Monitoring report form for CDM project activity
(Version 06.0)

Complete this form in accordance with the instructions attached 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 PDD applicable to this monitoring report	11.2	
Version number of this monitoring report	01	
Completion date of this monitoring report	30/01/2019	
Monitoring period number	5th	
Duration of this monitoring period	01/09/2016 – 28/09/2018	
Monitoring report number for this monitoring report	01	
Project participants	• Brazil: Haztec Tecnologia e Planejamento Ambiental S.A.	
Host Party	Brazil	
Sectoral scopes	Sectoral Scope 13 : Waste handling and disposal	
Applied methodologies and standardized baselines	ACM0001 - Version 11	
Amount of GHG emission reductions or net anthropogenic GHG removals achieved by the project activity in this monitoring period	Amount achieved before 1 January 2013	Amount achieved from 1 January 2013
	0	286,680
Amount of GHG emission reductions or net anthropogenic GHG removals estimated ex ante for this monitoring period in the PDD	344,825[1]	

[1] Calculated using the PDD estimation for 2016 (167,874) times the number of days in this monitoring period for this year (122 days) divided by the number of days in the year (365 days), plus PDD estimation for 2017 (180,673) plus PDD estimation for 2018 (108,041).

SECTION A. Description of project activity

A.1. 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 CO_2 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 15 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 11, 2015, the biogas plant was expanded, with the installation of a second flare with the same characteristics of the first flare (2,500 Nm^3/h maximum capacity), doubling the processing capacity for biogas combustion.

During the monitored period, in year 2016, were made improvements of the LFG collection system and drains in the landfill.

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.

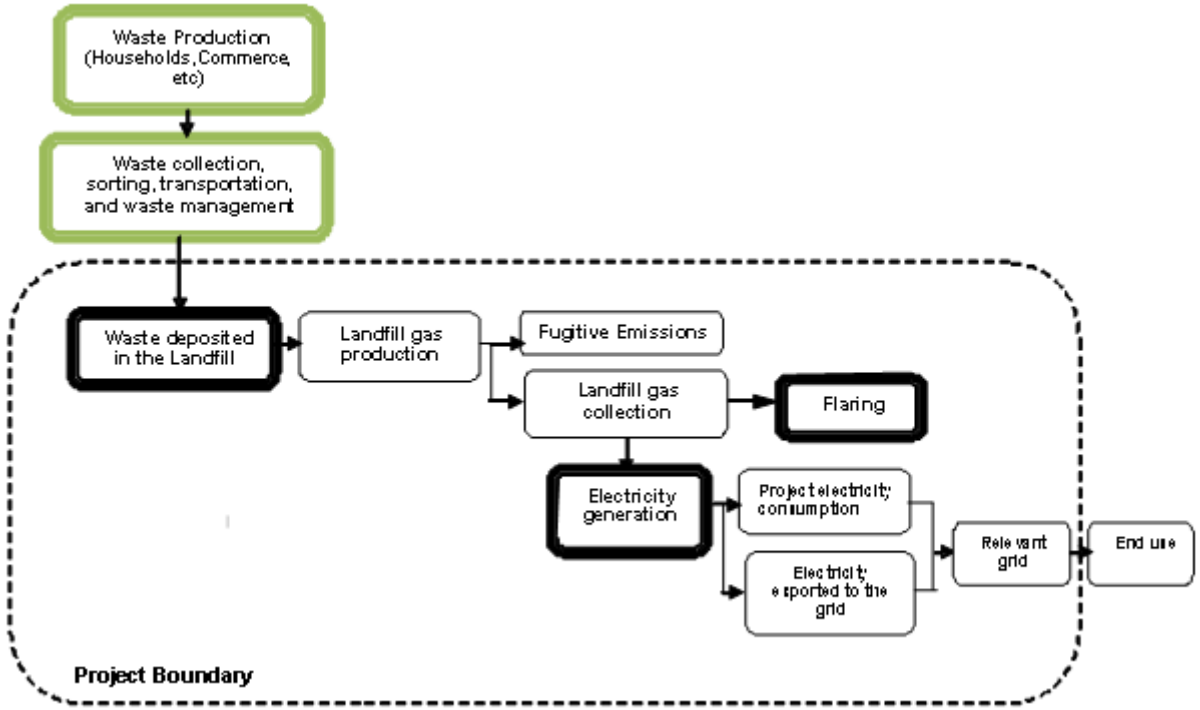

Figure 1: LFG flaring system in august 2016.

The total volume of emission reductions achieved in this monitoring period was 158,386 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 participants

Parties involved	Project participants	Indicate if the Party involved wishes to be considered as project participant (Yes/No)
Brazil (host)	Haztec Tecnologia e Planejamento Ambiental AS (private entity)	No

This monitoring report was developed and reviewed by:

Consultancy (Project Participant)	Project Proponent (Project Participant)
BENG	HAZTEC
João Sprovieri joao.sprovieri@beng.eng.br	Paulo Victor Laguardia Mejia Paulo.laguardia@haztec.com.br
Francisco Santo francisco.santo@beng.eng.br	Jonney Marques Mondini Jonney.Mondini@haztec.com.br

A.4. Reference to applied methodologies and standardized baselines

>>

The Project applies ACM0001 – version 11: "Consolidated baseline and monitoring methodology for landfill gas project activities."[2]

Tools to which the methodology refers to are the following[3]:

- 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 type and duration

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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).

SECTION B. Implementation of project activity

B.1. Description of implemented project activity

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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

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

[3] Please refer to <http://cdm.unfccc.int/Reference/tools/index.html>

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.

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 Nm³/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 were no main incidents that occurred during the period of this monitoring report
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 the registered monitoring plan, applied methodologies or standardized baselines

>>
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 the start date of the crediting period

>>
Not applicable.

B.2.4. Inclusion of monitoring plan

>>
Not applicable.

B.2.5. Permanent changes to the registered monitoring plan, or permanent deviation of monitoring from the applied methodologies, standardized baselines, or other applied standards or tools

>>
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

>>
Not applicable.

SECTION C. Description of monitoring system

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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.

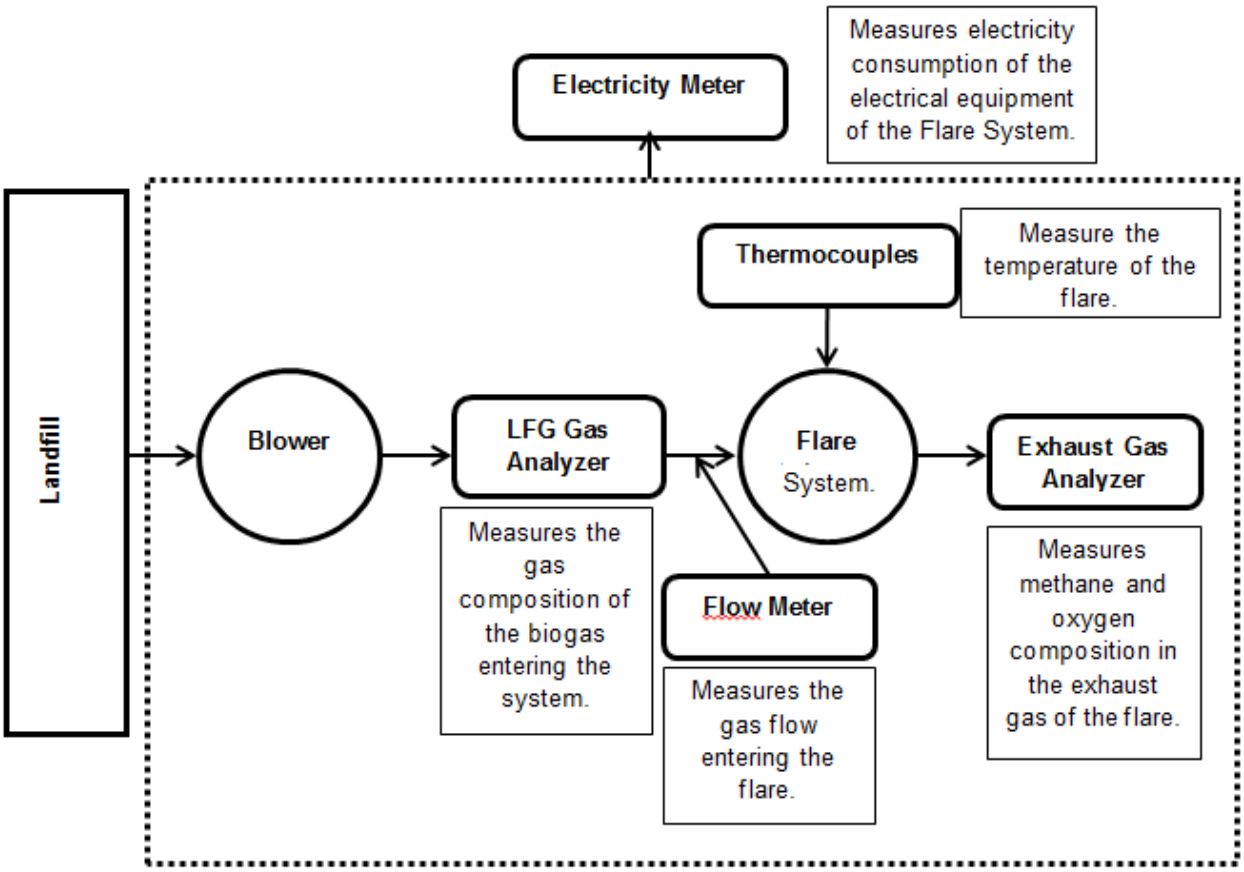
LFG Gas Analyzer
The LFG Gas analyzer, is used to measure the biogas composition before the gas enters the flaring system. The manufacturer of the gas analyzer is Siemens.

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

(Copy this table for each data or parameter.)

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/parameter	Calculation of baseline emissions
Additional comments	-

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/parameter	Calculation of baseline emissions
Additional comments	-

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 ºC and 1.013 bar)
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	-

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/parameter	Calculation of baseline emissions
Additional comments	-

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/parameter	Calculation of baseline emissions
Additional comments	-

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/parameter	Calculation of baseline emissions
Additional comments	-

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/parameter	Calculation of baseline emissions
Additional comments	-

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/parameter	Calculation of baseline emissions
Additional comments	-

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/parameter	Calculation of baseline emissions
Additional comments	-

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/parameter	Calculation of baseline emissions
Additional comments	-

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/parameter	Calculation of baseline emissions
Additional comments	-

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/parameter	Calculation of baseline emissions
Additional comments	-

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/parameter	Calculation of baseline emissions
Additional comments	-

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/parameter	Calculation of baseline emissions
Additional comments	-

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/parameter	Calculation of baseline emissions
Additional comments	-

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/parameter	Calculation of baseline emissions
Additional comments	-

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/parameter	Calculation of baseline emissions
Additional comments	-

Data/Parameter	MV_n
Unit	m^3/Kmol
Description	Volume of one mole of any ideal gas at normal temperature and pressure
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/parameter	Calculation of baseline emissions
Additional comments	-

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/parameter	Calculation of project emissions
Additional comments	-

D.2. Data and parameters monitored

(Copy this table for each data or parameter.)

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
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></td></tr>
<tr><td>Calibration frequency:</td><td>3 years from the date of the last calibration</td></tr>
<tr><td>Calibration Date:</td><td></td></tr>
<tr><td>Valid up to:</td><td></td></tr>
<tr><td>Operation Period:</td><td></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></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></td></tr>
<tr><td>Valid up to:</td><td></td></tr>
<tr><td>Operation Period:</td><td></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/parameter</td><td>Calculation of baseline emissions</td></tr>
<tr><td>Additional comments</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

Monitoring equipment	**FLARE 01** **Type: Swirl flow meter** Accuracy class: ± 0.5% of full scale Serial number: Calibration frequency: 3 years from the date of the last calibration Calibration Date: Valid up to: Operation Period: **FLARE 02** **Type: Swirl flow meter** Accuracy class: ± 0.5% of full scale Serial number: Calibration frequency: 3 years from the date of the last calibration Manufacturer Calibration: Valid up to: Operation Period:
Measuring/reading/recording frequency	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.
Calculation method (if applicable)	N/A
QA/QC procedures	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.
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	$LFG_{flare,y}$ 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

Data/Parameter	**$W_{CH4, y}$**
Unit	m^3 CH4/m^3 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: N Calibration frequency: 12 months Calibration Date Valid up to Calibration Date Valid up to Operation Period:
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/parameter	Calculation of baseline emissions.
Additional comments	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/parameter	Calculation of baseline emissions
Additional comments	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
Measured/calculated/ default	Measured
Source of data	Project Developer
Value(s) of monitored parameter	Please refer to ER calculation spreadsheet

<table>
<tr><td>Monitoring equipment</td><td></td></tr>
<tr><td>Measuring/reading/recording frequency</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></td></tr>
<tr><td>Calibration frequency:</td><td>12 Months from start of operation</td></tr>
<tr><td>Calibration</td><td></td></tr>
<tr><td>Validity:</td><td></td></tr>
<tr><td>Operation Period:</td><td></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></td></tr>
<tr><td>Calibration frequency:</td><td>12 Months from start of operation</td></tr>
<tr><td>Calibration</td><td></td></tr>
<tr><td>Validity:</td><td></td></tr>
<tr><td>Operation Period:</td><td></td></tr>
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<tr><td>Calibration</td><td></td></tr>
<tr><td>Validity:</td><td></td></tr>
<tr><td>Operation Period:</td><td></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>Calculation method (if applicable)</td><td>Data is measured continuously.</td></tr>
<tr><td>QA/QC procedures</td><td>N/A</td></tr>
<tr><td>Purpose of data/parameter</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>Additional comments</td><td>Calculation of baseline emissions</td></tr>
<tr><td></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"></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"></td></tr>
<tr><td>Valid up to</td><td colspan="2"></td></tr>
<tr><td>Calibration Date</td><td colspan="2"></td></tr>
<tr><td>Valid up to</td><td colspan="2"></td></tr>
<tr><td>Operation Period:</td><td colspan="2"></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/parameter</td><td>Calculation of baseline emissions</td></tr>
<tr><td>Additional comments</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>

<table>
<tr><td>Data/Parameter</td><td>fv$_{CH4,h}$</td></tr>
<tr><td>Unit</td><td>-</td></tr>
<tr><td>Description</td><td>Volumetric fraction of methane in the residual gas on wet basis in the hour h</td></tr>
<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 Table 1 of section E and the 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="2">Type: Siemens ULTRAMAT 23 (Gas Analyzer)</th></tr>
<tr><td>Accuracy class:</td><td>± 1%</td></tr>
<tr><td>Serial number:</td><td></td></tr>
<tr><td>Calibration frequency:</td><td>12 months</td></tr>
<tr><td>Calibration Date</td><td></td></tr>
<tr><td>Valid up to</td><td></td></tr>
<tr><td>Calibration Date</td><td></td></tr>
<tr><td>Valid up to</td><td></td></tr>
<tr><td>Operation Period:</td><td></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>
</table>

QA/QC procedures	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.
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	$\mathbf{fv}_{CH4,h}$ 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

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.
Monitoring equipment	**FLARE 01** **Type: Swirl flow meter** Accuracy class: ± 0.5% of full scale Serial number: Calibration frequency: 3 years from the date of the last calibration Calibration Date: Valid up to: Operation Period: **FLARE 02** **Type: Swirl flow meter** Accuracy class: ± 0.5% of full scale Serial number: Calibration frequency: 3 years from the date of the last calibration Manufacturer Calibration: Valid up to: Operation Period:
Measuring/reading/recording frequency	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.
Calculation method (if applicable)	N/A
QA/QC procedures	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
Purpose of data/parameter	Calculation of baseline emissions

Additional comments	$FV_{RG,h}$ 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

Data/Parameter	$fv_{CH4,FG,h}$
Unit	m^3 CH4/m^3 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: Accuracy class: CH4 ± (25 ppm + 0.25%); O2 ±1% Calibration frequency: 12 months Calibration Date Valid up to Calibration Date Valid up to Operation Period:
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/parameter	Calculation of baseline emissions.
Additional comments	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 table 2 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/parameter	Calculation of project emissions
Additional comments	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 Table 1 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: Models: Nemo 96HD Accuracy: Active energy class 0.5 Calibration frequency: 5 years from the date of the last calibration, as per Brazilian standard[4] Calibration Date Valid up to: Operation Period
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/parameter	Calculation of project emissions.
Additional comments	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}

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

Value(s) of monitored parameter	0.2955 (2017)
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/parameter	Calculation of project emissions
Additional comments	-

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^{o}C Maximum temperature: 1,430^{o}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/parameter	Calculation of baseline emissions
Additional comments	Only applicable in case of use of a default value.

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

Data/Parameter	**$LFG_{electricity,y}$**
Unit	Nm^3
Description	Amount of LFG sent to power plant at Normal temperature and pressure on a wet basis.
Measured/calculated/ default	Measured
Source of data	NA. The corresponding component has not been implemented as of this monitoring period

Value(s) of monitored parameter	-
Monitoring equipment	-
Measuring/reading/recording frequency	-
Calculation method (if applicable)	-
QA/QC procedures	-
Purpose of data/parameter	-
Additional comments	-

Data/Parameter	**Operation of the energy plants**
Unit	hours
Description	Operation of the energy plants in year y
Measured/calculated/ default	Measured
Source of data	NA. The corresponding component has not been implemented as of this monitoring period
Value(s) of monitored parameter	-
Monitoring equipment	-
Measuring/reading/recording frequency	-
Calculation method (if applicable)	-
QA/QC procedures	-
Purpose of data/parameter	-
Additional comments	The corresponding component has not been implemented as of this monitoring period

Data/Parameter	**EL_{LFG}**
Unit	MWh
Description	Net amount of electricity generated using LFG.
Measured/calculated/ default	Measured
Source of data	NA. The corresponding component has not been implemented as of this monitoring period
Value(s) of monitored parameter	-
Monitoring equipment	-
Measuring/reading/recording frequency	-
Calculation method (if applicable)	-
QA/QC procedures	-
Purpose of data/parameter	-
Additional comments	The corresponding component has not been implemented as of this monitoring period

Data/Parameter	$FC_{i,j,y}$
Unit	m^3/yr
Description	Onsite combustion of fossil fuels of type *i* (LPG or diesel) in process *j* (flare ignition system) during the year y
Measured/calculated/ default	Measured
Source of data	NA. The corresponding component has not been implemented as of this monitoring period
Value(s) of monitored parameter	-
Monitoring equipment	-
Measuring/reading/recording frequency	-
Calculation method (if applicable)	-
QA/QC procedures	-
Purpose of data/parameter	-
Additional comments	The corresponding component has not been implemented as of this monitoring period

Data/Parameter	$NCV_{i,y}$
Unit	GJ/m^3
Description	Weighted average net calorific value of fuel type *i* (LPG or diesel) in year y
Measured/calculated/ default	Values from the fuel supplier
Source of data	NA. The corresponding component has not been implemented as of this monitoring period
Value(s) of monitored parameter	-
Monitoring equipment	-
Measuring/reading/recording frequency	-
Calculation method (if applicable)	-
QA/QC procedures	-
Purpose of data/parameter	-
Additional comments	The corresponding component has not been implemented as of this monitoring period

Data/Parameter	$EF_{CO2,i,y}$
Unit	tCO_2/GJ
Description	Weighted average CO_2 emission factor of fuel type *i* (LPG or diesel) in year y
Measured/calculated/ default	Default
Source of data	IPCC default values at the upper limit of the uncertainty at a 95% confidence interval as provided in table 1.4 of chapter 1 of Vol 2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories (there is no available data from the fuel supplier).

Value(s) of monitored parameter	NA. The corresponding component has not been implemented as of this monitoring period
Monitoring equipment	-
Measuring/reading/recording frequency	-
Calculation method (if applicable)	-
QA/QC procedures	-
Purpose of data/parameter	-
Additional comments	The corresponding component has not been implemented as of this monitoring period

Data/Parameter	**$PE_{FC,y}$**
Unit	tCO_2e
Description	Project emissions from fossil fuel combustion
Measured/calculated/ default	Calculated
Source of data	NA. No fossil fuel combusted on site.
Value(s) of monitored parameter	-
Monitoring equipment	-
Measuring/reading/recording frequency	-
Calculation method (if applicable)	-
QA/QC procedures	-
Purpose of data/parameter	-
Additional comments	No fossil fuels combusted as of this monitoring report.

D.3. Implementation of sampling plan

>>
Not applicable – sampling approach is not applied

SECTION E. Calculation of emission reductions or net anthropogenic removals

E.1. Calculation of baseline emissions or baseline net removals

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

The following tables show the collected data, from the period 01/09/2016 to 28/09/2018 in the project site.

Parameter	$LFG_{total,y}$	$LFG_{flare,y}$	$W_{CH4,y}$	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
2016_09	2,017,897.1	2,017,897.1	51.5	750.4	750.4	739.2	739.2	278.7	18,481.1	18,481.0	16.0	18,465.0
2016_10	1,537,419.8	1,537,419.8	52.0	576.3	576.3	566.3	566.3	252.3	14,156.4	14,156.0	12.0	14,144.0
2016_11	1,599,850.9	1,599,850.9	50.9	586.5	586.5	582.6	582.6	98.3	14,564.0	14,564.0	11.0	14,553.0
2016_12	1,839,076.4	1,839,076.4	47.2	654.5	654.5	645.6	645.6	222.4	16,140.6	16,140.0	14.0	16,126.0
2017_01	2,240,964.4	2,240,964.4	48.4	777.6	777.6	765.9	765.9	293.3	19,146.6	19,146.0	11.0	19,135.0
2017_02	2,167,480.9	2,167,480.9	50.0	775.1	775.1	772.6	772.6	61.8	19,315.3	19,315.0	13.0	19,302.0
2017_03	2,467,803.0	2,467,803.0	49.7	874.2	874.2	871.5	871.5	68.0	21,786.6	21,786.0	15.0	21,771.0
2017_04	2,505,612.2	2,505,612.2	49.4	887.7	887.7	883.7	883.7	98.3	22,093.2	22,093.0	16.0	22,077.0
2017_05	2,630,551.1	2,630,551.1	48.9	930.3	930.3	915.7	915.7	363.3	22,893.6	22,893.0	16.0	22,877.0
2017_06	2,569,500.7	2,569,500.7	50.3	946.5	946.5	931.9	931.9	364.6	23,297.0	23,297.0	17.0	23,280.0
2017_07	2,547,986.7	2,547,986.7	48.9	932.4	932.4	511.7	511.7	10,517.3	12,791.8	12,791.0	17.0	12,774.0
2017_08	2,376,990.6	2,376,990.6	47.0	834.0	834.0	830.0	830.0	102.2	20,748.9	20,748.0	17.0	20,731.0
2017_09	2,420,441.3	2,420,441.3	47.5	835.4	835.4	821.8	821.8	339.8	20,545.9	20,545.0	17.0	20,528.0
2017_10	2,267,561.3	2,267,561.3	47.1	763.7	763.7	720.6	720.6	1,076.7	18,015.0	18,014.0	14.0	18,000.0
2017_11	1,053,093.6	1,053,093.6	32.2	337.5	337.5	331.3	331.3	154.5	8,283.3	8,283.0	7.0	8,276.0
2017_12	-	-	-	-	-	-	-	-	-	-	-	-
2018_01	-	-	-	-	-	-	-	-	-	-	-	-
2018_02	-	-	-	-	-	-	-	-	-	-	-	-
2018_03	-	-	-	-	-	-	-	-	-	-	-	-
2018_04	-	-	-	-	-	-	-	-	-	-	-	-
2018_05	-	-	-	-	-	-	-	-	-	-	-	-
2018_06	76686.8503	76686.8503	39.25464	22.0932	22.0932	18.15829	18.15829	98.37267	453.9573	453	2	451
2018_07	456325.436	456325.436	41.29054	140.2163	140.2163	135.5266	135.5266	117.2435	3388.165	3388	4	3384
2018_08	595773.006	595773.006	36.38868	181.1034	181.1034	178.0172	178.0172	77.15483	4450.429	4450	5	4445
2018_09	918886.521	918886.521	32.74284	269.3348	269.3348	254.7495	254.7495	364.6326	6368.737	6368	7	6361
TOTAL	**34,289,901.7**	**34,289,901.7**		**12,075**	**12,075**	**11,477**	**11,477**	**14,949**	**286,921**	**286,911**	**231**	**286,680**

Table 1: Data Monitored in the Monitoring Period (01/09/2016 to 28/09/2018)

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 (ηflare,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 removals

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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 $EF_{grid,OM,y}$ = 0.5580 (tCO_2/MWh) and $EF_{grid,\,BM,y}$ = 0.2553(tCO_2/MWh). The information was collected from the website of the Brazilian Ministry of

Science and Technology[5]. Following this procedure, the calculated value of the $EF_{EL,j,y}$, in the reference period, is 0.4067(tCO_2/MWh) for 2015.

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)

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:

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

Parameter:	$EC_{PJ, j, y}$ (MW.h)	$PE_{EC,y}$ (tCO_2)	$PE_{EC,y}$ (tCO_2) Rounded up
2016_09	31.00	15.13	16.00
2016_10	23.00	11.22	12.00
2016_11	22.00	10.74	11.00
2016_12	27.00	13.18	14.00
2017_01	30.00	10.64	11.00
2017_02	34.00	12.06	13.00
2017_03	41.00	14.54	15.00
2017_04	43.00	15.25	16.00
2017_05	45.00	15.96	16.00
2017_06	47.00	16.67	17.00
2017_07	46.00	16.31	17.00
2017_08	46.00	16.31	17.00
2017_09	46.00	16.31	17.00
2017_10	37.00	13.12	14.00
2017_11	19.00	6.74	7.00
2017_12	0.00	0.00	0.00
2018_01	0.00	0.00	0.00
2018_02	0.00	0.00	0.00
2018_03	0.00	0.00	0.00
2018_04	0.00	0.00	0.00
2018_05	0.00	0.00	0.00
2018_06	3.00	1.06	2.00
2018_07	10.00	3.55	4.00
2018_08	13.00	4.61	5.00
2018_09	19.00	6.74	7.00
TOTAL	582.00	220.10	231.00

Table 2: Project Emissions from electricity consumption

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

E.3. Calculation of leakage emissions

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

E.4. Calculation of emission reductions or net anthropogenic removals

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**
09/2016	18,481	16	-	18,465
10/2016	14,156	12	-	14,144
11/2016	14,564	11	-	14,553
12/2016	16,140	14	-	16,126
01/2017	19,146	11	-	19,135
02/2017	19,315	13	-	19,302
03/2017	21,786	15	-	21,771
04/2017	22,093	16	-	22,077
05/2017	22,893	16	-	22,877
06/2017	23,297	17	-	23,280
07/2017	12,791	17	-	12,774
08/2017	20,748	17	-	20,731
09/2017	20,545	17	-	20,528
10/2017	18,014	14	-	18,000
11/2017	8,283	7	-	8,276
12/2017	0	0	-	0
01/2018	0	0	-	0
02/2018	0	0	-	0
03/2018	0	0	-	0
04/2018	0	0	-	0
05/2018	0	0	-	0
06/2018	453	2	-	451
07/2018	3,388	4	-	3,384
08/2018	4,450	5	-	4,445
09/2018	6,368	7	-	6,361
Total	286,911	231	0	286,680

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

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

	Baseline GHG emissions or baseline net GHG removals ($t CO_2e$)	**Project GHG emissions or actual net GHG removals ($t CO_2e$)**	**Leakage GHG emissions ($t CO_2e$)**	**GHG emission reductions or net anthropogenic GHG removals ($t CO_2e$)**		
				Before 01/01/2013	**From 01/01/2013**	**Total amount**
Total	286,911	231	-		286,680	286,680

E.5. Comparison of emission reductions or net anthropogenic removals achieved with estimates in the registered PDD

Amount achieved during this monitoring period ($t CO_2e$)	**Amount estimated ex ante ($t CO_2e$)**
286,680	344,825[6]

[6] Calculated using the PDD estimation for 2016 (167,874) times the number of days in this monitoring period for this year (122 days) divided by the number of days in the year (365 days), plus PDD estimation for 2017 (180,673) plus PDD estimation for 2018 (108,041).

E.6. Remarks on increase in achieved emission reductions

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The CERs amount achieved during this monitoring period is 17% lower than the CERs amount estimated ex-ante in the registered PDD.

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Document information

Version	*Date*	*Description*
06.0	7 June 2017	Revision to: • Ensure consistency with version 01.0 of the "CDM project standard for project activities" (CDM-EB93-A04-STAN); • Make editorial improvements.
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 (EB 70, 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).
01.0	28 May 2010	EB 54, Annex 34. Initial adoption.

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