Monitoring report form

(Version 05.1)

Complete this form in accordance with the Attachment "Instructions for filling out the monitoring report form" at the end of this form.

MONITORING REPORT		
Title of the project activity	CTR Candeias Landfill Gas Project	
UNFCCC reference number of the project activity	3958	
Version number of the monitoring report	Version 1	
Completion date of the monitoring report	05/02/2016	
Monitoring period number and duration of this monitoring period	3nd Monitoring Period 01/01/2015 – 31/12/2015 (both days included)	
Project participant(s)	**Brazil:** Haztec Tecnologia e Planejamento Ambiental SA **Spain:** International Bank for Reconstruction and Development, as Trustee of the Spanish Carbon Fund (SCF); Kingdom of Spain - Ministry of Agriculture, Food and Environment and Ministry of Economy and Competitiveness; Endesa Generacion S.A. **Sweden:** Swedish Energy Agency **Norway:** Norwegian Ministry of Climate and Environment **Germany:** E.ON Climate & Renewables GmbH	
Host Party	Brazil	
Sectoral scope(s)	Sectoral Scope 13 : Waste handling and disposal	
Selected methodology(ies)	ACM0001 - Version 11 "*Consolidated baseline and monitoring methodology for landfill gas project activities*"	
Selected standardized baseline(s)	N/A	
Estimated amount of GHG emission reductions or net GHG removals by sinks for this monitoring period in the registered PDD	161,434 tCO_2e	
Total amount of GHG emission reductions or net GHG removals by sinks achieved in this monitoring period	GHG emission reductions or net GHG removals by sinks reported up to 31 December 2012	GHG emission reductions or net GHG removals by sinks reported from 1 January 2013 onwards
	N/A	138,906 tCO_2e

SECTION A. Description of project activity

A.1. Purpose and general description of project activity

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The objective of the CTR Candeias Landfill Gas Project is to capture and burn the methane (CH4) emissions generated by the decay of organic waste from the CTR Candeias Sanitary landfill located in the municipality of Jaboatão dos Guararapes, in the Recife Metropolitan Area. The project also intends to generate electricity from the combustion of methane and sell it to the national electricity grid and thus reduce CO2 emissions by displacing electricity generated from fossil fuels.

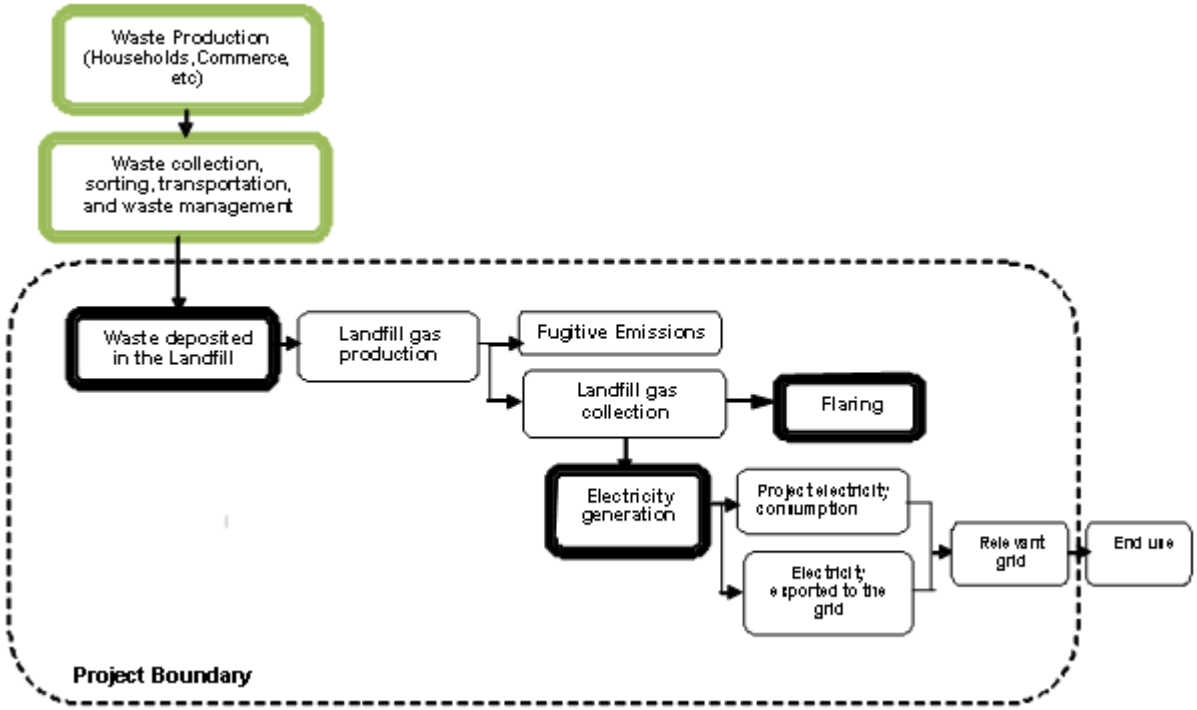
The project activity generates emission reductions by avoiding methane emissions through the destruction of the methane generated by the landfill.

The landfill of CTR Candeias, is strategically located close to major cities in the Recife Metropolitan Area and is the first sanitary landfill in the State of Pernambuco. The landfill started operations in August 2007 and received all necessary environmental licenses for operations. The landfill was designed to operate over a 16 years-period and will thus be closed by the end of 2022.The municipal landfill covers an area of over 170,000 m2 and will receive about 11 million tons of solid waste during the period 2007-2022.

The monitoring equipment was installed on December 12, 2012. The official start-up date of the landfill gas (LFG) extraction and flaring system happened on December 14, 2012. The monitoring system started to record the variables for ER calculation on December 15, 2012.

On May, 2015, it was installed the second flare, enabling increased volumes of biogas combustion.

Electricity production has not been in place during this monitored period. The conception, specifications and design have not been completed yet. Therefore, during this monitoring period, no electricity was generated using LFG.



The total volume of emission reductions achieved in this monitoring period was 138,906 tCO_2e.

A.2. Location of project activity

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The project site is located in the Municipality of Jaboatão dos Guararapes in the Recife Metropolitan Area, state of Pernambuco, Brazil. Several poor communities are located in the vicinity of the project. The landfill is strategically situated close to three major cities in the state of Pernambuco: Recife, Jaboatão dos Guararapes, and Cabo de Santo Agostinho. Due to its central location, the landfill will potentially provide services to a metropolitan area of 3.8 million inhabitants. The site, which is located at coordinates Latitude -8.164258; Longitude:-34.985286, is shown on Map 1.

Map 1 – Location of the CTR Candeias Landfill Gas Project (Source: IBGE).

A.3. Parties and project participant(s)

Party involved ((host) indicates a host Party)	Private and/or public entity(ies) project participants (as applicable)	Indicate whether the Party involved wishes to be considered as project participant (yes/no)
Brazil (host)	Haztec Tecnologia e Planejamento Ambiental AS (private entity)	No
Spain	International Bank for Reconstruction and Development, as Trustee of the Spanish Carbon Fund (SCF) (multilateral) Kingdom of Spain - Ministry of Agriculture, Food and Environment and Ministry of Economy and Competitiveness (public entity) Endesa Generacion S.A. (private entity)	Yes
Sweden	Swedish Energy Agency (public entity)	Yes
Norway	Norwegian Ministry of Climate and Environment (public entity)	Yes
Germany	E.ON Climate & Renewables GmbH (private entity)	No

A.4. Reference of applied methodology and standardized baseline

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The Project applies ACM0001 – version 11: "Consolidated baseline and monitoring methodology for landfill gas project activities."[1]

Tools to which the methodology refers to are the following[2]:

- Version 05.2 – "Tool for the demonstration and assessment of additonality"
- Version 01.0.0 - "Tool to determine project emissions from flaring gases containing methane".
- Version 01- "Tool to calculate baseline, project and/or leakage emissions from electricity consumption".
- Version 02- "Tool to calculate project or leakage CO2 emissions from fossil fuel combustion".
- Version 05- "Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site".
- Version 02.2.0 - "Tool to calculate the emission factor for an electricity system".

A.5. Crediting period of project activity

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The project activity has a crediting period that can be renewed two times. The current crediting period of the project activity, to which this monitored period applies, is the first which began on 29/09/2011 and runs for 7 years until 28/09/2018 (both days included).

A.6. Contact information of responsible persons/entities

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Ecopesa Ambiental S.A. (Responsible entity for completing the CDM-MR-FORM)
1000 Estrada Velha da Muribeca, 54325-042 | Jaboatão dos Guararapes | Pernambuco | Brazil
Helena Vasconcelos Martins Reis, Operations Supervisor (helena@ctrcandeias.com.br).

SECTION B. Implementation of project activity

B.1. Description of implemented registered project activity

>>

Candeias landfill site started receiving waste in 2007. The landfill is expected to receive waste for 15 years. Waste received over this period will reach about 11 million tons. This estimate is based on the volume received and monitored between 2007-2009 and expected waste to be disposed from 2010 until closure 2022.

The LFG collection and flaring system has a capacity for 5,000 Nm³/h. The system is designed to allow for expansion with new component, such as an electricity generation. The project entity is currently evaluating the installation of these additional components for the upcoming years.

The process in which the LFG is collected and flared has 3 main stages:

1. LFG is collected in the wells and transported in the landfill pipeline system with the use a blower;
2. LFG enters in the pre-treatment system which removes excess moisture and impurities;
3. LFG is send to the flare system for its combustion.

[1] http://cdm.unfccc.int/methodologies/DB/D44X8FH8SFCXREE6037AXJSBGGFVDO

[2] Please refer to <http://cdm.unfccc.int/goto/MPappmeth>

Landfill gas collection system: State-of-the-art gas collection technology includes the items listed below.

- Vertical wells used to extract gas and leachate;
- Horizontal wells used to extract gas;
- Optimal well spacing for maximum gas collection whilst minimizing costs;
- Wellheads designed for gas measurements;
- Blowers;
- Condensate extraction and storage systems designed at strategic low points throughout the gas system; and
- Pipeline collection system to connect the LFG collected with the electricity generation and flaring systems.

The landfill is covered by clay to prevent the biogas to come out through the landfill surface.

Landfill gas pre-treatment system: Once the landfill gas is collected and transported through pipes, the landfill gas will reach pre-treatment system (demister), in which the moisture of landfill gas will be removed.

Enclosed flaring system:
The enclosed flare selected is designed to operate continuously with automatic temperature control to safely destroy the biogas generated by solid waste. The flare system includes the items listed below.

- Enclosed flare with controlled combustion system;
- Blower system used to direct gas for flaring;
- Equipment to ensure continuous monitoring of the LFG composition (methane, oxygen, dioxide of carbon and balance), flow and burn temperature; and
- Security restarts system, in cases the system shuts down.

The flare system, with a capacity to process 5,000 Nm3/h of LFG (two flares 2500 Nm^3/h each), will achieve destruction efficiency greater than 99% of total organic compounds and greater than 98% of total non-methane volatile organic compounds (NMVOC) throughout the entire flare operating range.

The main incidents that occurred during the period of this monitoring report are listed in the following table:

Start	End	Incidence	Corrective action
02/07/2015 04:31	17/07/2015 16:41	Unscheduled LFG Gas Analyzer maintenance	Repair / Corrected and Calibrated
30/10/2015 09:49	18/11/2015 11:28	Unscheduled Exhaust Gas Analyzer maintenance	Repair / Corrected and Calibrated

During the installation of the second flare, the system was turned off. The system was also turned off for preventive maintenance, inspection, cleaning or to replace a part. No ERs have been claimed for any of these periods

B.2. Post-registration changes

B.2.1. Temporary deviations from registered monitoring plan, applied methodology or applied standardized baseline

>>
Not applicable.

B.2.2. Corrections

>>
Corrections to the PDD have been approved prior to this verification.
Please refer to: PRC-3958-001 (Effective approval date 7 February 2014).

B.2.3. Changes to start date of crediting period

>>
Not applicable.

B.2.4. Inclusion of a monitoring plan to the registered PDD that was not included at registration

>>
Not applicable.

B.2.5. Permanent changes from registered monitoring plan, applied methodology or applied standardized baseline

>>
Permanent changes from registered monitoring plan have been approved prior to this verification.
Please refer to: PRC-3958-001 (Effective approval date 7 February 2014).

B.2.6. Changes to project design of registered project activity

>>
Not applicable.

B.2.7. Types of changes specific to afforestation or reforestation project activity

>>
Not applicable.

SECTION C. Description of monitoring system

>>
The following equipment is used to monitor the operation of the project and the emission reductions.
The control of maintenance and inspection schedules was defined considering the equipment manufacture´s specifications and orientations.

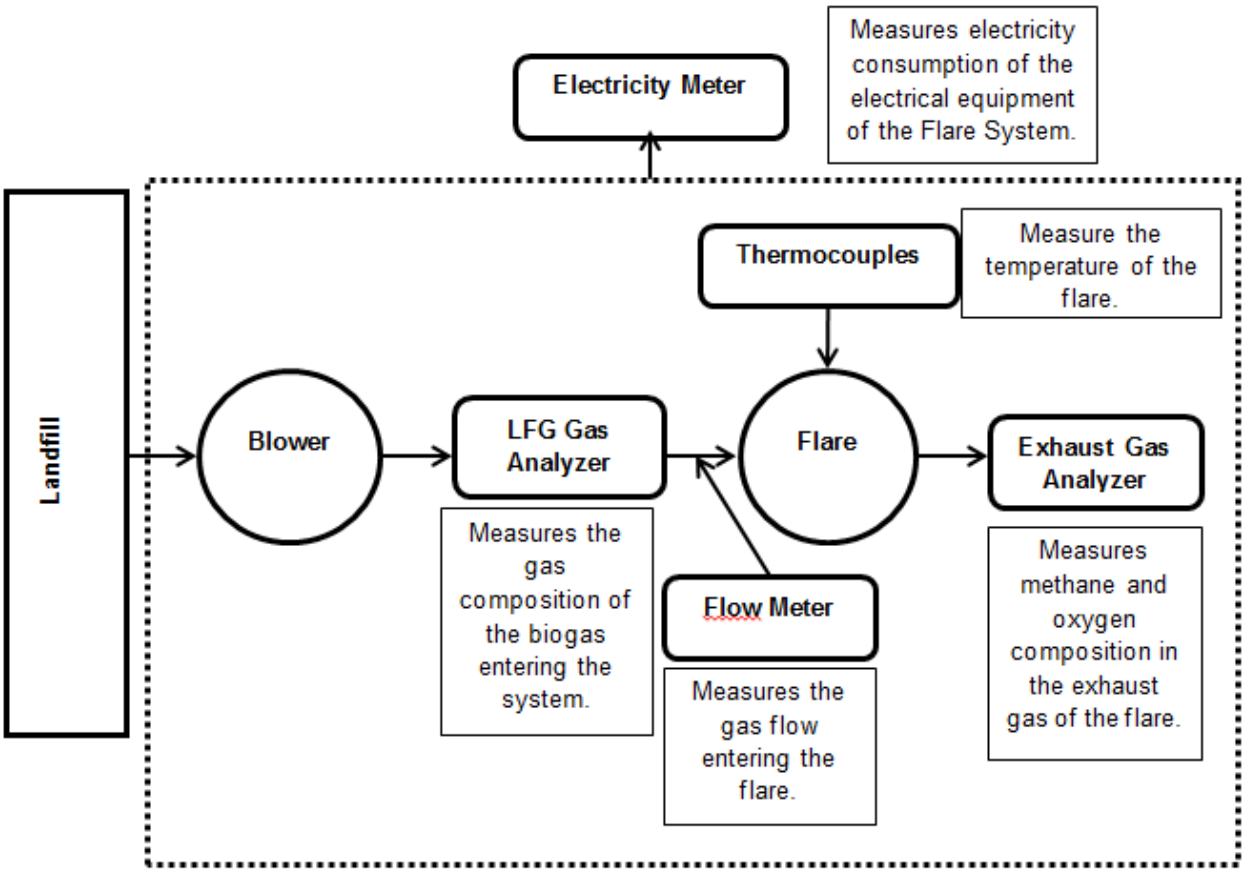
LFG Gas Analyzer
The LFG Gas analyzer, is used to measure the biogas composition before the gas enters the flaring system. The manufacturer of the gas analyzer is Siemens.

Flow Meter
The flow meters are used to measure the gas flow entering in each the flare system. The Project uses thermal mass flow meters manufactured by ABB that operates with a measurement control system of the biogas temperature and pressure in the pipeline to calculate the flow in normal conditions (Nm3/h – normal cubic meter per hour).

Thermocouples
High performance equipment to control the flare temperature is installed in each the flare towers. The manufacturer of the thermocouples used is ELSI S.R.L.

Exhaust Gas Analyzer
The Exhaust Gas Analyzer provides continuous monitoring of methane and oxygen in the exhaust gas of the flare to calculate the biogas flaring efficiency. The manufacturer of the gas analyzer is Siemens.

Energy Meter
The Energy Meter of the Project Site operates in order to measure electricity consumption of the Flare System. The equipment manufacturer is IME S.p.A.



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

Monitoring Manager. Responsible for the monitoring plan and supervision on the collected data. The manager reports monthly about project performance and data. Additionally, the manager will report immediately to senior company management if non-conformance in the performance is detected such as flow meters not working. The Monitoring Manager is the main contact person for the verifiers, Brazilian DNA and any other designated entity, during the crediting period.

Project Team. The LFG project team discusses the performance of the LFG capture and flaring project. Members of the project team include the Monitoring Manager and the General Manager of the Candeias landfill.

Internal inspection. The monitoring plan including all defined procedures, reports, data, and personnel are inspected internally to ensure the monitoring activities are in-compliance and to define new procedures in case of need.

SECTION D. Data and parameters

D.1. Data and parameters fixed ex ante or at renewal of crediting period

The following parameters, listed in the registered PDD, will not be used during the current monitoring period: $BE_{CH4,SWDS,y}$; φ; OX ; F ; f ; z ; DOC_f ; MCF ; DOC_j ; K_j ; E_{DS} ; W_X ; $p_{n,j,x}$.

Data / Parameter:	**Regulatory requirements relating to landfill gas**
Unit:	Norms
Description:	Regulatory requirements relating to landfill gas from ABNT NBR (*Associação Brasileira de Normas Tecnicas* / Brazilian Association of Technical Norms) and (*Norma Brasileira* / Brazilian Norm), including: ABNT NBR 8419:1992 Versão Corrigida: 1996. *Apresentação de projetos de aterros sanitários de resíduos sólidos urbanos* / Introduction of Projects for Sanitary Landfills of Municipal Solid Waste.
Source of data:	Publicly available information
Value(s) applied):	-
Choice of data or measurement methods and procedures	There have been no changes in the regulations. The information will be recorded, to use it for changes in the adjustment factor (AF) or directly to $MD_{BL,y}$ at renewal of the credit period.
Purpose of data:	Calculation of baseline emissions
Additional comment:	-

Data / Parameter:	**GWP_{CH4}**
Unit:	tCO_2/tCH_4
Description:	Global Warming Potential of CH_4
Source of data:	IPCC Guidelines
Value(s) applied):	25
Choice of data or measurement methods and procedures	Shall be updated accordingly to any future COP/MOP decisions
Purpose of data:	Calculation of baseline emissions
Additional comment:	-

Data / Parameter:	**D_{CH4}**
Unit:	t_{CH4}/m^3_{CH4}
Description:	Methane density
Source of data:	ACM0001, Version 11
Value(s) applied):	0.0007168
Choice of data or measurement methods and procedures	At standard T and P (0 degrees C and 1.013 bar)
Purpose of data:	Calculation of baseline emissions
Additional comment:	-

Data / Parameter:	**MM_{CH4}**
Unit:	kg/kmol
Description:	Molecular mass of methane
Source of data:	Constant.

Value(s) applied):	16.04
Choice of data or measurement methods and procedures	As per the *"Tool to determine project emissions from flaring gases containing methane"*, Version1
Purpose of data:	Calculation of baseline emissions
Additional comment:	-

Data / Parameter:	**MM_{CO}**
Unit:	kg/kmol
Description:	Molecular mass of carbon monoxide
Source of data:	Constant.
Value(s) applied):	28.01
Choice of data or measurement methods and procedures	As per the *"Tool to determine project emissions from flaring gases containing methane"*, Version1
Purpose of data:	Calculation of baseline emissions
Additional comment:	-

Data / Parameter:	**MM_{CO2}**
Unit:	kg/kmol
Description:	Molecular mass of carbon dioxide
Source of data:	Constant.
Value(s) applied):	44.01
Choice of data or measurement methods and procedures	As per the *"Tool to determine project emissions from flaring gases containing methane"*, Version1
Purpose of data:	Calculation of baseline emissions
Additional comment:	-

Data / Parameter:	**MM_{O2}**
Unit:	kg/kmol
Description:	Molecular mass of oxygen
Source of data:	Constant.
Value(s) applied):	32.00
Choice of data or measurement methods and procedures	As per the *"Tool to determine project emissions from flaring gases containing methane"*, Version1
Purpose of data:	Calculation of baseline emissions
Additional comment:	-

Data / Parameter:	**MM_{H2}**
Unit:	kg/kmol
Description:	Molecular mass of hydrogen
Source of data:	Constant.
Value(s) applied):	2.02

Choice of data or measurement methods and procedures	As per the *"Tool to determine project emissions from flaring gases containing methane"*, Version1
Purpose of data:	Calculation of baseline emissions
Additional comment:	-

Data / Parameter:	**MM_{N2}**
Unit:	kg/kmol
Description:	Molecular mass of nitrogen
Source of data:	Constant.
Value(s) applied):	28.02
Choice of data or measurement methods and procedures	As per the *"Tool to determine project emissions from flaring gases containing methane"*, Version1
Purpose of data:	Calculation of baseline emissions
Additional comment:	-

Data / Parameter:	**AM_c**
Unit:	kg/kmol
Description:	Atomic mass of carbon
Source of data:	Constant.
Value(s) applied):	12.00
Choice of data or measurement methods and procedures	As per the *"Tool to determine project emissions from flaring gases containing methane"*, Version1
Purpose of data:	Calculation of baseline emissions
Additional comment:	-

Data / Parameter:	**AM_H**
Unit:	kg/kmol
Description:	Atomic mass of hydrogen
Source of data:	Constant.
Value(s) applied):	1.01
Choice of data or measurement methods and procedures	As per the *"Tool to determine project emissions from flaring gases containing methane"*, Version1
Purpose of data:	Calculation of baseline emissions
Additional comment:	-

Data / Parameter:	**AM_O**
Unit:	kg/kmol
Description:	Atomic mass of oxygen
Source of data:	Constant.
Value(s) applied):	16.00
Choice of data or measurement methods and procedures	As per the *"Tool to determine project emissions from flaring gases containing methane"*, Version1

Purpose of data:	Calculation of baseline emissions
Additional comment:	-

Data / Parameter:	**AM_N**
Unit:	kg/kmol
Description:	Atomic mass of nitrogen
Source of data:	Constant.
Value(s) applied):	14.01
Choice of data or measurement methods and procedures	As per the *"Tool to determine project emissions from flaring gases containing methane"*, Version1
Purpose of data:	Calculation of baseline emissions
Additional comment:	-

Data / Parameter:	**P_n**
Unit:	Pa
Description:	Atmospheric pressure at normal conditions
Source of data:	Constant.
Value(s) applied):	101,325
Choice of data or measurement methods and procedures	As per the *"Tool to determine project emissions from flaring gases containing methane"*, Version1
Purpose of data:	Calculation of baseline emissions
Additional comment:	-

Data / Parameter:	**R_u**
Unit:	$Pa.m^3/kmol.K$
Description:	Universal ideal gas constant
Source of data:	Constant.
Value(s) applied):	8,314.472
Choice of data or measurement methods and procedures	As per the *"Tool to determine project emissions from flaring gases containing methane"*, Version1
Purpose of data:	Calculation of baseline emissions
Additional comment:	-

Data / Parameter:	**T_n**
Unit:	K
Description:	Temperature at normal conditions
Source of data:	Constant.
Value(s) applied):	273.15
Choice of data or measurement methods and procedures	As per the *"Tool to determine project emissions from flaring gases containing methane"*, Version1
Purpose of data:	Calculation of baseline emissions
Additional comment:	-

Data / Parameter:	MF_{O2}
Unit:	Dimensionless
Description:	O_2 volumetric fraction of air
Source of data:	Constant.
Value(s) applied):	0.21
Choice of data or measurement methods and procedures	As per the *"Tool to determine project emissions from flaring gases containing methane"*, Version1
Purpose of data:	Calculation of baseline emissions
Additional comment:	-

Data / Parameter:	MV_n
Unit:	m^3/Kmol
Description:	Volume of one mole of any ideal gas at normal
Source of data:	Constant.
Value(s) applied):	22.414
Choice of data or measurement methods and procedures	As per the *"Tool to determine project emissions from flaring gases containing methane"*, Version1
Purpose of data:	Calculation of baseline emissions
Additional comment:	-

Data / Parameter:	TDL_y
Unit:	%
Description:	Average technical transmission and distribution losses in the grid in year y for the voltage level at which electricity is obtained from the grid at the project site.
Source of data:	Default value according to the "*Tool to calculate project emissions from electricity consumption" version 01.*
Value(s) applied):	20%
Choice of data or measurement methods and procedures	Default value according to the "*Tool to calculate project emissions from electricity consumption" version 01.*
Purpose of data:	Calculation of project emissions
Additional comment:	-

D.2. Data and parameters monitored

The following parameters, listed in the registered PDD, will not be used during the current monitoring period: **$LFG_{electricity,y}$; EL_{LFG} ; Operation of the energy plant ; $PE_{FC,j,y}$; $FC_{i,j,y}$; $NCV_{i,y}$; $EF_{CO2,i,y}$;**

Data / Parameter:	$LFG_{total,y}$
Unit:	Nm^3
Description:	Total amount of landfill gas captured at normal temperature and pressure on a wet basis.
Measured/ Calculated / Default:	Measured on site with a flow meter on each flare.
Source of data:	Project developer

<table>
<tr><td>Value(s) of monitored parameter:</td><td>Please refer to Table 1 of section E and the ER calculation spreadsheet</td></tr>
<tr><td>Monitoring equipment:</td><td>
<table>
<tr><td colspan="2">FLARE 01</td></tr>
<tr><td></td><td>Type: Swirl flow meter</td></tr>
<tr><td>Accuracy class:</td><td>± 0.5% of full scale</td></tr>
<tr><td>Serial number:</td><td>241488749/X002</td></tr>
<tr><td>Calibration frequency:</td><td>3 years from the date of the last calibration</td></tr>
<tr><td>Manufacturer Calibration:</td><td>21/06/2012</td></tr>
<tr><td>Valid up to:</td><td>20/06/2015</td></tr>
<tr><td>Calibration Date:</td><td>18/06/2015</td></tr>
<tr><td>Valid up to:</td><td>17/06/2018</td></tr>
</table>
<table>
<tr><td colspan="2">FLARE 02</td></tr>
<tr><td></td><td>Type: Swirl flow meter</td></tr>
<tr><td>Accuracy class:</td><td>± 0.5% of full scale</td></tr>
<tr><td>Serial number:</td><td>242540862/X001</td></tr>
<tr><td>Calibration frequency:</td><td>3 years from the date of the last calibration</td></tr>
<tr><td>Manufacturer Calibration:</td><td>28/08/2014</td></tr>
<tr><td>Valid up to:</td><td>27/08/2017</td></tr>
</table>
</td></tr>
<tr><td>Measuring/ Reading/ Recording frequency:</td><td>Measured continuously. Data to be aggregated monthly and yearly. The flow meter includes automatic measure of the Temperature and Pressure so the measure is expressed in normalized cubic meter.

The data is monitored continuously and registered every minute in the system database. Information is aggregated to an hourly average value for each flare. The hourly value is used for the calculation of emission reductions and later aggregated monthly and yearly for reporting purposes. The total flow is the sum of the data of each flare.</td></tr>
<tr><td>Calculation method (if applicable):</td><td>N/A</td></tr>
<tr><td>QA/QC procedures:</td><td>The flow meter was calibrated by the factory and has been subject to regular maintenance. The calibration frequency is every 3 years as per manufacturer recommendations.</td></tr>
<tr><td>Purpose of data:</td><td>Calculation of baseline emissions</td></tr>
<tr><td>Additional comment:</td><td>-</td></tr>
</table>

Data / Parameter:	**$LFG_{flare,y}$**
Unit:	Nm^3
Description:	Amount of landfill gas flared at normal temperature and pressure on a wet basis.
Measured/ Calculated / Default:	Measured on site with a flowmeter
Source of data:	Project developer
Value(s) of monitored parameter:	Please refer to Table 1 of section E and the ER calculation spreadsheet

<table>
<tr><td>Monitoring equipment:</td><td>
<table>
<tr><td colspan="2">FLARE 01</td></tr>
<tr><td></td><td>Type: Swirl flow meter</td></tr>
<tr><td>Accuracy class:</td><td>± 0.5% of full scale</td></tr>
<tr><td>Serial number:</td><td>241488749/X002</td></tr>
<tr><td>Calibration frequency:</td><td>3 years from the date of the last calibration</td></tr>
<tr><td>Manufacturer Calibration:</td><td>21/06/2012</td></tr>
<tr><td>Valid up to:</td><td>20/06/2015</td></tr>
<tr><td>Calibration Date:</td><td>18/06/2015</td></tr>
<tr><td>Valid up to:</td><td>17/06/2018</td></tr>
</table>
<table>
<tr><td colspan="2">FLARE 02</td></tr>
<tr><td></td><td>Type: Swirl flow meter</td></tr>
<tr><td>Accuracy class:</td><td>± 0.5% of full scale</td></tr>
<tr><td>Serial number:</td><td>242540862/X001</td></tr>
<tr><td>Calibration frequency:</td><td>3 years from the date of the last calibration</td></tr>
<tr><td>Manufacturer Calibration:</td><td>28/08/2014</td></tr>
<tr><td>Valid up to:</td><td>27/08/2017</td></tr>
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</td></tr>
<tr><td>Measuring/ Reading/ Recording frequency:</td><td>Measured continuously. Data to be aggregated monthly and yearly. The flow meter includes automatic measure of the Temperature and Pressure so the measure is expressed in normalized cubic meter.

The data is monitored continuously and registered every minute in the system database. Information is aggregated to an hourly average value for each flare. The hourly value is used for the calculation of emission reductions and later aggregated monthly and yearly for reporting purposes.</td></tr>
<tr><td>Calculation method (if applicable):</td><td>N/A</td></tr>
<tr><td>QA/QC procedures:</td><td>The flow meter was calibrated by the factory and has been subject to regular maintenance. The calibration frequency is every 3 years as per manufacturer recommendations.</td></tr>
<tr><td>Purpose of data:</td><td>Calculation of baseline emissions</td></tr>
<tr><td>Additional comment:</td><td>$LFG_{flare,y}$ is considered to be equivalent to the variable $FV_{RG,h}$ (volumetric flow rate of the residual gas) as described in the “Tool to determine Project emissions from flaring gases containing methane” EB 28 Annex 13 used to determine project emissions from flaring. Data will be kept for 2 years after end of crediting period or last issuance of CERs for the project activity</td></tr>
</table>

Data / Parameter:	$w_{CH4,\,y}$
Unit:	m³ CH4/m³ LFG
Description:	Methane fraction in the landfill gas on a wet basis
Measured/ Calculated / Default:	Measured
Source of data:	Gas Analyzer
Value(s) of monitored parameter:	Please refer to Table 1 of section E and the ER calculation spreadsheet.

Monitoring equipment:	**Type: Siemens ULTRAMAT 23 (Gas Analyzer)** Accuracy class: ± 1% Serial number: N1C7778 Calibration frequency: 12 months Calibration Date 22/07/2014 Valid up to 21/07/2015 Calibration Date 19/01/2015 Valid up to 18/01/2016 Calibration Date 25/06/2015 Valid up to 24/06/2016 Calibration Date 15/07/2015 Valid up to 14/07/2016
Measuring/ Reading/ Recording frequency:	Measured continuously. Data to be aggregated, monthly and yearly.
Calculation method (if applicable):	N/A
QA/QC procedures:	The gas analyzer is subject to regular maintenance and testing. The calibration regime is regular, in accordance with manufacturer specifications to ensure its accuracy.
Purpose of data:	Calculation of baseline emissions.
Additional comment:	w_{CH4} is considered to be equivalent to the variable $fv_{CH4,h}$ (volumetric fraction of the component CH_4 in the residual gas in the hour h) as described in the *"Tool to determine Project emissions from flaring gases containing methane"*, EB 28 Annex 13. Data will be kept for 2 years after end of crediting period or last issuance of CERs for the project activity.

Data / Parameter:	**$PE_{flare,y}$**
Unit:	tCO_2e
Description:	Project emissions from flaring of the residual gas stream in year *y*
Measured/ Calculated / Default:	Calculated
Source of data:	Project Developer
Value(s) of monitored parameter:	Please refer to Table 1 of section E and the ER calculation spreadsheet.
Monitoring equipment:	See parameters $fv_{i,h}$, $FV_{RG,h}$, t_{O2},h, $fv_{CH4,FG,h}$ and T_{flare}
Measuring/ Reading/ Recording frequency:	Measured continuously. Data to be aggregated, monthly and yearly.
Calculation method (if applicable):	Calculated as per the *"Tool to determine project emissions from flaring gases containing methane"*, EB 28 Annex 13
QA/QC procedures:	As per the "*Tool to determine project emissions from flaring gases containing methane*", EB 28 Annex 13
Purpose of data:	Calculation of baseline emissions
Additional comment:	Data will be kept for 2 years after end of crediting period or last issuance of CERs for the project activity.

Data / Parameter:	**T_{flare}**
Unit:	°C
Description:	Temperature in the exhaust gas of the flare

<table>
<tr><td>Measured/
Calculated /
Default:</td><td>Measured</td></tr>
<tr><td>Source of data:</td><td>Project Developer</td></tr>
<tr><td>Value(s) of monitored parameter:</td><td>Please refer to ER calculation spreadsheet</td></tr>
<tr><td>Monitoring equipment:</td><td>
<table>
<tr><td colspan="2">FLARE 01</td></tr>
<tr><td colspan="2">ELSI Thermocouples, Model M1 (type S)</td></tr>
<tr><td>Accuracy class:</td><td>±4.204 °C (<600 ^{0}C)
±2.704 °C or ±0.0025 x temperature (>=600 ^{0}C)</td></tr>
<tr><td>Serial number:</td><td>04-13/65160</td></tr>
<tr><td>Calibration frequency:</td><td>12 Months from start of operation</td></tr>
<tr><td>Calibration</td><td>16/09/2014</td></tr>
<tr><td>Validity:</td><td>15/09/2015</td></tr>
<tr><td>Calibration</td><td>15/09/2015</td></tr>
<tr><td>Validity:</td><td>14/09/2016</td></tr>
<tr><td>Operation Period:</td><td>16/09/2014 up to now</td></tr>
</table>
<table>
<tr><td colspan="2">FLARE 02</td></tr>
<tr><td colspan="2">ELSI Thermocouples, Model M1 (type S)</td></tr>
<tr><td>Accuracy class:</td><td>±4.204 °C (<600 ^{0}C)
±2.704 °C or ±0.0025 x temperature (>=600 ^{0}C)</td></tr>
<tr><td>Serial number:</td><td>08-14/67560</td></tr>
<tr><td>Calibration frequency:</td><td>12 Months from start of operation</td></tr>
<tr><td>Calibration</td><td>16/09/2014</td></tr>
<tr><td>Validity:</td><td>06/05/2016</td></tr>
<tr><td>Operation Period:</td><td>06/05/2015 up to now</td></tr>
</table>
The validity of the calibration period starts at the moment the equipment initiates operation in the Flare System.
</td></tr>
<tr><td>Measuring/
Reading/
Recording frequency:</td><td>Data is measured continuously.</td></tr>
<tr><td>Calculation method (if applicable):</td><td>N/A</td></tr>
<tr><td>QA/QC procedures:</td><td>Measuring instruments are subject to regular maintenance and testing regime, based on the manufacturer’s recommended schedule and procedures</td></tr>
<tr><td>Purpose of data:</td><td>Calculation of baseline emissions</td></tr>
<tr><td>Additional comment:</td><td>Required to determine adequate operation and operating hours of the flare. Data will be kept for 2 years after end of crediting period or last issuance of CERs for the project activity.</td></tr>
</table>

Data / Parameter:	$t_{O2,h}$
Unit:	--
Description:	Volumetric fraction of O_2 in the exhaust gas of the flare on wet basis in the hour *h*
Measured/ Calculated / Default:	Measured
Source of data:	Project Developer

<table>
<tr><td>Value(s) of monitored parameter:</td><td>Please refer to ER calculation spreadsheet</td></tr>
<tr><td>Monitoring equipment:</td><td>The gas analyser is used to measure the exhaust gas composition. The manufacturer of the gas analyser is Siemens.
<table>
<tr><th colspan="3">Type: Siemens ULTRAMAT 23 (Flare Emissions Analyzer)</th></tr>
<tr><td>Serial number:</td><td colspan="2">N1C7779</td></tr>
<tr><td rowspan="2">Accuracy class:</td><td>CH4</td><td>O2</td></tr>
<tr><td>± (25 ppm + 0.25%)</td><td>±1%</td></tr>
<tr><td>Calibration frequency:</td><td colspan="2">12 months</td></tr>
<tr><td>Calibration Date:</td><td colspan="2">22/07/2014</td></tr>
<tr><td>Valid up to:</td><td colspan="2">21/07/2015</td></tr>
<tr><td>Calibration Date</td><td colspan="2">19/01/2015</td></tr>
<tr><td>Valid up to</td><td colspan="2">18/01/2016</td></tr>
<tr><td>Calibration Date</td><td colspan="2">25/06/2015</td></tr>
<tr><td>Valid up to</td><td colspan="2">24/06/2016</td></tr>
<tr><td>Calibration Date</td><td colspan="2">16/11/2015</td></tr>
<tr><td>Valid up to</td><td colspan="2">15/11/2016</td></tr>
</table></td></tr>
<tr><td>Measuring/ Reading/ Recording frequency:</td><td>Data is measured continuously and aggregated monthly and yearly</td></tr>
<tr><td>Calculation method (if applicable):</td><td>N/A</td></tr>
<tr><td>QA/QC procedures:</td><td>Analyzers will be calibrated according to the manufacturer’s recommendation and in accordance with appropriate national/international standards to ensure its accuracy. A zero check and a typical value check will be performed by comparison with a standard certified gas.</td></tr>
<tr><td>Purpose of data:</td><td>Calculation of baseline emissions</td></tr>
<tr><td>Additional comment:</td><td>Monitoring of this parameter is due to continuous monitoring of the flare efficiency. Data will be kept for 2 years after end of crediting period or last issuance of CERs for the project activity.</td></tr>
</table>

Data / Parameter:	$\mathbf{fv}_{CH4,h}$
Unit:	-
Description:	Volumetric fraction of methane in the residual gas on wet basis in the hour h
Measured/ Calculated / Default:	Measured
Source of data:	Project developer
Value(s) of monitored parameter:	Please refer to Table 1 of section E and the ER calculation spreadsheet

<table>
<tr><td>Monitoring equipment:</td><td>The gas analyser is used to measure the exhaust gas composition. The manufacturer of the gas analyser is Siemens.

<table><tr><th colspan="2">Type: Siemens ULTRAMAT 23 (Gas Analyzer)</th></tr><tr><td>Accuracy class:</td><td>+ 1%</td></tr><tr><td>Serial number:</td><td>N1C7778</td></tr><tr><td>Calibration frequency:</td><td>12 months</td></tr><tr><td>Calibration Date</td><td>22/07/2014</td></tr><tr><td>Valid up to</td><td>21/07/2015</td></tr><tr><td>Calibration Date</td><td>19/01/2015</td></tr><tr><td>Valid up to</td><td>18/01/2016</td></tr><tr><td>Calibration Date</td><td>25/06/2015</td></tr><tr><td>Valid up to</td><td>24/06/2016</td></tr><tr><td>Calibration Date</td><td>15/07/2015</td></tr><tr><td>Valid up to</td><td>14/07/2016</td></tr></table></td></tr>
<tr><td>Measuring/ Reading/ Recording frequency:</td><td>Measured continuously and aggregated monthly and yearly.
The flow meter includes automatic measure of the Temperature and Pressure so the measure is expressed in normalized cubic meter.</td></tr>
<tr><td>Calculation method (if applicable):</td><td>N/A</td></tr>
<tr><td>QA/QC procedures:</td><td>Gas analyzer will be periodically calibrated according to the manufacturer’s recommendation and in accordance with appropriate national/international standards to ensure its accuracy. A zero check and a typical value check will be performed by comparison with a standard certified gas.</td></tr>
<tr><td>Purpose of data:</td><td>Calculation of baseline emissions</td></tr>
<tr><td>Additional comment:</td><td>$\mathbf{fv}_{CH4,h}$ is considered to be equivalent to the variable w_{CH4} (methane fraction in the landfill gas on a wet basis).
Data will be kept for 2 years after end of crediting period or last issuance of CERs for the project activity</td></tr>
</table>

Data / Parameter:	$\mathbf{Fv}_{RG,h}$
Unit:	m^3/h
Description:	Volumetric flow rate of the residual gas on wet basis at normal (NTP) conditions in the hour h
Measured/ Calculated / Default:	Measured
Source of data:	Project developer
Value(s) of monitored parameter:	Please refer to Table 1 of section E and the ER calculation spreadsheet.

<table>
<tr><td>Monitoring equipment:</td><td>
<table>
<tr><td colspan="2">FLARE 01</td></tr>
<tr><td></td><td>Type: Swirl flow meter</td></tr>
<tr><td>Accuracy class:</td><td>± 0.5% of full scale</td></tr>
<tr><td>Serial number:</td><td>241488749/X002</td></tr>
<tr><td>Calibration frequency:</td><td>3 years from the date of the last calibration</td></tr>
<tr><td>Installation Date:</td><td>12/12/2012</td></tr>
<tr><td>Manufacturer Calibration:</td><td>21/06/2012</td></tr>
<tr><td>Valid up to:</td><td>20/06/2015</td></tr>
<tr><td>Calibration Date:</td><td>18/06/2015</td></tr>
<tr><td>Valid up to:</td><td>17/06/2018</td></tr>
</table>
<table>
<tr><td colspan="2">FLARE 02</td></tr>
<tr><td></td><td>Type: Swirl flow meter</td></tr>
<tr><td>Accuracy class:</td><td>± 0.5% of full scale</td></tr>
<tr><td>Serial number:</td><td>242540862/X001</td></tr>
<tr><td>Calibration frequency:</td><td>3 years from the date of the last calibration</td></tr>
<tr><td>Installation Date:</td><td>/05/2015</td></tr>
<tr><td>Manufacturer Calibration:</td><td>28/08/2014</td></tr>
<tr><td>Valid up to:</td><td>27/08/2017</td></tr>
</table>
</td></tr>
<tr><td>Measuring/ Reading/ Recording frequency:</td><td>Measured continuously.
Data to be aggregated, monthly and yearly.
The flow meter includes automatic measure of the Temperature and Pressure so the measure is expressed in normalized cubic meter.</td></tr>
<tr><td>Calculation method (if applicable):</td><td>N/A</td></tr>
<tr><td>QA/QC procedures:</td><td>Flow meters are to be periodically calibrated according to the manufacturer’s recommendations. It will be subject to a regular maintenance, testing and calibration regime in accordance with manufacturer specifications and appropriate national/international standards to ensure its accuracy</td></tr>
<tr><td>Purpose of data:</td><td>Calculation of baseline emissions</td></tr>
<tr><td>Additional comment:</td><td>$FV_{RG,h}$ is considered the equivalent of the variable $LFG_{flared,y}$ (Amount of landfill gas flared at normal temperature and pressure).
Monitoring of this parameter is due to continuous monitoring of the flare efficiency.
Data will be kept for 2 years after end of crediting period or last issuance of CERs for the project activity</td></tr>
</table>

Data / Parameter:	$fv_{CH4,FG,h}$
Unit:	m³ CH4/m³ LFG
Description:	Concentration of methane in the exhaust gas of the flare on wet basis at normal conditions in the hour h
Measured/ Calculated / Default:	Measured
Source of data:	Gas Analyzer
Value(s) of monitored parameter:	Please refer to ER calculation spreadsheet.

Monitoring equipment:	**Type: Siemens ULTRAMAT 23 (Flare Emissions Analyzer)** Serial number: N1C7779 Accuracy class: CH4 ± (25 ppm + 0.25%); O2 ±1% Calibration frequency: 12 months Calibration Date: 22/07/2014 Valid up to: 21/07/2015 Calibration Date 19/01/2015 Valid up to 18/01/2016 Calibration Date 25/06/2015 Valid up to 24/06/2016 Calibration Date 16/11/2015 Valid up to 15/11/2016
Measuring/ Reading/ Recording frequency:	Measured continuously. Data to be aggregated, monthly and yearly.
Calculation method (if applicable):	N/A
QA/QC procedures:	The gas analyzer is subject to regular maintenance and testing. The calibration regime is regular, in accordance with manufacturer specifications to ensure its accuracy.
Purpose of data:	Calculation of baseline emissions.
Additional comment:	Data will be kept for 2 years after end of crediting period or last issuance of CERs for the project activity

Data / Parameter:	**$PE_{EC,y}$**
Unit:	tCO_2
Description:	Project emissions from electricity consumption by the project activity during the year y
Measured/ Calculated / Default:	Calculated as per the *"Tool to calculate baseline, project and/or leakage emissions from electricity consumption"*, Version 01.
Source of data:	Project developer
Value(s) of monitored parameter:	Refer to tables of section E.2
Monitoring equipment:	-
Measuring/ Reading/ Recording frequency:	Measured continuously. Data to be aggregated, monthly and yearly.
Calculation method (if applicable):	As per the *"Tool to calculate baseline, project and/or leakage emissions from electricity consumption"*, Version 01.
QA/QC procedures:	As per the *"Tool to calculate baseline, project and/or leakage emissions from electricity consumption"*, Version 01.
Purpose of data:	Calculation of project emissions
Additional comment:	Data will be kept for 2 years after end of crediting period or last issuance of CERs for the project activity

Data / Parameter:	**$EC_{PJ,y}$**
Unit:	MWh
Description:	Quantity of electricity consumed by the project activity during the year y

Measured/ Calculated / Default:	Measured
Source of data:	Project developer
Value(s) of monitored parameter:	Please refer to Table 2 of section E and the ER calculation spreadsheet
Monitoring equipment:	Two electricity meters are available on the project site. Only one electricity meter is used in operation the other equipment is used for spare part (back-up). **Type: IME Electricity Meter** Serial number: 2397270032 Models: Nemo 96HD Accuracy: Active energy class 0.5 Calibration frequency: 5 years from the date of the last calibration, as per Brazilian standard[3] Calibration Date 31/08/2012 Valid up to: 30/08/2017 Operation Period 12/12/2012 up to now
Measuring/ Reading/ Recording frequency:	Electricity will be measured continuously using an electricity meter. Data will be aggregated at least annually as stated in the "*Tool to calculate Project emissions from electricity consumption" version 01.*
Calculation method (if applicable):	N/A
QA/QC procedures:	Electricity meter will be subject to regular maintenance and testing in accordance with stipulation of the meter supplier and in accordance with appropriate national/international standards to ensure accuracy
Purpose of data:	Calculation of project emissions.
Additional comment:	Data will be kept for 2 years after end of crediting period or last issuance of CERs for the project activity.

Data / Parameter:	**$EF_{grid, CM,y} = CEF_{elec,BL,y} = EF_{EL,j,y}$**
Unit:	tCO_2/MWh
Description:	Combined margin emission factor
Measured/ Calculated / Default:	Calculated using the *"Tool to calculate the emission factor for an electricity system"*, Version 2.2.0
Source of data:	Published data by the Brazilian Ministry of Science and Technology for values for OM_{grid} and BM_{grid}
Value(s) of monitored parameter:	0.4322 (value for 2013, latest available as of the date of this document)
Monitoring equipment:	-
Measuring/ Reading/ Recording frequency:	N/A
Calculation method (if applicable):	As per the *"Tool to calculate the emission factor for an electricity system"* version 2.2.0.
QA/QC procedures:	N/A
Purpose of data:	Calculation of project emissions
Additional comment:	-

[3] http://www.inmetro.gov.br/legislacao/rtac/pdf/RTAC001931.pdf

Data / Parameter:	Other flare operation parameters: T_{flare} and $LFG_{flare,y}$
Unit:	-
Description:	The range of operating conditions is defined according to the methodology and the manufacturer's specifications based on the flow of LFG to the flare and the temperature of the exhaust gas.
Measured/ Calculated / Default:	Measured
Source of data:	Project developer
Value(s) of monitored parameter:	Please refer to ER calculation spreadsheet
Monitoring equipment:	Thermocouple and flow meter measurements
Measuring/ Reading/ Recording frequency:	Monitored continuously.
Calculation method (if applicable):	Data will be continuously measured to ensure that the flares operate within the range specified by the methodology and the manufacturer in terms of the temperature of the exhaust gas and the LFG flow rate, as follows: Minimum temperature: 500°C Maximum temperature: 1,430°C Minimum flow rate: 500 Nm^3/h Maximum flow rate: 2,500 Nm^3/h The thermocouple and the flow meter will also follow the measurement methods and procedures described for T_{flare} and $LFG_{flare,y}$
QA/QC procedures:	As previously defined for T_{flare} and $LFG_{flare,y}$
Purpose of data:	Calculation of baseline emissions
Additional comment:	Only applicable in case of use of a default value.

D.3. Implementation of sampling plan

>>
Not applicable – sampling approach is not applied

SECTION E. Calculation of emission reductions or GHG removals by sinks

E.1. Calculation of baseline emissions or baseline net GHG removals by sinks

>>
According to the baseline methodology ACM0001 - Version 11, Baseline Emissions are calculated as follows:

$$BE_y = (MD_{project,y} - MD_{BL,y}) \times GWP_{CH_4} + EL_{LFG,y} \cdot CEF_{elec,BL,y} + ET_{LFG,y} \times CEF_{ther,BL,y}$$

Where:

BE_y = Baseline emissions in year y (t CO_2e).

$MD_{project,y}$ = The amount of methane that would have been destroyed/combusted during the year, n tons of methane (t CH_4) in project scenario.

$MD_{BL,y}$ = The amount of methane that would have been destroyed/combusted during the year in the absence of the project due to regulatory and/or contractual requirement, in tons of methane (t CH_4)

GWP_{CH4} = Global Warming Potential value for methane, 25 $tCO_2e/t\ CH_4$.

$EL_{LFG,y}$ = Net quantity of electricity produced using LFG, which in the absence of the project activity would have been produced by power plants connected to the grid or by an on-

site/off-site fossil fuel based captive power generation, during year y, in megawatt hours (MWh).

$CEF_{elecy,BL,y}$ = CO_2 emissions intensity of the baseline source of electricity displaced, in 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/air heater, during the year *y,* in TJ.

$CEF_{ther,BL,y}$ = CO_2 emissions intensity of the fuel used by boiler/air heater to generate thermal energy which is displaced by LFG based thermal energy generation, in tCO_2e/TJ.

The baseline emissions in a given year "y" (BE_y) is the difference between the amount of methane actually destroyed/combusted during the year ($MD_{project,y}$) and the amount of methane that would have been destroyed/combusted during the year in the absence of the project activity ($MD_{BL,y}$), times the approved Global Warming Potential value for methane (GWP_{CH4}), plus the net quantity of electricity displaced during the year (EG_y) multiplied by the CO_2 emissions intensity of the electricity displaced ($CEF_{electricity,y}$).

The term $MD_{BL,y}$ is equal to zero due to absence of any regulation and contractual requirements relating to this landfill site. The last term of the equation $ET_{LFG,y}$ x $CEF_{ther,BL,y}$ is equal to zero since there is no thermal energy produced by the project activity. In addition considering that there was no energy generation during this monitored period, parameters $EL_{LFG,y}$ and $CEF_{elec,y}$ will not be considered further in the Baseline Emission Reduction calculation.

The methane destroyed by the project activity ($MD_{project,y}$) during a year is determined by monitoring the quantity of methane actually flared and gas used to generate electricity and the total quantity of methane captured.

The sum of the quantities fed to de flare(s), to the power plant(s), to the boiler(s)/air heater(s)/heat generating equipment(s) and to the natural gas distribution network must be compared annually with the total quantity of methane generated. The lowest value of the two must be adopted as $MD_{project,y}$.

$$MD_{project,\,y} = MD_{flared,\,y} + MD_{electricity,\,y} + MD_{thermal,y} + MD_{PL,y}$$

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

As the project is not generating electricity $MD_{electricity,y} = 0$. As the project does not use the methane to generate thermal energy, neither to send to the pipeline for feeding the natural gas distribution network, $MD_{thermal,y} = 0$ and $MD_{PL,y} = 0$.

Therefore for the project activity the above equation is simplified to:

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

The quantity of methane destroyed by flaring (t CH_4) is calculated using the following equation:

$$MD_{flared,y} = (LFG_{flare,y} \times w_{CH_4,y} \times D_{CH4,y}) - (PE_{flared,y} / GWP_{CH4})$$

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 tons of methane per cubic meter of methane (tCH_4/m^3 CH_4).
- $PE_{flare,y}$ = Project emissions from flaring of the residual gas stream in year y (tCO_2e) determined following the procedure described in the *"Tool to determine project emissions from flaring gases Containing Methane".* If methane is flared through more than one flare, the $PE_{flare,y}$ shall be determined for each flare using the tool.

The flare efficiency is continuously monitored as described in the PDD. The data used to calculate the quantity of methane flared are uploaded every minute to the external data center to a management program. The results of the amount of methane flared are aggregated on a monthly basis.

As there is no electricity generation using landfill gas, the amount of aggregated monthly data of methane flared is adopted as $MD_{project}$.

The final formula used to calculate the Baseline Emission is $\mathbf{BE_y = MD_{project,y} * GWP_{CH4}}$

The following tables show the collected data, from the period 01/01/2015 to 31/12/3015 in the project site.

	$LFG_{total,y}$	$LFG_{flare,y}$	$W_{CH4,y}$	MD_{total}	MD_{flared}	$MD_{flared,y}$	$MD_{project,y}$	$PE_{flare,y}$	$MD_{project,y} * GWP_{CH4}$	BE_y	$PE_{EC,y}$	ER_y
Unit	Nm^3	Nm^3	% Vol.	tCH_4	tCH_4	tCH_4	tCH_4	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e
2015_01	963.924,1	963.924,1	52,1	367,1	367,1	366,3	366,3	20,2	9.156,8	9.156,0	5,0	9.151,0
2015_02	1.025.216,1	1.025.216,1	54,3	400,4	400,4	398,3	398,3	53,8	9.957,1	9.957,0	7,0	9.950,0
2015_03	1.160.665,4	1.160.665,4	54,0	456,3	456,3	454,2	454,2	53,2	11.355,1	11.355,0	6,0	11.349,0
2015_04	1.073.141,3	1.073.141,3	54,8	421,6	421,6	418,8	418,8	68,1	10.470,8	10.470,0	8,0	10.462,0
2015_05	1.225.508,3	1.225.508,3	54,5	482,6	482,6	473,6	473,6	224,5	11.840,0	11.839,0	7,0	11.832,0
2015_06	1.441.935,4	1.441.935,4	53,0	558,8	558,8	547,5	547,5	284,3	13.686,9	13.686,0	9,0	13.677,0
2015_07	1.212.552,3	1.212.552,3	23,6	216,2	216,2	215,0	215,0	31,6	5.373,8	5.373,0	9,0	5.364,0
2015_08	1.590.203,8	1.590.203,8	50,6	584,0	584,0	577,3	577,3	167,5	14.431,6	14.431,0	7,0	14.424,0
2015_09	1.401.802,6	1.401.802,6	51,6	517,8	517,8	514,3	514,3	88,1	12.856,6	12.856,0	13,0	12.843,0
2015_10	1.590.283,6	1.590.283,6	50,6	584,0	584,0	577,3	577,3	167,5	14.432,1	14.432,0	12,0	14.420,0
2015_11	1.848.036,0	1.848.036,0	51,9	701,2	701,2	286,3	286,3	10.371,4	7.158,7	7.158,0	13,0	7.145,0
2015_12	1.927.347,9	1.927.347,9	51,6	737,4	737,4	732,2	732,2	132,1	18.304,2	18.304,0	15,0	18.289,0
TOTAL	**16.460.616,7**	**16.460.616,7**		**6.027**	**6.027**	**5.561**	**5.561**	**11.662**	**139.024**	**139.017**	**111**	**138.906**

Table 1: Data Monitored in the Monitoring Period (01/01/2015 – 31/12/2015)

Determination of $PE_{flare,y}$

When applying the tool, the continuous monitoring of the efficiency is selected for the enclosed flare (option b). According to the tool, $PE_{flare,y}$ is determined as follows:

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.

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

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

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

Where:

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

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

Where:

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

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

Where:

- $fv_{i,h}$ = Volumetric fraction of component i in the residual gas in the hour h
- MM_i = Molecular mass of residual gas component i, kg/kmol
- i = Limited to the two main components CH_4 and N_2.

As per the tool, the project participant only measures the volumetric fraction of methane and considers the difference as 100% nitrogen (N2). Therefore, only elements C, H, N are included in the calculation of STEP 2.

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

Not applicable (refer to step 1), the simplified approach was slected, thus only the volumetric fraction of methane is to be measured and the difference to 100% is to be considered as being nitrogen (N_2).

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

This step is applicable to the project activity because the methane combustion efficiency of the flare will be continuously monitored.

The average volumetric flow rate of the exhaust gas in each hour *h* is determined 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:

$$TV_{n,FG,h} = V_{n,FG,h} XFM_{RG,h}$$

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

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

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
$V_{n,CO_2,h}$	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
$V_{n,O_2,h}$	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
$V_{n,N_2,h}$	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

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

Where:

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

$$V_{n,N_2,h} = MV_n * \left\{\frac{fm_{N,h}}{200AM_N} + \left(\frac{1 - MF_{O2}}{MF_{O2}}\right) * [F_h + n_{O2,h}]\right\}$$

Where:

Variable	SI unit	Description
$V_{n,N_2,h}$	m^3/ kg residual gas	Quantity of N_2 volume free in the exhaust gas of the flare at normal conditions per kg of residual gas in the hour h
MV_n	m^3/ kmol	Volume of one mole of any ideal gas at normal temperature and pressure (22.4 m^3/Kmol)
$fm_{N,h}$	-	Mass fraction of nitrogen in the residual gas in the hour h
AM_N	kg/ kmol	Atomic mass of nitrogen
MF_{O2}	-	O_2 volumetric fraction of air

F_h	kmol/kg residual gas	Stochiometric quantity of moles of O_2 required for a complete oxidation of one kg residual gas in hour h
$n_{O2,h}$	kmol/kg residual gas	Quantity of moles O_2 in the exhaust gas of the flare per kg residual gas flared in hour h

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

Where:

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

$$n_{O_2,h} = \frac{t_{O_2,h}}{\left[1 - \left({}^{t_{O_2,h}}/_{MF_{O_2}}\right)\right]} * \left[\frac{fm_{c,h}}{AM_c} + \frac{fm_{N,h}}{2AM_N} + \left(\frac{1 - MF_{O2}}{MF_{O2}}\right) x\ F_h\right]$$

Where:

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

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

Where

Variable	SI unit	Description
F_h	kmol O_2/kg residual gas	Stochiometric quantity of moles of O_2 required for a complete oxidation of one kg residual gas in

		hour *h*
$fm_{j,h}$	-	Mass fraction of element j in the residual gas in hour h
AM_j	kg/kmol	Atomic mass of element j
j	-	The elements carbon (index C) , hydrogen (index H) and oxygen (index O)

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

This step is applicable to this project activity because the combustion efficiency of the flare will be continuously monitored.

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

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

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

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

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

Where:

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

6. STEP 6. Determination of the hourly flare efficiency

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

In this case the flare efficiency in the hour h (□flare,h) is determined as follows in cases where the temperature of the exhaust gas of the flare (Tflare) is above 500°C for more than 40 minutes during the hour h :

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

Where:

Variable	SI unit	Description
$n_{flare,h}$	-	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

In case of the continuous monitoring system is unavailable for maintenance, or failure, the following methods will be used:

- 0% if the temperature in the exhaust gas of the flare (Tflare) is below 500 °C for more than 20 minutes during the hour *h*.
- 50%, if the temperature in the exhaust gas of the flare (Tflare) is above 500 °C for more than 40 minutes during the hour *h,* but the manufacturer's specifications on proper operation of the flare are not met at any point in time during the hour *h*.
- 90%, if the temperature in the exhaust gas of the flare (Tflare) is above 500 °C for more than 40 minutes during the hour *h* and the manufacturer's specifications on proper operation of the flare are met continuously during the hour *h*.

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

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

Where:

- $PE_{flare,y}$ = Project emissions from flaring of the residual gas stream in year y, tCO_2e.
- $\eta_{flare,h}$ = Flare efficiency in hour h
- GWP_{CH4} = Global Warming Potential of methane valid for the commitment period, tCO_2e/tCH_4

E.2. Calculation of project emissions or actual net GHG removals by sinks

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According to the baseline methodology ACM0001 - Version 11, Project Emissions are calculated as follows:

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

Where:

- $PE_{EC,y}$ = Emissions from consumption of electricity in the project case.
- $PE_{FC,j,y}$ = Emissions from consumption of heat

Project emissions from electricity consumption ($PE_{EC,y}$) are calculated following the *"Tool to calculate baseline, project and/or leakage emissions from electricity consumption",* version 01.

Scenario A applies to this project activity (i.e., electricity from the grid). Furthermore, the option **A1** has been selected, i.e., the combined margin emission factor is calculated, using the procedures of the Tool to calculate the emission factor for an electricity system ($EF_{EL,j/k/l,y} = EF_{grid,CM,y}$).

The generic approach has been selected for this project activity:

$$PE_{EC,y} = \sum_j EC_{PJ,j,y} \times EF_{EL,j,y} \times (1 + TDL_{j,y})$$

Where:

$EC_{PJ,,j,y}$	Quantity of electricity consumed by the project activity during the year y (MWh/y)
$EF_{EL,j,y}$	Emission factor for the electricity grid ($EF_{EL,j/k/l,y} = EF_{grid,CM,y}$) in year y ($tCO_2$/MWh)
$TDL_{j,y}$	Average technical transmission and distribution losses for providing the electricity source j in year y
j	sources of electricity consumption in the project

According to the "Tool to calculate the emission factor for an electricity system" the grid emission factor is calculated as the weighted average of the operating margin emission factor and the build margin emission factor and is expressed in tCO_2/MWh, using the following formula:

$EF_{EL,j,y} = EF_{grid,\ CM,\ y} = EF_{\ grid,\ OM,\ y} \times W_{OM} + EF_{\ grid,\ BM,\ y} \times W_{BM}$

Where: $EF_{EL,j,y}$ = Emission factor for the electricity grid ($EF_{EL,j/k/l,y} = EF_{grid,CM,y}$) in year y ($tCO_2$/MWh)
$EF_{\ grid,\ OM,\ y}$: Operating margin CO_2 emission factor in year y (tCO_2/MWh)
$EF_{\ grid,\ BM,\ y}$: Build margin CO_2 emission factor in year y (tCO2/MWh)
W_{OM}: Weighting for operating margin emission factor (%)
W_{BM}: Weighting for build margin emission factor (%)

According to the Tool, W_{OM} = 0.5 and W_{BM} = 0.5 for the first crediting period.

The data used for the calculation is $EF_{grid,OM,y}$ = 0.5837 (tCO_2/MWh) and $EF_{grid,\ BM,y}$ = 0.2963 (tCO_2/MWh). The information was collected from the website of the Brazilian Ministry of Science and Technology[4]. Following this procedure, the calculated value of the $EF_{EL,j,y}$, in the reference period, is 0.4400 (tCO_2/MWh) for 2014 (latest data available as of the date of this report).

Project emissions from fossil fuel combustion ($PE_{FC,j,y}$) are calculated following version 02 of "*Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion*". For this project, LPG (Liquefied Petroleum Gas) is used for the ignition of the flare system, and an option has been included to account for project emissions that might occur in case the backup diesel generator is used, thus these emissions are calculated as follows:

$PE_{FC,j,y} = FC_{i,j,y} * COEF_{i,y}$

Where

$FC_{i,j,y}$	is the quantity of fossil fuel *i* (LPG or diesel) combusted in process *j* (flare ignition) during year *y* (m^3)
$COEF_{i,y}$	is the CO_2 emission coefficient of the fuel (tCO_2/ m^3 fuel)

Due to data availability, $COEF_{i,y}$ is calculated following Option B of the tool:

$COEF_{i,y} = NCV_{i,y} * EF_{CO2i,y}$
Where

$NCV_{i,y}$	Is the weighted average net calorific value of the fuel type *i* in year *y* (GJ/ m^3)
$EF_{CO2i,y}$	Is the weighted average CO_2 emission factor of fuel type *i* in year *y* (tCO_2/GJ)

[4] http://www.mct.gov.br/index.php/content/view/74689.html

Given that there was no fossil fuel consumption during this monitored period, project emissions are only those coming from electricity consumption. These are as follows:

Parameter:	$EC_{PJ,j,y}$ (MW.h)	$PE_{EC,y}$ (tCO_2)	$PE_{EC,y}$ (tCO_2) Rounded up
2015_01	9,70	4,27	5,00
2015_02	13,92	6,12	7,00
2015_03	12,65	5,56	6,00
2015_04	16,63	7,31	8,00
2015_05	14,19	6,25	7,00
2015_06	19,19	8,44	9,00
2015_07	19,90	8,75	9,00
2015_08	14,32	6,30	7,00
2015_09	27,52	12,11	13,00
2015_10	25,47	11,20	12,00
2015_11	27,70	12,19	13,00
2015_12	32,26	14,20	15,00
Total	233,44	102,71	111,00

Table 2: Project Emissions from electricity consumption

** To be conservative, the Project Emissions are rounded up.*

E.3. Calculation of leakage

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According to the baseline methodology ACM0001 - Version 11, no leakage effects need to be accounted under that methodology.

E.4. Summary of calculation of emission reductions or net GHG removals by sinks

According to the baseline methodology ACM0001 - Version 11, Emissions Reductions are calculated as follows:

$$ER_y = BE_y - PE_y$$

Where:

- ER_y = Emission reductions in year y (tCO_2e/yr)
- BE_y = Baseline emissions in year y (tCO_2e/yr)
- PE_y = Project emissions in year y (tCO_2e/yr)

Emission Reductions				
Description / Date	**Baseline Emissions**	**Project Emissions**	**Leakage**	**Emission Reductions**
Parameter	**BE_y[1]**	**PE_y[2]**	**Leakage**	**ER_y**
Unit	**tCO_2e**	**tCO_2e**	**tCO_2e**	**tCO_2e**
01/2015	9.156,0	5,0	-	9.151,0
02/2015	9.957,0	7,0	-	9.950,0
03/2015	11.355,0	6,0	-	11.349,0
04/2015	10.470,0	8,0	-	10.462,0
05/2015	11.839,0	7,0	-	11.832,0
06/2015	13.686,0	9,0	-	13.677,0
07/2015	5.373,0	9,0	-	5.364,0
08/2015	14.431,0	7,0	-	14.424,0
09/2015	12.856,0	13,0	-	12.843,0
10/2015	14.432,0	12,0	-	14.420,0
11/2015	7.158,0	13,0	-	7.145,0
12/2015	18.304,0	15,0	-	18.289,0
Total	**139.017**	**111**	**-**	**138.906**

[1] *To be conservative, the Baseline Emissions are rounded down.*

[2] *To be conservative, the Project Emissions are rounded up.*

Item	**Baseline emissions or baseline net GHG removals by sinks ($t CO_2e$)**	**Project emissions or actual net GHG removals by sinks ($t CO_2e$)**	**Leakage ($t CO_2e$)**	**GHG emission reductions or net GHG removals by sinks ($t CO_2e$) achieved in the monitoring period**		
				Up to 31/12/2012	**From 01/01/2013**	**Total amount**
Total	139,017	111	-	0	138,906	138,906

E.5. Comparison of actual emission reductions or net GHG removals by sinks with estimates in registered PDD

Item	**Values estimated in ex ante calculation of registered PDD**	**Actual values achieved during this monitoring period**
Emission reductions or GHG removals by sinks ($t CO_2e$)	161,434	138,906

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

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Non applicable since the actual value is below the PDD value.

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Appendix 1. Contact information of project participants and responsible persons/entities

Project participant and/or responsible person/ entity	☐ Project participant ☒ Person/entity responsible for completing the CDM-MR-FORM
Organization name	Ecopesa Ambiental S.A.
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Document information

Version	*Date*	*Description*
05.1	4 May 2015	Editorial revision to correct version numbering.
05.0	1 April 2015	Revisions to: • Include provisions related to delayed submission of a monitoring plan; • Provisions related to the Host Party; • Remove reference to programme of activities; • Overall editorial improvement.
04.0	25 June 2014	Revisions to: • Include the Attachment: Instructions for filling out the monitoring report form (these instructions supersede the "Guideline: Completing the monitoring report form" (Version 04.0)); • Include provisions related to standardized baselines; • Add contact information on a responsible person(s)/ entity(ies) for completing the CDM-MR-FORM in A.6 and Appendix 1; • Change the reference number from *F-CDM-MR* to *CDM-MR-FORM*; • Editorial improvement.
03.2	5 November 2013	Editorial revision to correct table in page 1.
03.1	2 January 2013	Editorial revision to correct table in section E.5.
03.0	3 December 2012	Revision required to introduce a provision on reporting actual emission reductions or net GHG removals by sinks for the period up to 31 December 2012 and the period from 1 January 2013 onwards (EB70, Annex 11).
02.0	13 March 2012	Revision required to ensure consistency with the "Guidelines for completing the monitoring report form" (EB 66, Annex 20).
01	28 May 2010	EB 54, Annex 34. Initial adoption.

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