2e}. Table 4 summarizes the total emission reductions generated by the Project.

Table 4: Total ERs.

	Tons of CO_{2e}
Baseline emissions	82,861
Project emissions for electricity consumption	1
Emission reductions	**82,860**

The ERs required for this period is **82,860 tCO_{2e}.**

E.5. Comparison of actual emission reductions with estimates in the CDM-PDD

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This section shall include a comparison of actual values of the emission reductions achieved during the monitoring period with the estimations in the registered CDM-PDD.

Item	Values applied in ex-ante calculation of the registered CDM-PDD	Actual values reached during the monitoring period
Emission reductions (tCO_2e)	**194,588**	**82,860**

E.6. Remarks on difference from estimated value in the PDD

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The value of the emission reductions reached during the monitoring period (from 04/06/2011 to 30/09/2011) is different from the estimated value in the PDD, which correspond to 63,441 tCO_2e (119 days). The actual value is increased of 19,419 tCO_2e.

The main reasons of the underestimation of the ER are, as follows:

1) The technology of disposal and removal of the leachate from the wells itself has increased the productivity of the biogas in the site.
2) The working hours of the engines are more than the expected and, consequently the energy produced was more than forecast. This is due to the fact that, the estimation of emission reductions was made considering 7,500 generators working hours, which is generators' average working hours of all the 10 years crediting period. Since the monitored period is situated in the first working period of the plant, the engines required little maintenance, resulting in a high performance. Moreover, in September 2011 the power capacity was increased because of the inclusion of a fourth engine.

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History of the document

Version	Date	Nature of revision
01	EB 54, Annex 34 28 May 2010	Initial adoption.
Decision Class: Regulatory **Document Type**: Guideline, Form **Business Function**: Issuance		