Monitoring report form for CDM programme of activities

(Version 02.0)

Complete this form in accordance with the instructions attached at the end of this form.

MONITORING REPORT		
Title of the PoA	Caixa Econômica Federal Solid Waste Management and Carbon Finance Project CPAs running in this Monitoring Period: CPA-1: Landfill gas recovery, energy generation and biogas distribution from CTR Santa Rosa CPA-2: CTR São Gonçalo	
UNFCCC reference number of the PoA	6573	
Version numbers of the PoA-DD applicable to this monitoring report	7.1	
Version number of this monitoring report	3	
Completion date of this monitoring report	11/10/2018	
Monitoring period number	7th Monitoring Period	
Duration of this monitoring period	01/07/2017 - 31/12/2017	
Monitoring report number for this monitoring period	1	
Coordinating/managing entity	Caixa Econômica Federal	
Host Parties	Host Party of the PoA	Is this the host Party of a CPA covered in this monitoring report? (yes/no)
	Brazil	Yes
Sectoral scopes	Sectoral Scope 13 - Waste handling and disposal	
Applied methodologies and standardized baselines	Methodology: ACM0001 – "Consolidated baseline methodology for landfill gas project activities – Version 11" Standardized baselines – N/A	
Amount of GHG emission reductions or net anthropogenic GHG removals achieved by all CPAs covered in this monitoring report in this monitoring period	Amount achieved before 1 January 2013	Amount achieved from 1 January 2013
		Total: 727,969tCO_2e CPA-1: 601,060 tCO_2e CPA-2: 126,909 tCO_2e

Amount of GHG emission reductions or net anthropogenic GHG removals estimated ex ante for this monitoring period in the CPA-DDs for the CPAs covered in this monitoring report	Total: 589,480 tCO_2e (Adjusted for the period) [1] CPA-1: 489,657 tCO_2e CPA-2: 99,823 tCO_2e

PART I Monitoring of programme of activities (PoA)

SECTION A. Description of PoA

A.1. General description of PoA

>>

According to the first National GHG Emissions inventory conducted by the Brazilian Ministry of Science and Technology[2], Brazil has over 6,000 waste depositing sites, receiving over 60,000 tons of waste per day. Of this amount, 76% of the total waste was deposed in dumpsites with no management, gas collection or water treatment and usually without any license or under no control by the environmental agencies concerned.

Brazil's National Energy Plan 2030[3], states that solid urban wastes are an important source of renewable energy generation and therefore Brazil's solid waste policy should target its use as a source for energy. In this sense the Brazilian Government has worked to design a program that promotes sustainable energy recovery from Municipal Solid Waste (MSW), bringing together the actions of various governmental entities involved. This program shall be in line with the established National Sanitation Policy[4], the guidelines for the management of municipal solid waste and will take into account the opportunities arising from the Law of Public Consortia.

Since current practice of uncontrolled GHG emissions in landfills is largely prevalent today, the PoA contribute to achieve the goals outlined in both the National Sanitation Policy and Brazil's National Energy Plan. Furthermore, the PoA will help to promote the implementation of LFG capture and combustion/energy generation/distribution systems through the CDM to mitigate the GHG emissions that would have otherwise been completely vented to the atmosphere.

This PoA generates emission reductions by avoiding methane emissions through the destruction of the methane generated by the landfill, and through generation of renewable energy and upgrade of biogas. As of today, the PoA includes 2 CPAs: CPA-1: Landfill gas recovery, energy generation and biogas distribution from CTR Santa Rosa and the CPA-2: CTR São Gonçalo, which both has implemented the first component of the project, gas flare.The conception, specifications and design for the other components (electricity generation and LFG distribution) are in process and the new components are expected to be implemented in the future. Therefore, during this monitoring period, emission reductions are only generated by the flaring system.

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[1] The period has been adjusted for the period of 184 days from the estimated volume from CPA-DD.

[2] Ministry of Science and Technology, First Brazilian Inventory of Anthropogenic Greenhouse Gas emissions, "Methane Emissions from waste treatment and disposal", 2002, page 15. Available at: http://www.bvsde.paho.org/bvsacd/cd25/methane.pdf

[3] Information on the National Energy Plan, PNE3,0 is available at the following site: http://www.epe.gov.br/PNE/Forms/Empreendimento.aspx

4 http://www.cidades.gov.br/index.php/apresentacao-plansab.html

A.1.1. Corresponding generic component project activities (CPAs)

Title and reference number of the corresponding generic CPA	Version of the PoA-DD	Sectoral scopes	Applied methodologies and standardized baselines
CPA-XX [Landfill name]	7.1	Sectorial Scope 13 - Waste handling and disposal	*ACM0001 – "Consolidated baseline methodology for landfill gas project activities – Version 11"* *"Tool for determining methane emissions avoided from disposal of waste at a solid waste disposal site" – Version 05.1.0* *"Tool to calculate project or leakage CO2 emissions from fossil fuel combustion" – Version 02* *"Tool to determine project emissions from flaring gases containing methane" – EB28, Annex 13* *"Tool to calculate baseline, project and/or leakage emissions from electricity consumption" Version 01* *"Tool to calculate the emission factor for an electricity system" Version 02.2.1*

A.1.2. CPAs included in the PoA

Title and UNFCCC reference number of the CPA	Title and reference number of the corresponding generic CPA	Version of the PoA-DD	Crediting period type and duration	Covered in this monitoring report? (yes/no)
6573 – 0001 - Landfill gas recovery, energy generation and biogas distribution from CTR Santa Rosa	CPA-1: Landfill gas recovery, energy generation and biogas distribution from CTR Santa Rosa	7.1	Renewable - 05/10/2012 – 04/10/2019	Yes
6573 – 0002 - CTR São Gonçalo	CPA-2: CTR São Gonçalo	7.1	Renewable – 18/05/2016 – 17/05/2023	Yes

A.2. Coordinating/managing entity

>>
Caixa Econômica Federal
Diretoria Executiva de Saneamento e Infraestrutura
Setor Bancário Sul Quadra 4 lotes 3/ 4 - 12º Andar
Edifício Matriz
Brasília DF 70092-900 Brazil
Email: geops@caixa.gov.br
Adailton Ferreira Trindade
Manager

SECTION B. Implementation of PoA

B.1. Description of implemented PoA

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The management system of the PoA has been implemented by CAIXA, the CME of the PoA, as described in the PoA-DD.

Caixa Economica Federal has followed the topics bellow for the management system:
- screened and validated the projects for inclusion in the PoA;
- carried out the inclusion process;
- trained the CPA Implementers;
- managed the records of CPA including data required to calculate emission reductions;
- ensured rigorous reporting of the CPA Entity;
- verified information sent by the CPA Entity;
- prepared the monitoring report at PoA level.

B.2. Post-registration changes to PoA

B.2.1. Corrections

>>
Not Applicable.

B.2.2. Inclusion of monitoring plan

>>
Not Applicable.

B.2.3. Permanent changes to the registered monitoring plan, or permanent deviation of monitoring from the applied methodologies, standardized baselines, or other applied standards or tools

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Applicable from the period prior to this monitoring period:
DOE Verification and Certification Report (version 1, completion date: 08/07/2014)
PRC-6573-001 - Effective approval date 04/03/2014

1. In case the continuous monitoring system of the flare efficiency is unavailable for maintenance or failure, default values will be applied if the flare has been operated in accordance with manufacturer specifications.

2. Transference of parameter TDLy (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) from the section of monitored parameters to the section of fixed parameters.

3. Inclusion of the monitored parameter identified as “Other flare operation parameters” that is intended to comprehend all manufacturer’s specifications for the operation of the flare and the required data and procedures to monitor these specifications. The default values referred to in item 1 above can only be applied if the flare has been operated in accordance with manufacturer specifications.

The request and assessment documents are available online at: http://cdm.unfccc.int/PRCContainer/DB/prcp853738999/view.

B.2.4. Changes to programme design

>>
Not applicable

PART II Monitoring of CPAs

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SECTION C. Implementation of CPAs

C.1. Description of implemented CPAs

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CPA-1: Landfill gas recovery, energy generation and biogas distribution from CTR Santa Rosa

The privately operated landfill of Waste Treatment Center (Central de Tratamento de Resíduos - CTR) Santa Rosa is located in Rio de Janeiro state, in Seropédica municipality, close to Rio de Janeiro city, the second most populous Brazilian city. CTR Santa Rosa covers an area of 1,699,512.97 m² and started receiving waste in March 2011, having received all necessary environmental licenses for operation. The landfill receives domestic solid waste from Rio de Janeiro, Seropédica and Itaguaí municipalities.

As per the registered CPA, the LFG collected in CTR Santa Rosa can be used to generate electricity, upgraded and distributed via a natural gas distribution network, or flared, to avoid any methane emissions going into the atmosphere. At the time of this monitoring report, only the flaring component has been implemented.

The LFG collection and flaring system has a total capacity of 17,500 Nm³/h (2,500 Nm³/h Flare#1, 5,000 Nm³/h Flare#2, 5,000 Nm³/h Flare#3 and 5,000 Nm³/h Flare#4). The CPA-1 contains the following components:

Landfill gas pre-treatment station

The state-of-the-art gas collection technology in this CPA 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 while minimizing costs.
•Wellheads designed for gas measurements.
•Condensate extraction and storage systems designed at strategic low points throughout the gas system.

All LFG collected is pre-treated to remove moisture and other impurities in order to prevent the corrosion of the subsequent systems.

Landfill gas flaring system

CPA-1 CTR Santa Rosa has a flaring system in place. The LFG flare system includes the items provided below:

•Four enclosed flares with controlled combustion systems.
•A blower system used to cause negative pressure in the pipeline (before blower) and positive pressure (after blower) to direct gas for flare.
•Monitoring equipment for continuous monitoring of gas composition, flow and burn temperature.
•Security restart system, in the case of a system shut down.

The current project process is shown in the following simplified monitoring diagram:

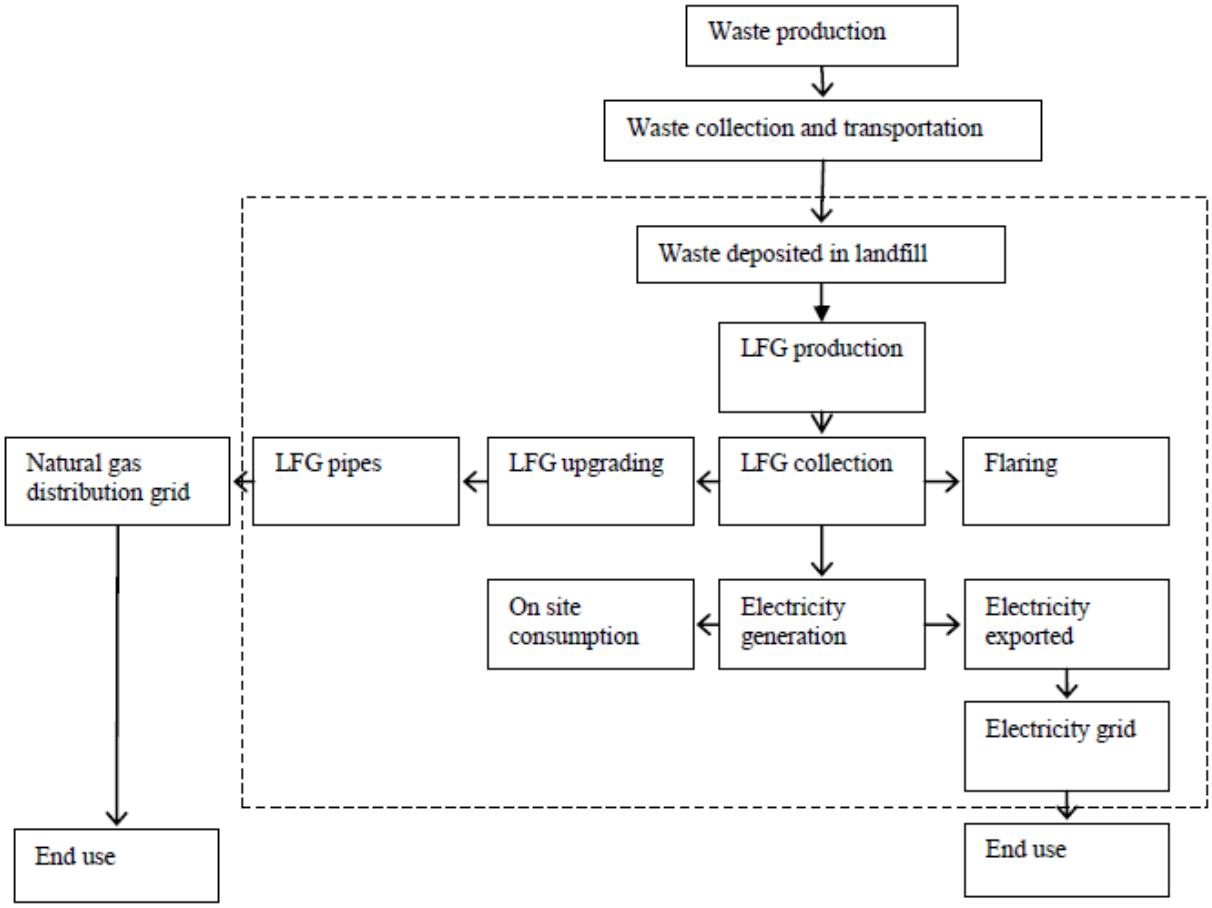


Figure 1 – Simplified schematic representation of the CPA project boundary

The project design considers the implementation of an electricity generation component and/or a LFG upgrading system for selling the gas. As of this monitoring period only the flaring system has been implemented.

The following list summarizes the relevant dates for CPA-1:

- 19/04/2011: Start date of the landfill operations.
- 16/10/2012: Start date, construction of the LFG collection and flaring system.
- 13/11/2012: Start of operations of the LFG collection and flaring system (Flare#1).
- 23/08/2013: Start of operations of Flare #2.
- 21/02/2016: Start of operations of Flare #3.
- 01/04/2017: Start of operations of Flare #4.

The total volume of emission reductions achieved in this monitoring period was 601,060 tCO_2e.

During the period, the main incidents that occurred are listed in the table below. The table includes incidents that resulted in a non Emission Reductions for more than 6 hours. No ERs have been claimed for any of these periods.

Start	End	Incidence	Correction Action	Remarks
01/07/2017 00:00	21/07/2017 09:12	Flare 1 flow meter lack of communication with PLC	Replacement of electronic component in order to restablish communication	Flare 1

16/11/2017 10:08	16/11/2017 17:38	Failure of combustion thermocouple with inconsistent value recording	Replacing the Thermocouple with New Equipment	Flare 4
17/11/2017 00:11	17/11/2017 00:43			
17/11/2017 03:41	17/11/2017 14:08			
23/12/2017 19:25	24/12/2017 04:31	Lack of electricity	Call to the electricity company to restore the supply	Energy
24/12/2017 06:06	24/12/2017 11:14			

The system was also turned off in some occasions for preventive maintenance, calibrations, inspection, cleaning or to replace a part.

CPA-2: CTR São Gonçalo

The privately operated landfill of CTR São Gonçalo is located in Rio de Janeiro state, in São Gonçalo municipality. This CPA currently covers an area of 106,500m² and is expected to cover an area of 439,280m² when closed in 2036. The landfill started receiving waste in 03 Feb 2012, having received all necessary environmental licenses for operation. The landfill receives domestic solid waste from São Gonçalo and Niteroi municipalities.

As per the registered CPA, the LFG collected in CTR São Gonçalo can be used to generate electricity, upgraded and distributed via a natural gas distribution network, or flared, to avoid any methane emissions going into the atmosphere. At the time of this monitoring report, only the flaring component has been implemented.

The LFG collection and flaring system has a total capacity of 5,499 Nm³/h. The CPA-2 CTR São Gonçalo contains the following components:

Landfill gas pre-treatment station

The state-of-the-art gas collection technology in this CPA 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 while minimizing costs.
•Wellheads designed for gas measurements.
•Condensate extraction and storage systems designed at strategic low points throughout the gas system.

All LFG collected is pre-treated to remove moisture and other impurities in order to prevent the corrosion of the subsequent systems.

Landfill gas flaring system

CPA-2 CTR São Gonçalo has a flaring system in place. The LFG flare system includes the items provided below:

•Two enclosed flare with controlled combustion systems.
•A blower system used to cause negative pressure in the pipeline (before blower) and positive pressure (after blower) to direct gas for flare.
•Monitoring equipment for continuous monitoring of gas composition, flow and burn temperature.
•Security restart system, in the case of a system shut down.

The current project process is shown in the following simplified monitoring diagram:

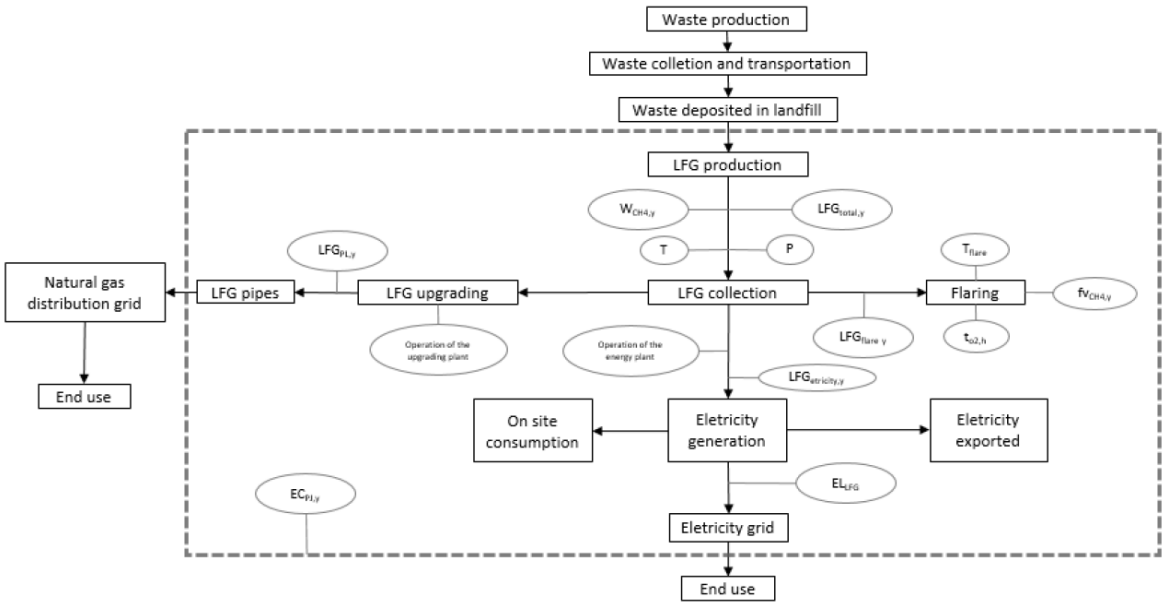


Figure 2 – Simplified schematic representation of the CPA project boundary

The project design considerers the implementation of an electricity generation component and/or a LFG upgrading system for selling the gas. As of this monitoring period only the flaring system has been implemented.

The following list summarizes the relevant dates for CPA-2:

- 03/02/2012: Start date of the landfill operations.
- 25/06/2015: Start date, construction of the LFG collection and flaring system.
- 18/05/2016: Start of operations of the LFG collection and flaring system (Flare#1).
- 23/03/2017: Start of operations of Flare #2.

The total volume of emission reductions achieved in this monitoring period was 126,909 tCO_2e.

During the period, the main incidents that occurred are listed in the table below. The table includes incidents that resulted in a non Emission Reductions for more than 6 hours. No ERs have been claimed for any of these periods.

Start	End	Incidence	Correction Action	Remarks
04/06/2017 22:07	05/06/2017 07:41	Eletric generator water pump failure	Call maintenance	No ER claimed during period
19/06/2017 00:34	19/06/2017 07:37	Air compressor was turned off	No particulary reason discovered	No ER claimed during period
28/06/2017 16:17	29/06/2017 07:57	Comunication of PC1 and PLC went off	Reset the PC	No ER claimed during period

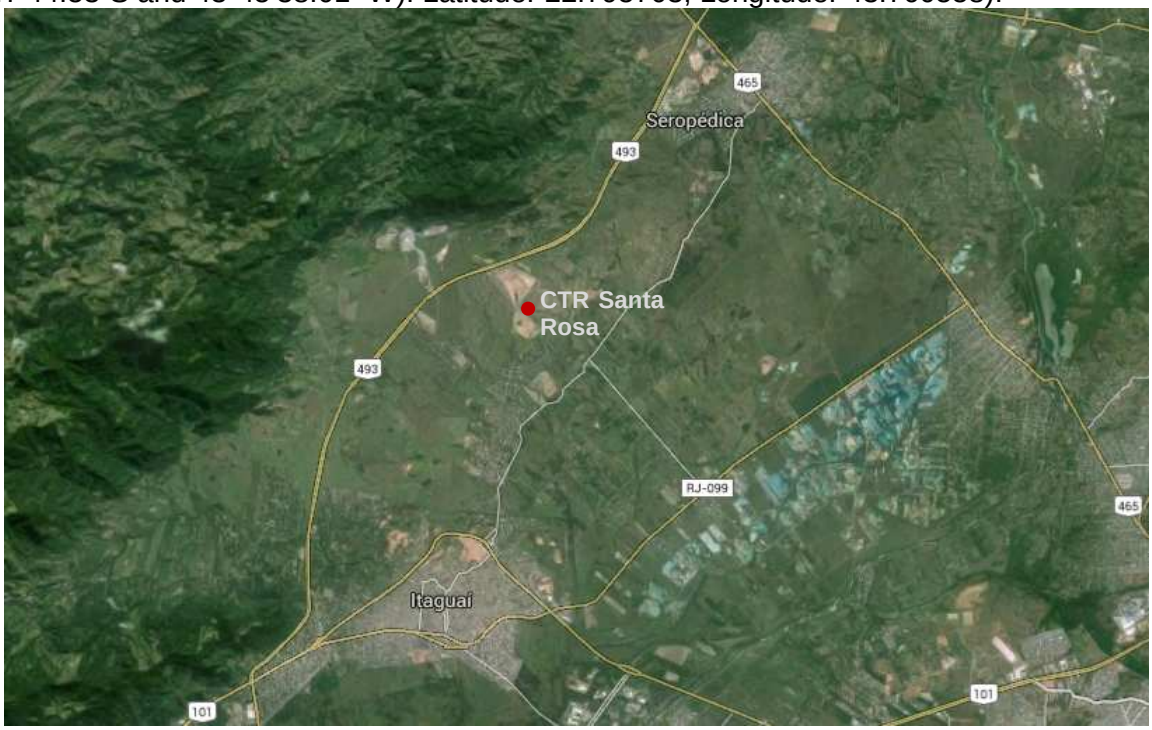
The system was turned off in some occasions for preventive maintenance, calibrations, inspection, cleaning or to replace a part.

C.2. Location of CPAs

>>

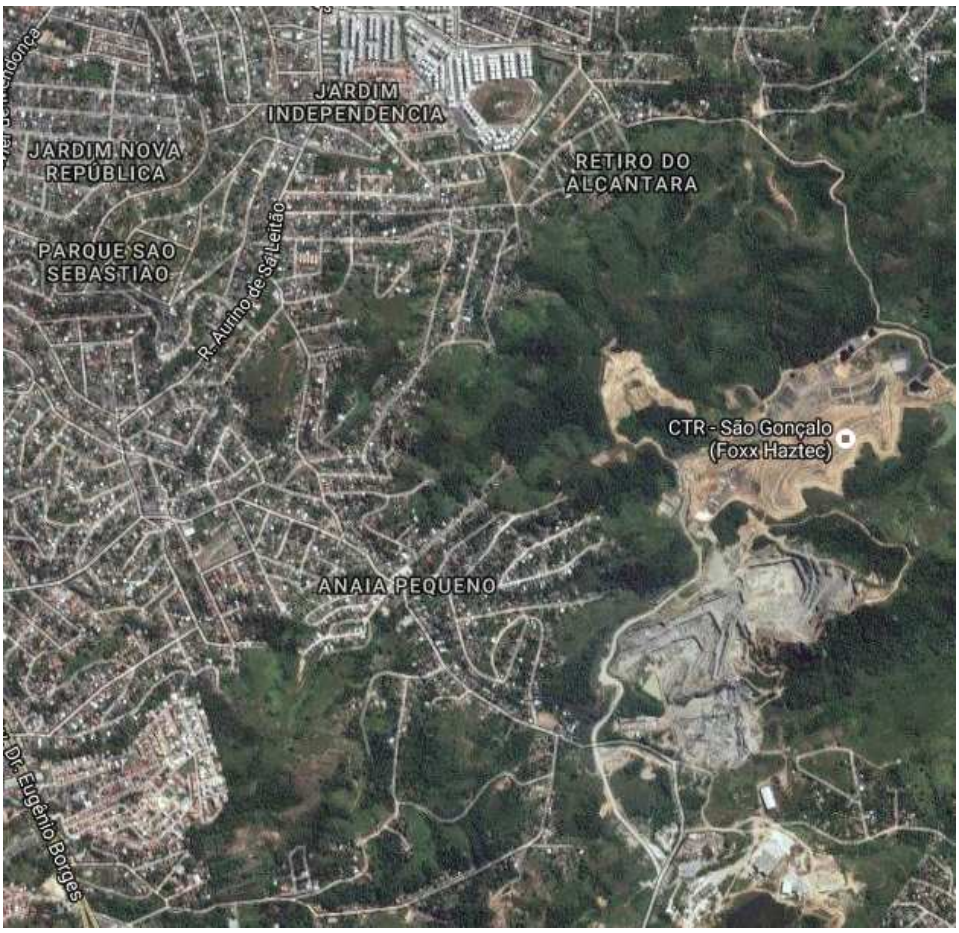
The project boundary of the PoA, and consequently the CPA-DD, is the country of Brazil.

CPA-1 is located in Rio de Janeiro state, between Seropédica and Itaguaí municipality (22º47'44.53"S and 43º45'38.01" W). Latitude:-22.795703, Longitude:-43.760558).



Source: maps.google.com.br

CPA-2 is located in Rio de Janeiro state, in São Gonçalo municipality (22º51'29.79"S and 42º59'20.71" W). Latitude: -22.858275, Longitude: -42.989086).



Source: maps.google.com.br

C.3. Post-registration changes to CPAs

C.3.1. Temporary deviations from the monitoring plans in the included CPA-DDs, applied methodologies or standardized baselines

>>

CPA-1:

DOE Verification and Certification Report (version 1, completion date: 08/07/2014):

From the date of installation of the second flare (August 2013), until July 2014, the main flow meter was in operation, measuring the total LFG flow. For most of this period, a single flare was in operation. However, by examining the records, it was identified that for some periods of time there was simultaneous operations of the two flares. This can be directly traced in the monitoring system by two “ON/OFF” variables linked to the operation of each of the flares (there is one variable by flare, and the “ON” position determines that the valve of the pipe connecting to the flare is open). By using these variables in the calculations, it is possible to identify those periods. Using a conservative approach, two measures have been taken by the PE: i) Only claim credits for those periods of time when a single flare is operating, so that the flow of gas is linked to destruction of methane in the relevant flare along with all its monitored parameters; ii) Apply a zero flare efficiency and therefore not claim any credits during those periods of time when it was detected that both flares were simultaneously operational, as it is not possible to determine the flow directed to each flare.

C.3.2. Corrections

>>

Applicable from the period prior to this monitoring period (CPA-1):

DOE Verification and Certification Report (Report nº: 10477 – 14/025, version 1, completion date: 08/07/2014)
PRC-6573-001 - Effective approval date 04/03/2014
CDM-CPA-DD-FORM (version 7.5, completion date: 11/09/2015)

A minor correction to the CPA-DD was requested to clarify that the LFG system of the project includes an enclosed flare system. The flare system might be comprised of one or more individual flares.

A correction is requested to clarify that the volumetric flow rate of the residual gas ($FV_{RG,h}$) should be defined as measured on wet basis. This is in line with information from the manufacturer. This correction is also in line with methodology requirements, as the basis for w_{CH4} (and $fv_{CH4,h}$) was already defined in the CPA-DD as wet, and data for both $FV_{RG,h}$ and w_{CH4} should be used in the same basis for the calculations.

An additional correction is requested to exclude specific value ranges of temperature and flow rate in the description of parameter "Other flare operation parameters: T_{flare} and $LFG_{flare,y}$" and just refer to "manufacturer's specifications".

C.3.3. Changes to the start date of the crediting period

>>
A request was required to change the date of the credit period at CPA 2-DD registered. Therefore, the initial date of the crediting period has changed for 18/05/2016 to 17/05/2023. This change do not affect the start of this monitoring period.

C.3.4. Inclusion of monitoring plan

>>
Not Applicable.

C.3.5. Permanent changes to the included monitoring plans, or permanent deviation of monitoring from the applied methodologies, standardized baselines, or other applied standards or tools

>>
Applicable from the period prior to this monitoring period (CPA-1):
DOE Verification and Certification Report (version 1, completion date: 08/07/2014)
PRC-6573-001 - Effective approval date 04/03/2014

1. In case the continuous monitoring system of the flare efficiency is unavailable for maintenance or failure, default values will be applied if the flare has been operated in accordance with manufacturer specifications.

2. Transference of parameter TDLy (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) from the section of monitored parameters to the section of fixed parameters.

3. Inclusion of the monitored parameter identified as "Other flare operation parameters" that is intended to comprehend all manufacturer's specifications for the operation of the flare and the required data and procedures to monitor these specifications. The default values referred to in item 1 above can only be applied if the flare has been operated in accordance with manufacturer specifications.

C.3.6. Changes to project design

>>
Not Applicable.

SECTION D. Description of monitoring system of CPAs

>>
The following equipment is used to monitor the operation of the projects and the emission reductions.

The control of maintenance and inspection schedules was defined considering the equipment manufacture´s specifications and orientations.

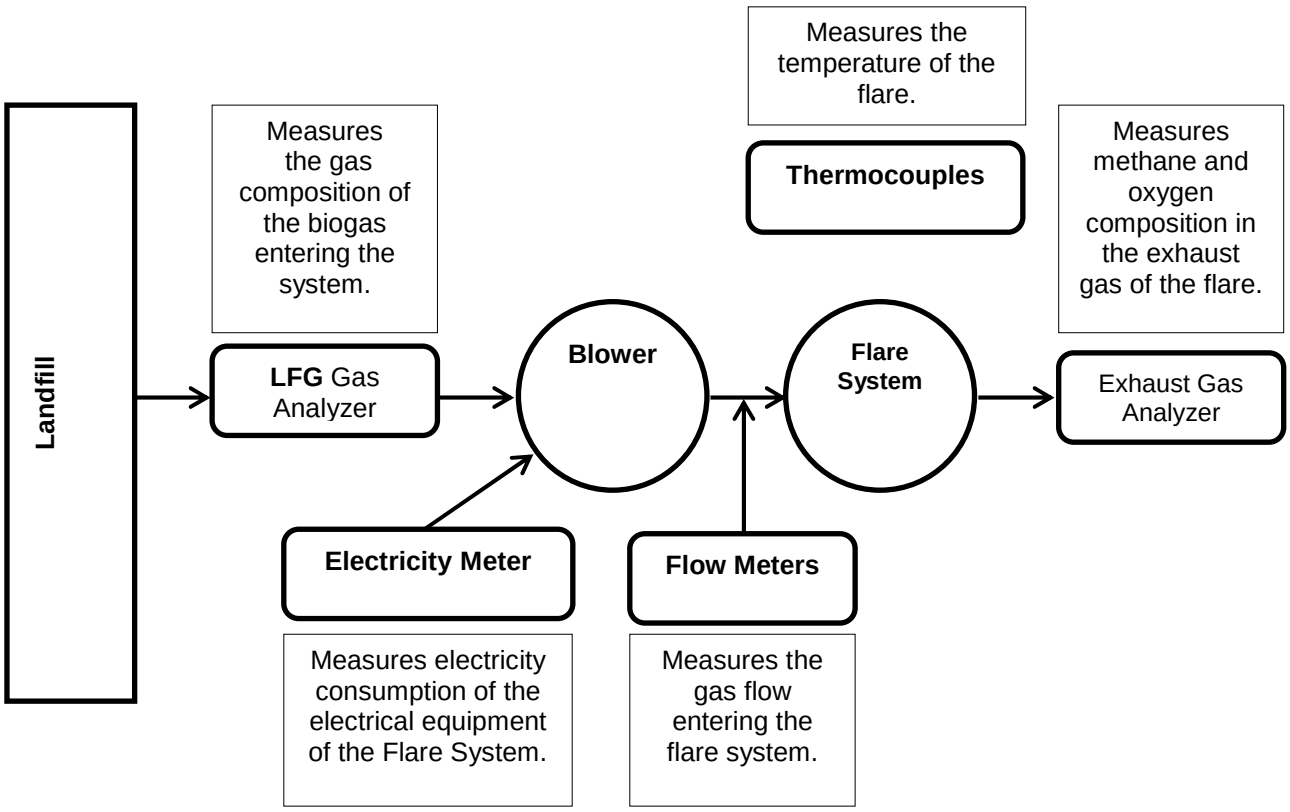


Diagram of the monitoring equipment

CPA-1: CTR SANTA ROSA

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

Flow Meter
The flow meter is used to measure the gas flow entering the flare system. The Project uses differential pressure flow meters, that operate 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 the flare tower.

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.

Energy Meter
The Energy Meter of the Project Site operates in order to measure electricity consumption of the Flare System.

Emergency procedures for data monitoring.

The CPA-1 implementer had in place a number of procedures to handle problems with data transfer and/or storage:

- PLC continuously receives data from monitoring equipament installed at degassing plant.
- Data is stored by Manufacturer's Supervisorio Software, which is installed in 2 computers (PC1 and PC2), located at Control Room. PC2 is only used for controlling and/or storing data in case PC1 is unavailable.
- Once a day, the data is transfered to the local server as a back-up copy.

To mitigate the risk of data losses on the local server and/or Supervisorio System, the CPA-1 implementer has a daily automatic backup procedure using an external server.

CAIXA also receives copies of the monthly generation that can be used as a backup in case of need.

Project management responsibility.

Ciclus Ambiental staff has operational and data collection obligations to fulfil, in order to maximize the GHG emissions reductions, ensuring that sufficient information is available to calculate ERs in a transparent and verifiable manner, allowing a fast and successful verification of these ERs.

CAIXA has the responsibility for the collection of monitored data in CPA-1, the emission reduction estimates, producing the monitoring reports and reporting to the DOE. CAIXA also maintain all necessary data to undertake the PoA monitoring plan, such as a list of all projects under review for inclusion in the PoA and the performing data and parameters for each registered CPA.

All provided data by CPA-1 implementer are checked for completeness and quality.

Data Storage

Both CAIXA and the CPA-1 implementer have in place procedures to archive all relevant documents, and all data recording of the monitored data that include paper and electronic versions, backup systems and periodic checking for data entry mistakes.

All records are kept for at least 2 years after the end of the crediting period.

Operation related documents are stored by the CPA-1 implementer in both hard and soft versions. All commercial documents as well as those related to PoA requirements defined by the CME are stored by CAIXA in both hard and soft versions. All these documents can be accessed and traced for CDM auditing purposes.

CPA-2: CTR SÃO GONÇALO

LFG Gas Analyzer
The LFG Gas Analyser is used to measure the biogas composition before the gas enters the flaring system.

Flow Meter

The flow meter is used to measure the gas flow entering the flare system. The Project uses a differential pressure flow meter 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 the flare tower.

Exhausted Gas Analyzer
The Exhausted Gas Analyzer provides continuous monitoring of methane and oxygen in the exhaust gas of the flare to calculate the biogas flaring efficiency.

Energy Meter
This equipment has not been used at the biogas plant.
There was an implementation delay of the Electricity Meter equipment. While this equipment is not been installed at the biogas plant, the project has used a diesel generator to provide electricity.

Emergency procedures for data monitoring.

The CPA-2 implementer has in place a number of procedures to handle problems with data transfer and/or storage:

- Continuously, the data is transfered from the monitoring equipment to local drives .
- Once a day, the data is transfered from the local drives to the local server.
- To mitigate the risk of data losses on the local server, the CPA-2 implementer had applied a daily backup procedure using acorporate server.
- CAIXA receives copies of the monthly generation that can be used as a backup in case of need.

Project management responsibility

“Central de Tratamento de Resíduos São Gonçalo” (CTR São Gonçalo) staff has operational and data collection obligations to fulfill, in order to maximize the GHG emissions reductions, ensuring that sufficient information is available to calculate ERs in a transparent and verifiable manner, allowing a fast and successful verification of these ERs.

CAIXA has the responsibility for the collection of monitored data in CPA-2 the emission reduction estimates, producing the monitoring reports and reporting to the DOE.

All provided data by CPA-2 implementer are checked for completeness and quality by CAIXA.

Data Storage

Both CAIXA and the CPA-2 implementer have in place procedures to archive all relevant documents, and all data recording of the monitored data that include paper and electronic versions, backup systems and periodic checking for data entry mistakes.

All records will be kept for at least 2 years after the end of the crediting period.

Operation related documents are stored by the CPA-2 implementer in both hard and soft versions. All commercial documents as well as those related to PoA requirements defined by the CME are stored by CAIXA in both hard and soft versions. All these documents can be accessed and traced for CDM auditing purposes.

SECTION E. Data and parameters

E.1. Data and parameters fixed ex ante

The following parameters, listed in the registereds CPA-DD, have been determined ex-ante and/or will not be used during the current monitoring period: Regulatory requirements relating to landfill gas; B

$E_{CH4,SWDS,y}$; MD_{Hist} ; MG_{Hist} ; φ ; OX ; F; DOC_f ; MCF ; DOC_j; k_j ; E_{DS} ; $P_{n,j,x}$; η_{ugf}.

Parameters fixed for both CPAs

Data/Parameter	**GWP_{CH4}**
Unit	t CO_2 / t CH_4
Description	Global Warming Potential of CH_4
Source of data	IPCC Fourth Assessment Report: Climate Change 2007
Value(s) applied	25
Choice of data or measurement methods and procedures	Shall be updated according to any future COP/MOP decisions.
Purpose of data/parameter	Calculation of baseline emissions.
Additional comments	Shall be updated according to any future COP/MOP decisions.

Data/Parameter	**DCH4**
Unit	t CH_4 / m^3 CH_4
Description	Methane density
Source of data	2006 IPCC Guidelines for National Greenhouse Gas Inventories
Value(s) applied	0.0007168
Choice of data or measurement methods and procedures	At standard T and P (0°C and 1.013 bar) the densit y of methane is 0.0007168 tCH_4 / m_3CH_4
Purpose of data/parameter	Calculation of baseline emissions.
Additional comments	At standard T and P (0°C and 1.013 bar) the densit y of methane is 0.0007168 tCH_4 / m_3CH_4

Data/Parameter	**TDLy**
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 baseline, project and/or leakage emissions from electricity consumption*" version 01
Value(s) applied	20%
Purpose of data/parameter	Calculation of project emissions.
Additional comments	

E.2. Data and parameters monitored

The following parameters, listed in the registered CPA, are not be used during the current monitoring period and/or refer to a component not yet implemented, such as the electricity generation and the purification of LFG and distribution through a natural gas pipeline: $LFG_{electricity,y}$; EL_{LFG}; Operation of the energy plant; $MG_{PR,y;}$; W_x ; Z ; $LFG_{PL,y}$; Operation of the upgrading gas plant.

The parameters $EF_{grid,CM,y}$; $EF_{grid,BM,y}$; $EF_{grid,OM,y}$ has been used only for CPA 1.

The parameters $NCV_{i,y}$; $FCi_{j,y}$; and $EF_{CO2,i,y}$ has been used only for CPA 2.

CPA-1 data and parameters

Data/Parameter	T
Unit	℃
Description	Temperature of the landfill gas
Measured/calculated/ default	Measured
Source of data	Project implementer
Value(s) of monitored parameter	N/A
Monitoring equipment	No separate monitoring is necessary when using flow meters that automatically measure the temperature and pressure, expressing LFG volumes in normalized cubic meters
Measuring/reading/recording frequency	Monitored continuously
Calculation method (if applicable)	N/A
QA/QC procedures	Measuring instruments shall be subject to a regular maintenance and testing regime, based on the manufacturer's recommendations
Purpose of data/parameter	Calculation of baseline emissions.
Additional comments	Data will be kept for 2 years after end of crediting period

Data/Parameter	P
Unit	Pa
Description	Pressure of the landfill gas
Measured/calculated/ default	Measured
Source of data	Project implementer
Value(s) of monitored parameter	N/A
Monitoring equipment	Measured continuously to determine the density of methane DCH4. No separate monitoring is necessary when using flow meters that automatically measure the temperature and pressure, expressing LFG volumes in normalized cubic meters
Measuring/reading/recording frequency	Monitored continuously
Calculation method (if applicable)	N/A

QA/QC procedures	Measuring instruments shall be subject to a regular maintenance and testing regime, based on the manufacturer's recommendations
Purpose of data/parameter	Calculation of baseline emissions.
Additional comments	Data will be kept for 2 years after end of crediting period

Data / Parameter:	**$LFG_{total,y}$**
Unit:	Nm^3
Description:	Total amount of landfill gas captured at normal temperature and pressure
Measured/ Calculated / Default:	Measured
Source of data:	From project implementer, measured on site
Value(s) of monitored parameter:	Please refer to Table 1 and 2 in section H, and ER calculation spreadsheet

Monitoring equipment:

There are two Deltabar S PMD70 Endress+Hauser flow meter available on site, one for Flare 1 and the other for Flare 2:

Type: Differential pressure Flow Meter	
Accuracy:	± 0.696%
Serial number:	H901DB0109D
Calibration frequency:	12 months
Calibration Date:	10/08/2016
Validity:	09/08/2017
Calibration Date:	04/08/2017
Validity	03/08/2018
Operation Period:	01/07/2017 to 31/12/2017 for Flare #1

Type: Differential pressure Flow Meter	
Accuracy:	± 0.696%
Serial number:	F804240109D
Calibration frequency:	12 months
Calibration Date:	10/08/2016
Validity:	09/08/2017
Calibration Date:	04/08/2017
Validity	03/08/2018
Operation Period:	01/07/2017 to 31/12/2017 for Flare #2

And two 266DSH ABB flow meter available on site, one for Flare 3 and the other for Flare 4:

Type: Differential pressure Flow Meter	
Accuracy:	+/-0.075%
Serial number:	3K646615009427
Calibration frequency:	49 months
Calibration Date:	14/10/2016
Validity	13/11/2020
Calibration Date:	04/08/2017
Validity	03/09/2021
Operation Period:	01/07/2017 to 31/12/2017 for Flare #3

Type: Differential pressure Flow Meter	
Accuracy:	+/-0.075%
Serial number:	3K646616045657
Calibration frequency:	49 months
Calibration Date:	22/12/2016
Validity	21/01/2021
Calibration Date:	04/08/2017
Validity	03/09/2021
Operation Period:	01/07/2017 to 31/12/2017 for Flare #4

Measuring/ Reading/ Recording frequency:	Measured continuously (average value in a time interval not greater than an hour) by flow meter continuously; data to be aggregated monthly and yearly.
Calculation method (if applicable):	NA

QA/QC procedures:	Flow meters shall be subject to a regular maintenance and testing regime, based on the manufacturer's recommended schedule and procedures, to ensure accuracy
Purpose of data:	Calculation of baseline emissions.
Additional comment:	Data will be kept for 2 years after end of crediting period.

Data/parameter:	**$LFG_{Flare,y}$**
Unit	Nm^3
Description	Flow of LFG to the flare. Amount of landfill gas flared at normal temperature and pressure.
Measured/ calculated/ default	Measured
Source of data	From project implementer, measured on site
Value(s) of monitored parameter	Please refer to Table 1 in section H, and ER calculation spreadsheet

Monitoring equipment

There are two Deltabar S PMD70 Endress+Hauser flow meter available on site, one for Flare 1 and the other for Flare 2:

Type: Differential pressure Flow Meter	
Accuracy:	± 0.696%
Serial number:	H901DB0109D
Calibration frequency:	12 months
Calibration Date:	10/08/2016
Validity:	09/08/2017
Calibration Date:	04/08/2017
Validity	03/08/2018
Operation Period:	01/07/2017 to 31/12/2017 for Flare #1

Type: Differential pressure Flow Meter	
Accuracy:	± 0.696%
Serial number:	F804240109D
Calibration frequency:	12 months
Calibration Date:	10/08/2016
Validity:	09/08/2017
Calibration Date:	04/08/2017
Validity	03/08/2018
Operation Period:	01/07/2017 to 31/12/2017 for Flare #2

And two 266DSH ABB flow meter available on site, one for Flare 3 and the other for Flare 4:

Type: Differential pressure Flow Meter	
Accuracy:	± 0.075%
Serial number:	3K646615009427
Calibration frequency:	49 months
Calibration Date:	14/10/2016
Validity	13/11/2020
Calibration Date:	04/08/2017
Validity	03/09/2021
Operation Period:	01/07/2017 to 31/12/2017 for Flare #3

Type: Differential pressure Flow Meter	
Accuracy:	+/-0.075%
Serial number:	3K646616045657
Calibration frequency:	49 months
Calibration Date:	22/12/2016
Validity	21/01/2021
Calibration Date:	04/08/2017
Validity	03/09/2021
Operation Period	01/07/2017 to 31/12/2017 for Flare #4

Measuring/ reading/ recording frequency:	Measured continuously (average value in a time interval not greater than an hour) by flow meter continuously; data to be aggregated monthly and yearly.
Calculation method (if applicable):	NA

QA/QC procedures:	Flow meters shall be subject to a regular maintenance and testing regime, based on the manufacturer's recommended schedule and procedures, to ensure accuracy
Purpose of data:	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" used to determine project emissions from flaring. Data will be kept for 2 years after end of crediting period.

Data / Parameter:	**$w_{CH4,y}$**
Unit:	m^3 CH_4 / m^3 LFG
Description:	Methane fraction in the landfill gas
Measured/Calculated / Default:	Measured
Source of data:	Measured by continuous gas quality analyser.
Value(s) of monitored parameter:	Please refer to the Table 1 in section H, and ER calculation spreadsheet
Monitoring equipment:	There was a Raw Gas Analyser, model Ultramat 23 manufactured by Siemens available on site.

Type: Siemens Ultramat 23 Raw Gas analyser	
Accuracy:	± 1%
Serial number:	N1F3920
Calibration frequency:	12 months
Calibration Date:	06/10/2016
Validity	05/10/2017
Calibration Date:	29/09/2017
Validity	28/09/2018
Operation Period:	01/07/2017 to 31/12/2017

Measuring/Reading/ Recording frequency:	Monitored continuously
Calculation method (if applicable):	NA
QA/QC procedures:	The gas analyser shall be subjected to regular maintenance and calibration, based on the manufacturer's recommended schedule and procedures, to ensure accuracy
Purpose of data:	Calculation of baseline emissions.
Additional comment:	$w_{CH4,y}$ is considered to be equivalent to the variable $fv_{CH4,h}$ (volumetric fraction of the component CH_4 in the landfill gas in the hour h) as described in the "Tool to determine Project emissions from flaring gases containing methane". Monthly calibrations performed on site by the plant operators by a conservative approach. Data will be kept for 2 years after end of crediting period.

Data / Parameter:	**$EF_{grid, CM,y}$**
Unit:	tCO_2/MWh
Description:	Combined Margin CO_2 emission factor for the project electricity system in year *y*
Measured/Calculated / Default:	Calculated as per the "Tool to calculate the emission factor for an electricity system" version 02.2.1.
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:	0.2955 for 2017
Monitoring equipment:	Monitored yearly using published data from the Brazilian Ministry of Science and Technology (Brazil DNA)
Measuring/Reading/ Recording frequency:	Monitored yearly
Calculation method (if applicable):	Calculated as per the "Tool to calculate the emission factor for an electricity system" version 02.2.1.
QA/QC procedures:	This value will be updated yearly as per the monitored data $EF_{grid,BM,y}$ and $EF_{grid,OM,y}$ using the latest published data from Brazil's DNA
Purpose of data:	Calculation of project emissions.
Additional comment:	$EF_{grid,\ CM,y} = CEF_{elecy,BLy} = EF_{EL,j,y}$ This value will be reported within each CPA, and will be monitored ex-post. Data will be kept for two years after end of crediting period

Data / Parameter:	**$EF_{grid,\ BM,y}$**
Unit:	tCO_2/MWh
Description:	Build margin CO_2 emission factor for the project electricity system in year *y*
Measured/Calculated / Default:	Calculated as per the "Tool to calculate the emission factor for an electricity system" version 02.2.1.
Source of data:	Based on yearly published data from the Brazilian Ministry of Science and Technology (Brazilian DNA)
Value(s) of monitored parameter:	0.0028 for 2017
Monitoring equipment:	Monitored yearly using published data from the Brazilian Ministry of Science and Technology (Brazil DNA)
Measuring/Reading/ Recording frequency:	Monitored yearly.
Calculation method (if applicable):	Calculated as per the "Tool to calculate the emission factor for an electricity system version 02.2.1.
QA/QC procedures:	This value will be updated and monitored as per the latest published data from Brazil's DNA.
Purpose of data:	Calculation of project emissions.
Additional comment:	This value will be reported within each CPA, and will be monitored ex-post. Data will be kept for two years after end of crediting period.

Data / Parameter:	**$EF_{grid,OM,y}$**
Unit:	tCO_2/MWh
Description:	Operating margin CO_2 emission factor for the project electricity system in year *y*
Measured/ Calculated / Default:	Calculated as per the "Tool to calculate the emission factor for an electricity system" version 02.2.1.
Source of data:	Based on yearly published data from the Brazilian Ministry of Science and Technology (Brazilian DNA)
Value(s) of monitored parameter:	0.5882 for 2017
Monitoring equipment:	Monitored yearly using published data from the Brazilian Ministry of Science and Technology (Brazil DNA)
Measuring/Reading/ Recording frequency:	Monitored yearly.

Calculation method (if applicable):	Monitored yearly using published data from the Brazilian Ministry of Science and Technology (Brazil DNA). The dispatch data analysis is used, option (C) of the "Tool to calculate the emission factor for an electricity system". Version 02.2.1
QA/QC procedures:	This value will be updated and monitored as per the latest published data from Brazil's DNA.
Purpose of data:	Calculation of project emissions.
Additional comment:	This value will be reported within CPA, and will be monitored ex-post. Data will be kept for two years after end of crediting period.

Data / Parameter:	T_{flare}
Unit:	℃
Description:	Temperature in the exhaust gas of the flare
Measured/Calculated / Default:	Measured
Source of data:	Project implementer
Value(s) of monitored parameter:	Please refer to ER calculation spreadsheet

Monitoring equipment:

Flare #1 thermocouple:

Type: ECIL Type S	
Accuracy:	±0.25%
Reference:	120/17
Calibration frequency:	Annual, from the time of installation
Installation date:	23/03/2017
Validity:	22/03/2018
Operation Period:	01/07/2017 – 31/12/2017

Flare #2 thermocouple:

Type: ECIL Type S	
Accuracy:	±0.25%
Reference:	121/17
Calibration frequency:	Annual, from the time of installation
Installation date:	23/03/2017
Validity:	22/03/2018
Operation Period:	01/07/2017 – 31/12/2017

Flare #3 thermocouple:

	Type: ELSI Type S
Accuracy:	±0.04%
Reference:	E16TS0273
Calibration frequency:	Annual, from the time of installation
Installation date:	27/04/2017
Validity:	26/04/2018
Operation Period:	01/07/2017 – 31/12/2017

Flare #4 thermocouple:

	Type: ELSI Type S
Accuracy:	±0.04%
Reference:	E17TS004
Calibration frequency:	Annual, from the time of installation
Installation date:	01/04/2017
Validity:	31/03/2018
Operation Period:	01/07/2017 – 09/11/2017

Type: ECIL Type S	
Accuracy:	±0.25%
Reference:	82/17
Calibration frequency:	Annual, from the time of installation
Installation date:	09/11/2017
Validity:	08/11/2018
Operation Period:	09/11/2017 – 17/11/2017

Type: ECIL Type S	
Accuracy:	±0.25%
Reference:	454/17
Calibration frequency:	Annual, from the time of installation
Installation date:	17/11/2017
Validity:	16/11/2018
Operation Period:	17/11/2017 – 31/12/2017

Measuring/Reading/ Recording frequency:	Data is measured continuously.
Calculation method (if applicable):	N/A
QA/QC procedures:	Measuring instruments are subject to regular maintenance and testing regime, based on the manufacturer's recommended schedule and procedures
Purpose of data:	Calculation of baseline emissions
Additional comment:	Required to determine adequate operation and operating hours of the flare. Data will be kept for at least two years after the end of the crediting period with an annual frequency of calibration or replacement as per the "Tool to determine project emissions from flaring gases containing methane" – EB28, Annex 13

Data / Parameter:	$t_{O2,h}$
Unit:	--
Description:	Volumetric fraction of O_2 in the exhaust gas of the flare in the hour *h*
Measured/Calculated / Default:	Measured
Source of data:	Project Implementer
Value(s) of monitored parameter:	Please refer to ER calculation spreadsheet

<table>
<tr><td>Monitoring equipment:</td><td>A gas analyser is used to measure the exhaust gas composition. The manufacturer of the gas analyser for Flares 1 and 2 is NUK.

Flare #1:
<table><tr><th colspan="2">Type: NUK GAE O_2 Exhaust Gas Analyser</th></tr><tr><td>Serial number:</td><td>A1847</td></tr><tr><td>Accuracy:</td><td>± 1.0%</td></tr><tr><td>Calibration frequency:</td><td>No external calibration required, according to manufacturer. Every two weeks calibrations performed on site by the plant operators</td></tr><tr><td>Operation Period:</td><td>01/07/2017 to 31/12/2017</td></tr></table>
Flare #2:
<table><tr><th colspan="2">Type: NUK GAE O_2 Exhaust Gas Analyser</th></tr><tr><td>Serial number:</td><td>A1848</td></tr><tr><td>Accuracy:</td><td>± 1.0%</td></tr><tr><td>Calibration frequency:</td><td>No external calibration required, according to manufacturer. Every two weeks calibrations performed on site by the plant operators</td></tr><tr><td>Operation Period:</td><td>01/07/2017 to 31/12/2017</td></tr></table>
The manufacturer of the gas analyser for Flares 3 and 4 is Siemens.

Flare #3:
<table><tr><th colspan="2">Type: SIEMENS Ultramat 23 O_2 Exhaust Gas Analyzer</th></tr><tr><td>Serial number:</td><td>N1F3921</td></tr><tr><td>Accuracy:</td><td>± 1.0%</td></tr><tr><td>Calibration frequency:</td><td>12 months</td></tr><tr><td>Calibration Date:</td><td>06/10/2016</td></tr><tr><td>Validity</td><td>05/10/2017</td></tr><tr><td>Calibration Date:</td><td>29/09/2017</td></tr><tr><td>Validity</td><td>28/09/2018</td></tr><tr><td>Operation Period:</td><td>01/07/2017 to 31/12/2017</td></tr></table>
Flare #4:
<table><tr><th colspan="2">Type: SIEMENS Ultramat 23 O_2 Exhaust Gas Analyzer</th></tr><tr><td>Serial number:</td><td>N1HN918</td></tr><tr><td>Accuracy:</td><td>± 1.0%</td></tr><tr><td>Calibration frequency:</td><td>12 months</td></tr><tr><td>Calibration Date:</td><td>26/01/2017</td></tr><tr><td>Validity</td><td>25/01/2018</td></tr><tr><td>Calibration Date:</td><td>29/09/2017</td></tr><tr><td>Validity</td><td>28/09/2018</td></tr><tr><td>Operation Period:</td><td>01/07/2017 to 31/12/2017</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>Analysers are 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 is performed by comparison with a standard certified gas.</td></tr>
<tr><td>Purpose of data:</td><td>Calculation of baseline emissions</td></tr>
</table>

Additional comment:	Monitoring of this parameter is due to continuous monitoring of the flare efficiency. Monthly calibrations performed on site by the plant operators by a conservative approach. Data will be kept for 2 years after end of crediting period or last issuance of CERs for the project activity.

Data / Parameter:	**$fv_{CH4,h}$**
Unit:	-
Description:	Volumetric fraction of methane in the residual gas in the hour *h.*
Measured/Calculated / Default:	Measured
Source of data:	Project Implementer
Value(s) of monitored parameter:	Please refer to ER calculation spreadsheet
Monitoring equipment:	There was a Raw Gas Analyser, model Ultramat 23 manufactured by Siemens available on site.

Type: Ultramat 23 Raw Gas analyser	
Accuracy:	± 1%
Serial number:	N1F3920
Calibration frequency:	12 months
Calibration Date:	06/10/2016
Validity	05/10/2017
Calibration Date:	29/09/2017
Validity	28/09/2018
Operation Period:	01/07/2017 to 31/12/2017

Measuring/ Reading/ Recording frequency:	Monitored continuously
Calculation method (if applicable):	NA
QA/QC procedures:	The gas analyser shall be subjected to regular maintenance and calibration, based on the manufacturer's recommended schedule and procedures, to ensure accuracy
Purpose of data:	Calculation of baseline emissions.
Additional comment:	Monthly calibrations performed on site by the plant operators by a conservative approach. Data will be kept for two years after end of crediting period.

Data / Parameter:	**$FV_{RG,h}$**
Unit:	m^3/h
Description:	Volumetric flow rate of the residual gas in wet basis at normal (NTP) conditions in the hour h
Measured/ Calculated / Default:	Measured
Source of data:	From project implementer, measured on site
Value(s) of monitored parameter:	Please refer to table 1 in section H, and ER calculation spreadsheet

Monitoring equipment:

There are two Deltabar S PMD70 Endress+Hauser flow meter available on site, one for Flare 1 and the other for Flare 2:

Type: Differential pressure Flow Meter	
Accuracy:	± 0.696%
Serial number:	H901DB0109D
Calibration frequency:	12 months
Calibration Date:	10/08/2016
Validity	09/08/2017
Calibration Date:	04/08/2017
Validity	03/08/2018
Operation Period:	01/07/2017 to 31/12/2017 for Flare #1

Type: Differential pressure Flow Meter	
Accuracy:	± 0.696%
Serial number:	F804240109D
Calibration frequency:	12 months
Calibration Date:	10/08/2016
Validity	09/08/2017
Calibration Date:	04/08/2017
Validity	03/08/2018
Operation Period:	01/07/2017 to 31/12/2017 for Flare #2

And two 266DSH ABB flow meter available on site, one for Flare 3 and the other for Flare 4:

Type: Differential pressure Flow Meter	
Accuracy:	+/-0.075%
Serial number:	3K646615009427
Calibration frequency:	49 months
Calibration Date:	14/10/2016
Validity	13/11/2020
Calibration Date:	04/08/2017
Validity	03/09/2021
Operation Period:	01/07/2017 to 31/12/2017 for Flare #3

Type: Differential pressure Flow Meter	
Accuracy:	+/-0.075%
Serial number:	3K646616045657
Calibration frequency:	49 months
Calibration Date:	22/12/2016
Validity	21/01/2021
Calibration Date:	04/08/2017
Validity	03/09/2021
Operation Period:	01/07/2017 to 31/12/2017 for Flare #4

Measuring/ Reading/ Recording frequency:	Measured continuously (average value in a time interval not greater than an hour) by flow meter continuously; data to be aggregated monthly and yearly.
Calculation method (if applicable):	NA

QA/QC procedures:	Flow meters shall be subject to a regular maintenance and testing regime, based on the manufacturer's recommended schedule and procedures, to ensure accuracy
Purpose of data:	Calculation of baseline emissions.
Additional comment:	Data will be kept for 2 years after end of crediting period

Data / Parameter:	$\mathbf{fv_{CH4,FG,h}}$
Unit:	mg/m^3
Description:	Concentration of methane in the exhaust gas of the flare in dry basis at normal conditions in the hour h
Measured/Calculated / Default:	Measured
Source of data:	Project Implementer
Value(s) of monitored parameter:	Please refer to 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 for Flare 1 and Flare 2 is NUK.

Flare #1:
<table>
<tr><th colspan="2">Type: NUK GAE CH_4 Exhaust Gas Analyser</th></tr>
<tr><td>Serial number:</td><td>A1903</td></tr>
<tr><td>Accuracy:</td><td>± 2.0%</td></tr>
<tr><td>Calibration frequency:</td><td>No external calibration required, according to manufacturer. Every two weeks calibrations performed on site by the plant operators</td></tr>
<tr><td>Operation Period:</td><td>01/07/2017 to 31/12/2017</td></tr>
</table>
Flare #2:
<table>
<tr><th colspan="2">Type: NUK GAE CH_4 Exhaust Gas Analyser</th></tr>
<tr><td>Serial number:</td><td>A2055</td></tr>
<tr><td>Accuracy:</td><td>± 2.0%</td></tr>
<tr><td>Calibration frequency:</td><td>No external calibration required, according to manufacturer. Every two weeks calibrations performed on site by the plant operators</td></tr>
<tr><td>Operation Period:</td><td>01/07/2017 to 31/12/2017</td></tr>
</table>
The manufacturer of the gas analyser for Flares 3 and 4 is Siemens.

Flare #3:
<table>
<tr><th colspan="2">Type: SIEMENS Ultramat 23 - Exhaust Gas Analyzer</th></tr>
<tr><td>Serial number:</td><td>N1F3921</td></tr>
<tr><td>Accuracy:</td><td>± 1.0%</td></tr>
<tr><td>Calibration frequency:</td><td>12 months</td></tr>
<tr><td>Calibration Date:</td><td>06/10/2016</td></tr>
<tr><td>Validity</td><td>05/10/2017</td></tr>
<tr><td>Calibration Date:</td><td>29/09/2017</td></tr>
<tr><td>Validity</td><td>28/09/2018</td></tr>
<tr><td>Operation Period:</td><td>01/07/2017 to 31/12/2017</td></tr>
</table>
Flare #4:
<table>
<tr><th colspan="2">Type: SIEMENS Ultramat 23 - Exhaust Gas Analyzer</th></tr>
<tr><td>Serial number:</td><td>N1HN918</td></tr>
<tr><td>Accuracy:</td><td>± 1.0%</td></tr>
<tr><td>Calibration frequency:</td><td>12 months</td></tr>
<tr><td>Calibration Date:</td><td>26/01/2017</td></tr>
<tr><td>Validity</td><td>25/01/2018</td></tr>
<tr><td>Calibration Date:</td><td>29/09/2017</td></tr>
<tr><td>Validity</td><td>28/09/2018</td></tr>
<tr><td>Operation Period:</td><td>01/07/2017 to 31/12/2017</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>Analysers 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:	**$EC_{PJ,y}$**
Unit:	MWh
Description:	Quantity of electricity consumed by the project activity during the year y
Measured/Calculated / Default:	Measured
Source of data:	Project implementer
Value(s) of monitored parameter:	Please refer to Table 3 in section H, at Project Emissions from electricity consumption
Monitoring equipment:	There is an electricity meter SCHNEIDER available on the project site:

Type: SCHNEIDER Electricity Meter	
Serial number:	C034151170401
Models:	PM1200
Accuracy:	Active energy class 1; as per IEC 62052-11 & IEC 62053-22
Calibration frequency:	5 years as per Brazilian standard[5]
Manufacturer calibration	16/03/2015
Validity	15/03/2020
Operation Period	01/07/2017 to 31/12/2017

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 two years after end of crediting period.

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 implementer
Value(s) of monitored parameter:	Please refer to ER calculation spreadsheet
Monitoring equipment:	Thermocouple and flow meter measurements (please refer to equipment described under T_{flare} and $LFG_{flare,y}$)
Measuring/Reading/ Recording frequency:	Monitored continuously

[5] http://www.inmetro.gov.br/legislacao/rtac/pdf/RTAC001671.pdf

Calculation method (if applicable):	Data will be continuously measured to ensure that the flare/s 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: 1,200^{o}C Minimum flow rate: 500 Nm^{3}/h for flare #1 and flare #2 1,000 Nm^{3}/h for flare #3 and flare #4 Maximum flow rate: 2,500 Nm^{3}/h for flare #1 5,000 Nm^{3}/h for flare #2, flare #3 and flare #4 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.

CPA-2 data and parameters

Data/Parameter	**T**
Unit	^{o}C
Description	Temperature of the landfill gas
Measured/calculated/ default	Measured
Source of data	Project implementer
Value(s) of monitored parameter	N/A
Monitoring equipment	No separate monitoring is necessary when using flow meters that automatically measure the temperature and pressure, expressing LFG volumes in normalized cubic meters
Measuring/reading/recording frequency	Monitored continuously
Calculation method (if applicable)	N/A
QA/QC procedures	Measuring instruments shall be subject to a regular maintenance and testing regime, based on the manufacturer's recommendations
Purpose of data/parameter	Calculation of baseline emissions.
Additional comments	Data will be kept for 2 years after end of crediting period

Data/Parameter	**P**
Unit	Pa
Description	Pressure of the landfill gas
Measured/calculated/ default	Measured
Source of data	Project implementer
Value(s) of monitored parameter	N/A
Monitoring equipment	Measured continuously to determine the density of methane DCH4. No separate monitoring is necessary when using flow meters that automatically measure the temperature and pressure, expressing LFG volumes in normalized cubic meters
Measuring/reading/recording frequency	Monitored continuously
Calculation method (if applicable)	N/A

QA/QC procedures	Measuring instruments shall be subject to a regular maintenance and testing regime, based on the manufacturer's recommendations
Purpose of data/parameter	Calculation of baseline emissions.
Additional comments	Data will be kept for 2 years after end of crediting period

Data/Parameter	**$LFG_{total,y}$**
Unit	Nm^3
Description	Total amount of landfill gas captured at normal temperature and pressure
Measured/calculated/ default	Calculated
Source of data	Calculated by the sum of **$LFG_{Flare,\#1}$** and **$LFG_{Flare,\#2}$**
Value(s) of monitored parameter	Please refer to Table 2 in section H, and ER calculation spreadsheet
Monitoring equipment	There is one fixed Annubar flow meter from Simer installed before the flare 1. Another one is fixed Annubar flow meter from Simer installed before the flare 2. This equipment uses the differential pressure, that is read by a pressure sensor model 2600T developed by ABB to calculate the biogas flow.
Measuring/reading/recording frequency	Measured continuously (average value in a time interval not greater than an hour) by the Annubar flow meter (pressure sensor and temperature sensor); data to be aggregated monthly.
Calculation method (if applicable)	NA
QA/QC procedures	To ensure the correct reading, the sensor shall be subject to a regular maintenance and calibration regime based on the manufacture's recommended schedule.
Purpose of data/parameter	Calculation of baseline emissions.
Additional comments	Data will be kept for 2 years after end of crediting period.

Type: Diferential Pressure flow meter	
Accuracy:	0.075%
Serial number:	3K646615024640
Calibration frequency:	49 months
Calibration Date:	28/07/2016
Validity:	27/08/2020
Calibration Date:	04/08/2017
Validity	03/09/2021
Operation Period:	01/07/2017 to 31/12/2017 for Flare #1

Type: Diferential Pressure flow meter	
Accuracy:	0.075%
Serial number:	3K646617002535
Calibration frequency:	49 months
Calibration Date:	26/01/2017
Validity:	25/02/2021
Calibration Date:	12/12/2017
Validity	11/01/2022
Operation Period:	01/07/2017 to 31/12/2017 for Flare #2

<table>
<tr><td>Data/Parameter</td><td>LFG $_{Flare,y}$</td></tr>
<tr><td>Unit</td><td>Nm^3</td></tr>
<tr><td>Description</td><td>Flow of LFG to the flare. Amount of landfill gas flared at normal temperature and pressure.</td></tr>
<tr><td>Measured/calculated/ default</td><td>Measured</td></tr>
<tr><td>Source of data</td><td>From project implementer, measured on site</td></tr>
<tr><td>Value(s) of monitored parameter</td><td>Please refer to Table 2 in section H, and ER calculation spreadsheet</td></tr>
<tr><td>Monitoring equipment</td><td>There are fixed Annubar flow meter from Simer installed before each flare. This equipment uses the differential pressure, that is read by a pressure sensor model 2600T developed by ABB to calculate the biogas flow.
<table>
<tr><th colspan="2">Type: Diferential Pressure flow meter</th></tr>
<tr><td>Accuracy:</td><td>0.075%</td></tr>
<tr><td>Serial number:</td><td>3K646615024640</td></tr>
<tr><td>Calibration frequency:</td><td>49 months</td></tr>
<tr><td>Calibration Date:</td><td>28/07/2016</td></tr>
<tr><td>Validity:</td><td>27/08/2020</td></tr>
<tr><td>Calibration Date:</td><td>04/08/2017</td></tr>
<tr><td>Validity</td><td>03/09/2021</td></tr>
<tr><td>Operation Period:</td><td>01/07/2017 to 31/12/2017 for Flare #1</td></tr>
</table>
<table>
<tr><th colspan="2">Type: Diferential Pressure flow meter</th></tr>
<tr><td>Accuracy:</td><td>0.075%</td></tr>
<tr><td>Serial number:</td><td>3K646617002535</td></tr>
<tr><td>Calibration frequency:</td><td>49 months</td></tr>
<tr><td>Calibration Date:</td><td>26/01/2017</td></tr>
<tr><td>Validity</td><td>25/02/2021</td></tr>
<tr><td>Calibration Date:</td><td>12/12/2017</td></tr>
<tr><td>Validity</td><td>11/01/2022</td></tr>
<tr><td>Operation Period:</td><td>01/07/2017 to 31/12/2017 for Flare #2</td></tr>
</table></td></tr>
<tr><td>Measuring/reading/recording frequency</td><td>Measured continuously (average value in a time interval not greater than an hour) by the Annubar flow meter (pressure sensor and temperature sensor); data to be aggregated monthly.</td></tr>
<tr><td>Calculation method (if applicable)</td><td>NA</td></tr>
<tr><td>QA/QC procedures</td><td>To ensure the correct reading, the sensor shall be subject to a regular maintenance and calibration regime based on the manufacture’s recommended schedule.</td></tr>
<tr><td>Purpose of data/parameter</td><td>Calculation of baseline emissions.</td></tr>
<tr><td>Additional comments</td><td>Data will be kept for 2 years after end of crediting period.</td></tr>
</table>

Data/Parameter	**$w_{CH4,y}$**
Unit	m^3 CH_4 / m^3 LFG
Description	Methane fraction in the landfill gas

<table>
<tr><td>Measured/calculated/ default</td><td>Measured</td></tr>
<tr><td>Source of data</td><td>Measured by continuous gas quality analyzer.</td></tr>
<tr><td>Value(s) of monitored parameter</td><td>Please refer to the Table 2 in section H, and ER calculation spreadsheet</td></tr>
<tr><td>Monitoring equipment</td><td>One gas analizer model Ultramat 23, developed by SIEMENS is available on site.
<table>
<tr><th colspan="2">Type: gas analyzer</th></tr>
<tr><td>Accuracy:</td><td>±1%</td></tr>
<tr><td>Serial number:</td><td>N1F6765</td></tr>
<tr><td>Calibration frequency:</td><td>12 months</td></tr>
<tr><td>Calibration Date</td><td>31/08/2016</td></tr>
<tr><td>Validity</td><td>30/08/2017</td></tr>
<tr><td>Calibration Date:</td><td>02/08/2017</td></tr>
<tr><td>Validity:</td><td>01/08/2018</td></tr>
<tr><td>Calibration Date:</td><td>17/11/2017</td></tr>
<tr><td>Validity:</td><td>16/11/2018</td></tr>
<tr><td>Operation Period:</td><td>01/07/2017 to 03/10/2017 and 06/12/2017 to 31/12/2017</td></tr>
</table>
<table>
<tr><th colspan="2">Type: gas analyzer</th></tr>
<tr><td>Accuracy:</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>12/09/2017</td></tr>
<tr><td>Validity</td><td>11/09/2018</td></tr>
<tr><td>Operation Period:</td><td>03/10/2017 to 06/12/2017</td></tr>
</table></td></tr>
<tr><td>Measuring/reading/recording frequency</td><td>Measured continuously</td></tr>
<tr><td>Calculation method (if applicable)</td><td>NA</td></tr>
<tr><td>QA/QC procedures</td><td>To ensure accuracy, the gas analyzer shall be subjected to regular maintenance and calibration based on the manufacturer’s recommended schedule and procedures.</td></tr>
<tr><td>Purpose of data/parameter</td><td>Calculation of baseline emissions.</td></tr>
<tr><td>Additional comments</td><td>$w_{CH4,y}$ is considered to be equivalent to the variable $fv_{CH4,h}$ (volumetric fraction of the component CH_4 in the landfill gas in the hour h) as described in the “Tool to determine Project emissions from flaring gases containing methane”. Data will be kept for 2 years after end of crediting period.</td></tr>
</table>

Data/Parameter	**T_{flare}**
Unit	℃
Description	Temperature in the exhaust gas of the flare
Measured/calculated/ default	Measured
Source of data	Measured by continuous by thermocouple
Value(s) of monitored parameter	Please refer to ER calculation spreadsheet

<table>
<tr><td>Monitoring equipment</td><td>
There is one thermocouple type S M1.U07-S00-M0040.1-S20 developed by Elsi in the top of the flare #1
<table>
<tr><th colspan="2">Type: thermocouple type S</th></tr>
<tr><td>Accuracy:</td><td>±0.01% Full Range Input ± 0.05% Reading</td></tr>
<tr><td>Serial number:</td><td>E15TS0733</td></tr>
<tr><td>Calibration frequency:</td><td>365 days in continuous operation</td></tr>
<tr><td>Calibration Date:</td><td>11/08/2016</td></tr>
<tr><td>Start operation Date:</td><td>26/08/2016</td></tr>
<tr><td>Validity</td><td>25/08/2017</td></tr>
<tr><td>Operation Period:</td><td>01/07/2017 to 04/08/2017</td></tr>
</table>
<table>
<tr><th colspan="2">Type: thermocouple type S</th></tr>
<tr><td>Accuracy:</td><td>±0.01% Full Range Input ± 0.05% Reading</td></tr>
<tr><td>Serial number:</td><td>17595137</td></tr>
<tr><td>Calibration frequency:</td><td>365 days in continuous operation</td></tr>
<tr><td>Calibration Date:</td><td>11/04/2017</td></tr>
<tr><td>Start operation Date:</td><td>04/08/2017</td></tr>
<tr><td>Validity:</td><td>03/08/2018</td></tr>
<tr><td>Operation Period:</td><td>04/08/2017 to 31/12/2017</td></tr>
</table>
There is one thermocouple type k CM11-S-K developed by Roka in the top of the flare #2
<table>
<tr><th colspan="2">Type: thermocouple type K</th></tr>
<tr><td>Accuracy:</td><td>±2.5 or ±0.005(t)</td></tr>
<tr><td>Serial number:</td><td>70994</td></tr>
<tr><td>Calibration frequency:</td><td>365 days in continuous operation</td></tr>
<tr><td>Calibration Date:</td><td>22/02/2017</td></tr>
<tr><td>Start operation Date:</td><td>23/03/2017</td></tr>
<tr><td>Validity</td><td>22/03/2018</td></tr>
<tr><td>Operation Period:</td><td>01/07/2017 to 12/12/2017 for flare #2</td></tr>
</table>
<table>
<tr><th colspan="2">Type: thermocouple type K</th></tr>
<tr><td>Accuracy:</td><td>±2.5 or ±0.005(t)</td></tr>
<tr><td>Serial number:</td><td>9529/11</td></tr>
<tr><td>Calibration frequency:</td><td>365 days in continuous operation</td></tr>
<tr><td>Calibration Date:</td><td>12/12/2017</td></tr>
<tr><td>Start operation Date:</td><td>12/12/2017</td></tr>
<tr><td>Validity</td><td>11/12/2018</td></tr>
<tr><td>Operation Period:</td><td>12/12/2017 to 31/12/2017 for flare #2</td></tr>
</table>
</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>
</table>

QA/QC procedures	To ensure accuracy, the thermocouple shall be subjected to regular maintenance and calibration, based on the manufacturer's recommended schedule and procedures.
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	Parameter required to ensure adequate operation of the flare. Data will be kept for 2 years after end of crediting period.

Data/Parameter	$t_{O2,h}$
Unit	--
Description	Volumetric fraction of O_2 in the exhaust gas of the flare in the hour *h*
Measured/calculated/ default	Measured
Source of data	Measured by gas analyzer.
Value(s) of monitored parameter	Please refer to ER calculation spreadsheet
Monitoring equipment	One gas analyzer, model Ultramat 23 developed by SIEMENS, is available on the project site. Flare #1:

	Type: gas analyzer
Accuracy:	±1%
Serial number:	N1F6766
Calibration frequency:	12 months
Calibration Date:	31/08/2016
Validity:	30/08/2017
Calibration Date:	02/08/2017
Validity	01/08/2018
Operation Period:	01/07/2017 to 31/12/2017

And there is one gas analyser model F.E.A developed by LANDTEC for Flare#2.

	Type: gas analyzer
Accuracy:	0.1% + 1%
Serial number:	4857
Calibration frequency:	12 months
Calibration Date:	19/04/2017
Validity:	18/04/2018
Operation Period:	01/07/2017 to 31/12/2017

Measuring/reading/recording frequency	Measured continuously.
Calculation method (if applicable)	N/A
QA/QC procedures	To ensure accuracy, the gas analyzer shall be subjected to regular maintenance and calibration, based on the manufacturer's recommended schedule and procedures.
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	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

<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 in the hour h</td></tr>
<tr><td>Measured/calculated/ default</td><td>Measured</td></tr>
<tr><td>Source of data</td><td>Measured by continuous gas analyzer.</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>One gas analizer model Ultramat 23, developed by SIEMENS is available on site.
<table>
<tr><th colspan="2">Type: gas analyzer</th></tr>
<tr><td>Accuracy:</td><td>±1%</td></tr>
<tr><td>Serial number:</td><td>N1F6765</td></tr>
<tr><td>Calibration frequency:</td><td>12 months</td></tr>
<tr><td>Calibration Date</td><td>31/08/2016</td></tr>
<tr><td>Validity</td><td>30/08/2017</td></tr>
<tr><td>Calibration Date:</td><td>02/08/2017</td></tr>
<tr><td>Validity:</td><td>01/08/2018</td></tr>
<tr><td>Calibration Date:</td><td>17/11/2017</td></tr>
<tr><td>Validity:</td><td>16/11/2018</td></tr>
<tr><td>Operation Period:</td><td>01/07/2017 to 03/10/2017 and 06/12/2017 to 31/12/2017</td></tr>
</table>
<table>
<tr><th colspan="2">Type: gas analyzer</th></tr>
<tr><td>Accuracy:</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>12/09/2017</td></tr>
<tr><td>Validity</td><td>11/09/2018</td></tr>
<tr><td>Operation Period:</td><td>03/10/2017 to 06/12/2017</td></tr>
</table></td></tr>
<tr><td>Measuring/reading/recording frequency</td><td>Measured continuously</td></tr>
<tr><td>Calculation method (if applicable)</td><td>NA</td></tr>
<tr><td>QA/QC procedures</td><td>To ensure accuracy, the gas analyzer shall be subjected to regular maintenance and calibration, based on the manufacturer’s recommended schedule and procedures.</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.</td></tr>
</table>

Data/Parameter	**$FV_{RG,h}$**
Unit	m^3/h
Description	Volumetric flow rate of the residual gas in wet basis at normal (NTP) conditions in the hour h.
Measured/calculated/ default	Measured

<table>
<tr><td>Source of data</td><td>From project implementer, measured on site and aggregated hourly</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>There is one fixed Annubar flow meter from Simer installed before the flare. This equipment uses the differential pressure, that is read by a pressure sensor model 2600T developed by ABB to calculate the biogas flow.
<table>
<tr><th colspan="2">Type: Diferential Pressure flow meter</th></tr>
<tr><td>Accuracy:</td><td>0.075%</td></tr>
<tr><td>Serial number:</td><td>3K646615024640</td></tr>
<tr><td>Calibration frequency:</td><td>49 months</td></tr>
<tr><td>Calibration Date:</td><td>28/07/2016</td></tr>
<tr><td>Validity:</td><td>27/08/2020</td></tr>
<tr><td>Calibration Date:</td><td>04/08/2017</td></tr>
<tr><td>Validity</td><td>03/09/2021</td></tr>
<tr><td>Operation Period:</td><td>01/07/2017 to 31/12/2017 for Flare #1</td></tr>
</table>
<table>
<tr><th colspan="2">Type: Diferential Pressure flow meter</th></tr>
<tr><td>Accuracy:</td><td>0.075%</td></tr>
<tr><td>Serial number:</td><td>3K646617002535</td></tr>
<tr><td>Calibration frequency:</td><td>49 months</td></tr>
<tr><td>Calibration Date:</td><td>26/01/2017</td></tr>
<tr><td>Validity</td><td>25/02/2021</td></tr>
<tr><td>Calibration Date:</td><td>12/12/2017</td></tr>
<tr><td>Validity</td><td>11/01/2022</td></tr>
<tr><td>Operation Period:</td><td>01/07/2017 to 31/12/2017 for Flare #2</td></tr>
</table></td></tr>
<tr><td>Measuring/reading/recording frequency</td><td>Measured continuously (average value in a time interval not greater than an hour) by the Annubar flow meter (pressure sensor and temperature sensor); data to be aggregated monthly.</td></tr>
<tr><td>Calculation method (if applicable)</td><td>NA</td></tr>
<tr><td>QA/QC procedures</td><td>To ensure the correct reading, the sensor shall be subject to a regular maintenance and calibration regime based to the manufacture’s recommended schedule.</td></tr>
<tr><td>Purpose of data/parameter</td><td>Calculation of baseline emissions.</td></tr>
<tr><td>Additional comments</td><td>Data will be kept for 2 years after end of crediting period.</td></tr>
</table>

Data/Parameter	**$fv_{CH4,FG,h}$**
Unit	mg/m3
Description	Concentration of methane in the exhaust gas of the flare in wet basis at normal conditions in the hour h
Measured/calculated/ default	Measured
Source of data	Project Implementer
Value(s) of monitored parameter	Please refer to ER calculation spreadsheet

<table>
<tr><td>Monitoring equipment</td><td>One gas analyzer, model Ultramat 23 developed by SIEMENS, is available on the project site for Flare#1.
<table>
<tr><th colspan="2">Type: gas analyzer</th></tr>
<tr><td>Accuracy:</td><td>±1%</td></tr>
<tr><td>Serial number:</td><td>N1F6766</td></tr>
<tr><td>Calibration frequency:</td><td>12 months</td></tr>
<tr><td>Calibration Date:</td><td>31/08/2016</td></tr>
<tr><td>Validity:</td><td>30/08/2017</td></tr>
<tr><td>Calibration Date:</td><td>02/08/2017</td></tr>
<tr><td>Validity</td><td>01/08/2018</td></tr>
<tr><td>Operation Period:</td><td>01/07/2017 to 31/12/2017</td></tr>
</table>
And there is one gas analyser model F.E.A developed by LANDTEC for Flare#2.
<table>
<tr><th colspan="2">Type: gas analyser</th></tr>
<tr><td>Accuracy:</td><td>±[1ppm + 1%]</td></tr>
<tr><td>Serial number:</td><td>4857</td></tr>
<tr><td>Calibration frequency:</td><td>12 months</td></tr>
<tr><td>Calibration Date:</td><td>19/04/2017</td></tr>
<tr><td>Validity</td><td>18/04/2018</td></tr>
<tr><td>Operation Period:</td><td>01/07/2017 to 31/12/2017</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>

Data/Parameter	**$FC_{i,j,y}$**
Unit	m^3/y
Description	Quantity of biodiesel i combusted in process j during the year y
Measured/calculated/ default	On-site measurements
Source of data	On-site measurements
Value(s) of monitored parameter	Please refer to ER calculation spreadsheet
Monitoring equipment	Diesel generator
Measuring/reading/recording frequency	In this monitoring period has been used the fuel generator while the plant is not connected to the electricity grid. The volume mass is measured by the input by the biodiesel inside the equipment gallons.

Calculation method (if applicable)	N/A
QA/QC procedures	Equipment will be maintained in line with manufacture´s recommendations.
Purpose of data/parameter	Calculate project emission from fossil fuel combustion
Additional comments	Data will be kept for at least two years after the end of the crediting period

Data/Parameter	**$NCV_{i,y}$**
Unit	GJ/m^3
Description	Weighted average net calorific value of biodiesel i in year y
Measured/calculated/ default	Measured
Source of data	IPCC Guidelines (Table 1.2, Vol. 2) and Fuel Supplier
Value(s) of monitored parameter	46.71 GJ/m^3
Monitoring equipment	N/A
Measuring/reading/recording frequency	Monitored at each fuel delivery, from which weighted average annual values should be calculated.
Calculation method (if applicable)	N/A
QA/QC procedures	The value refers to the use of formula indicated by IPCC Guidelines. The density of the fuel was provided by the supplier. Values will be verified to check that they are within the uncertainty range of the IPCC default values as provided in Table 1.2, Vol. 2 of the 2006 IPCC Guidelines. If the values fall below this range collect additional information from the testing laboratory to justify the outcome or conduct additional measurements
Purpose of data/parameter	Required to calculate project emissions from fossil fuel combustion.
Additional comments	Following a conservative approach, it has been considered the maximum value of the IPCC Table 1.2, Vol.2, page 18 of the 2006 IPCC Guidelines for biodiesel as the diesel used contains a blend of diesel and biodiesel.

Data/Parameter	**$EF_{CO2,i,y}$**
Unit	tCO2/GJ
Description	Weighted average CO2 emission factor of biodiesel i in year y
Measured/calculated/ default	Measured
Source of data	If available, values provided by fuel supplier, but if not available then 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
Value(s) of monitored parameter	0.0843 was used considering the table 1.4 of IPCC Guidelines
Monitoring equipment	N/A
Measuring/reading/recording frequency	N/A
Calculation method (if applicable)	As per the “Tool to calculate project or leakage CO2 emissions from fossil fuel combustion” version 2.
QA/QC procedures	Will be checked against any future revision of IPCC Guidelines
Purpose of data/parameter	Calculation of project emissions.
Additional comments	For this monitoring period was used the IPCC default value. It was necessary to convert the units.

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 Implementer
Value(s) of monitored parameter	Please see additional comments below
Monitoring equipment	N/A Please refere to Aditional comments bellow
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)	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
QA/QC procedures	N/A
Purpose of data/parameter	**$EC_{PJ,y}$**
Additional comments	This equipment is not been used at the biogas plant. There was an implementation delay of the Electricity Meter equipment. While this equipment is not been installed at the biogas plant, the project has used a diesel generator to provide electricity. Because of this situation **$EC_{PJ,y}$** is considered as zero and project emissions from the generator are accounted in a conservative manner under the Project Emissions from fossil fuel combustion, **$PE_{FC,j,y}$**.

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 implementer
Value(s) of monitored parameter	Please refer to ER calculation spreadsheet
Monitoring equipment	Thermocouple and flow meter measurements (please refer to equipment described under T_{flare} and $LFG_{flare,y}$)
Measuring/reading/recording frequency	Monitored continuously

Calculation method (if applicable)	Data will be continuously measured to ensure that the flare/s 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: For Flare #1: Minimum temperature: 500°C Maximum temperature: 1,400°C Minimum flow rate: 500 Nm^3/h Maximum flow rate: 2,500 Nm^3/h For Flare #2: Minimum temperature: 500°C Maximum temperature: 1,093°C Minimum flow rate: 713.58 Nm^3/h Maximum flow rate: 2,998.7 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.

E.3. Implementation of sampling plan

>>
Not Applicable.

SECTION F. Calculation of emission reductions or net anthropogenic removals

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

>>
According to the baseline methodology ACM0001 - Version 11, Emissions Reductions 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/tCH_4
$EL_{LFG,y}$ = Net quantity of Electricity produced using LFG, which in the absence of the project activity would have been produced by power plants connected to the grid or by an 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 for each CPA 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 landfill gas projects as registered under this PoA. 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 CPAs. In addition the CPAs has not had any energy generation, therefore parameters $EL_{LFG,y}$ and $CEF_{elec,y}$ will not be considered further in the Baseline Emission Reduction calculation.

The methane destroyed by CPAs ($MD_{project,y}$) during a year is determined by monitoring the quantity of methane actually flared, sent to the natural as distribution grid, and used to generate electricity.

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 MDproject,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 CPAs did not use the methane to generate thermal energy, nor generate energy during this monitored period, and no gas has been sent to the natural gas distribution network, then $MD_{electricity,y}$ = 0, $MD_{thermal,y}$ = 0, and $MD_{PL,y}$ =0.

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^3CH_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 on a CPA, the $PE_{flare,y}$ shall be determined for each flare.

The CPAs under this PoA will implement enclosed flares. For enclosed flares, either of the following two options can be used to determine the flare efficiency:

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

b) Continuous monitoring of the methane destruction efficiency of the flare (flare efficiency) or 0% if the temperature in the exhaust gas of the flare (Tflare) is below 500 ℃ for more than 20 minutes during the hour h .

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

•0% if the temperature in the exhaust gas of the flare (T_{flare}) is below 500 ℃ for more than 20 minutes during the hour h .
•50%, if the temperature in the exhaust gas of the flare (T_{flare}) is above 500 ℃ for more than 40 minutes during the hour h, but the manufacturer's specifications on proper operation of the flare are not met at any point in time during the hour h.
•90%, if the temperature in the exhaust gas of the flare (T_{flare}) is above 500 ℃ 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.

In both cases for all CPAs, if there is no record of the temperature of the exhaust gas of the flare or if the recorded temperature is less than 500 ℃ for any particular hour, it shall be assumed that during that hour the flare efficiency is zero.

For both CPAs the flare efficiency is continuously monitored, following Option (b) of B.6.3 under the PoA. The data used to calculate the quantity of methane flared are uploaded every minute to a management program. The results of the amount of methane flared are aggregated on a monthly basis.

As there is no electricity generation, nor gas sent to the natural gas distribution network, in CPAs during this Monitored Period the amount of aggregated monthly data of methane flared is adopted as MDproject.

The final formula used to calculate the Baseline Emission for both CPAs is:

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

The following table shows the collected data, from the period 01/Jul/2017 to 31/Dec/2017.

Description / Date	Total amount of landfill gas captured	Amount of landfill gas flared	Methane fraction in the landfill gas	Quantity of methane captured	Quantities of methane fed to the flare	Quantity of methane destroyed by flaring	Amount of methane destroyed / combusted	Project Emissions from Flaring	Project Emissions from Electricity imported from the grid	Emission reductions from destroyed methane	Baseline Emissions	Emission Reductions
Parameter	$LFG_{total,y}$	$LFG_{flare,y}$	$W_{CH4,y}$	MD_{total}	MD_{flared}	$MD_{flared,y}$	$MD_{project,y}$	$PE_{flare,y}$	$PE_{EC,y}$	$MD_{project,y} * GWP_{CH4}$	BE_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
2017_07	10.250.911,6	10.250.911,6	51,9	3.811,1	3.811,1	3.798,8	3.798,8	305,6	54	94.970,8	94.970	94.916
2017_08	11.187.750,5	11.187.750,5	51,0	4.093,3	4.093,3	4.069,5	4.069,5	593,2	61	101.738,2	101.738	101.677
2017_09	11.168.543,7	11.168.543,7	51,0	4.079,2	4.079,2	4.055,7	4.055,7	588,4	61	101.392,2	101.392	101.331
2017_10	11.542.184,6	11.542.184,6	51,1	4.223,8	4.223,8	4.195,0	4.195,0	721,3	64	104.874,3	104.874	104.810
2017_11	10.825.615,4	10.825.615,4	51,4	3.979,5	3.979,5	3.920,8	3.920,8	1.467,1	62	98.019,5	98.019	97.957
2017_12	11.164.999,2	11.164.999,2	51,0	4.078,8	4.078,8	4.017,3	4.017,3	1.536,6	64	100.433,5	100.433	100.369
TOTAL	**66.140.005,1**	**66.140.005,1**	**51,2**	**24.265,6**	**24.265,6**	**24.057,1**	**24.057,1**	**5.212,2**	**366**	**601.428,6**	**601.426**	**601.060**

Table 1: CPA-1 Data Monitored (01/Jul/2017 to 31/Dec/2017)

Description / Date	Total amount of landfill gas captured	Amount of landfill gas flared	Methane fraction in the landfill gas	Quantity of methane captured	Quantities of methane fed to the flare	Quantity of methane destroyed by flaring	Amount of methane destroyed / combusted	Project Emissions from Flaring	Project Emissions from Fossil Fuel Combustion	Emission reductions from destroyed methane	Baseline Emissions	Emission Reductions
Parameter	$LFG_{total,y}$	$LFG_{flare,y}$	$W_{CH4,y}$	MD_{total}	MD_{flared}	$MD_{flared,y}$	$MD_{project,y}$	$PE_{flare,y}$	$PE_{FC,i,j,y}$	$MD_{project,y} * GWP_{CH4}$	BE_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
2017_07	2.171.251,0	2.171.251,0	51,9	806,4	806,4	791,3	791,3	377,8	43	19.781,3	19.781	19.738
2017_08	2.249.563,6	2.249.563,6	50,8	820,5	820,5	788,5	788,5	800,8	41	19.711,8	19.711	19.670
2017_09	2.264.659,8	2.264.659,8	51,8	840,8	840,8	819,4	819,4	533,3	49	20.486,1	20.486	20.437
2017_10	2.363.983,3	2.363.983,3	52,4	887,8	887,8	882,8	882,8	124,8	44	22.069,0	22.069	22.025
2017_11	2.516.781,5	2.516.781,5	53,0	956,6	956,6	940,6	940,6	399,2	45	23.514,9	23.514	23.469
2017_12	2.479.769,5	2.479.769,5	50,5	899,7	899,7	864,7	864,7	874,3	48	21.618,6	21.618	21.570
TOTAL	**14.046.008,6**	**14.046.008,6**	**51,7**	**5.211,7**	**5.211,7**	**5.087,3**	**5.087,3**	**3.110,2**	**270**	**127.181,7**	**127.179**	**126.909**

Table 2: CPA-2 Data Monitored (01/Jul/2017 to 31/Dec/2017)

Determination of $PE_{flare,y}$

When applying the tool to the CPAs, 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 (N2).

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

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/m3.
•$FV_{RG,h}$= Volumetric flow rate of the residual gas in dry basis at normal conditions in the hour h, m3/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.m3/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 CH4 and N2.

As per the tool, the project participant only measures the volumetric fraction of methane and considers the difference as 100% nitrogen (N_2). 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	Quantity of moles O_2 in the exhaust gas of the

	residual gas	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 the CPA because the combustion efficiency of the flare(s) 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 CPAs is enclosed flare with continuous monitoring.

In this case the flare efficiency in the hour h (ηflare,h) is

- 0% if the temperature in the exhaust gas of the flare (Tflare) is below 500 ℃ for more than 20 minutes during the hour *h* .
- determined as follows in cases where the temperature of the exhaust gas of the flare (Tflare) is above 500 ℃ for more than 40 minutes d uring 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 ℃ for more than 20 minutes during the hour *h* .
- 50%, if the temperature in the exhaust gas of the flare (Tflare) is above 500 ℃ 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 ℃ 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

F.2. Calculation of project emissions or actual net removals

>>

According to the baseline methodology ACM0001 - Version 11, Project Emissions for CPA-1 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 CPA-1 (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 CPAs under this PoA:

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

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 (tCO_2/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 $EF_{grid,OM,y}$ = 0.5882 (tCO_2/MWh) / $EF_{grid,BM,y}$ = 0.0028 (tCO_2/MWh) for 2017.

The information was collected from the website of the Brazilian Ministry of Science and Technology[6]. Following this procedure, the calculated value of the $EF_{EL,j,y}$ is 0.2955.

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*". These emissions are calculated as follows:

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

Where

$FC_{i,j,y}$	is the fossil fuel combusted of type i, in the process j, for the year y
$COEF_{i,y}$	is the CO_2 emission coefficient of the fossil fuel i

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

[6] http://www.mctic.gov.br/mctic/opencms/ciencia/SEPED/clima/arquivos/emissoes_co2/Despacho-2017.xlsx

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

Where
$NCV_{i,y}$ Is the weighted average net calorific value of the fuel type *i*
$EF_{CO2i,y}$ Is the weighted average CO_2 emission factor of fuel type *i*

During the period considered in this monitored report, PE for CPA-1 only origined from electricity consumption, while PE for CPA-2 only origined from fossil fuel consumption from the electricity generator. The tables below show the PE for each of the CPAs.

Table 3: Project Emissions from electricity consumption (CPA-1 only)

Parameter:	$EC_{PJ, j, y}$ (MW.h)		$EF_{EL,j,y}$	TDLj,y	$PE_{EC,y}$ (tCO2)	$PE_{EC,y}$ (tCO2)
Reference Year and Month YYYY_MM	Hour Meter Readings (kW.h) (A)	MWh used in the project (MW.h) (A+B)	Emission factor from electricity consumption of the project activity (tCO2/ MWh)	Average technical transmission and distribution losses for providing the electricity source j in year y	Project emissions from electricity consumption	Project emissions from electricity consumption Rounded Up
2017_07	150,017	150.02	0.2955	20%	53.19	54
2017_08	171,484	171.48	0.2955	20%	60.80	61
2017_09	169,933	169.93	0.2955	20%	60.25	61
2017_10	178,610	178.61	0.2955	20%	63.33	64
2017_11	173,919	173.92	0.2955	20%	61.67	62
2017_12	178,333	178.33	0.2955	20%	63.23	64
TOTAL	1,022,296.0	1022.30			362.48	366

To be conservative, the Project Emissions are rounded up for the final calculation of ERs

Table 4: Project Emissions from fossil fuel consumption (CPA-2 only)

Parameter:	$FC_{i,j,y}$		$NCV_{i,y}$	$EF_{CO2i,y}$	$COEF_{i,y}$	$PE_{FC,i,j,y}$ (tCO2)
Reference Year and Month YYYY_MM	Fuel Consumption (litres)	Fuel Consumption (m^3) = FCi,j,y	$NCV_{i,y}$ weighted average net calorific value of the fuel type i (LPG) in year y (GJ/m^3)	weighted average CO2 emission factor of fuel type i (LPG) in year y (tCO_2/GJ)	CO_2 emission Coefficient of LPG (tCO_2/m^3)	$PE_{FC, i, j, y}$ - Project emissions from fossil fuel combustion (tCO_2e)
2017_07	10,832	10.83	46.71	0.0843	3.9377	43.00
2017_08	10,179	10.18	46.71	0.0843	3.9377	41.00
2017_09	12,205	12.21	46.71	0.0843	3.9377	49.00
2017_10	10,966	10.97	46.71	0.0843	3.9377	44.00
2017_11	11,418	11.42	46.71	0.0843	3.9377	45.00
2017_12	12,073	12.07	46.71	0.0843	3.9377	48.00
TOTAL	67,673	67.67	-	-	-	270.00

To be conservative, the Project Emissions are rounded up for the final calculation of ERs

F.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.

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

CPA UNFCCC reference number	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
6573 - 0001	601,426	366	0	0	601,060	601,060
6573 - 0002	127,179	270	0	0	126,909	126,909
Total	728,605	636	0	0	727,969	727,969

F.5. Comparison of emission reductions or net anthropogenic removals achieved with estimates in the included CPA-DDs

CPA UNFCCC reference number	Amount achieved during this monitoring period (t CO_2e)	Amount estimated ex ante (t CO_2e)
6573 - 0001	601,060	489,657
6573 - 0002	126,909	99,823
Total	727,969	589,480

F.6. Remarks on increase in achieved emission reductions

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CPA-1

The emission reduction achieved in this period was ~20% higher than the amount estimated ex-ante because of the following reasons:

- This difference is mainly due to the use of the parameter GWP, which was 21 at the time of the estimative ex-ante calculation and actually is 25.
- Gas flow and CH4 content increase, slightly higher than usual, caused by the actual landfill operating layout, allowing wells on the top to be connected for gas extraction.

CPA-2

São Gonçalo's CPA-DD predicted to reduce baseline emissions for the year 2017 by 198,018 tCO2e. The Monitoring Report (MR) for the first half of this year ratified the volume of reductions in the amount of 95,380 tCO2e. In the second half of the year, the value determined by the respective MR was 126,909 tCO2e, a total volume of 222,289 tCO2e. This number is 12.26% higher than the ex-ante presented in the CPA-DD. This ratio seems to be quite reasonable considering that the operator has been investing in improving the operational management of the landfill and the gas capture efficiency, demonstrating increasing productivity in its results. Ex-ante estimates are conservative in that the volume of gas captured represents 50% of the total volume generated by the landfill. Already in the field practice of a well organized operation, the losses are much more modest, since they occur basically in the fronts of work. Proof of this is that in 2016 CTR São Gonçalo obtained a measured volume of 24,903,279 Nm^3, while ex-ante estimates pointed to 50% of 20,665,895 Nm^3, that is, 10,332,948 Nm^3 (see Appendix 2 - CAIXA CP-2 Sao Goncalo ER Calculations v5, at UNFCCC website).

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Document information

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