Monitoring report form for CDM project activity
(Version 07.0)

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

MONITORING REPORT		
Title of the project activity	Uberlândia landfills I and II	
UNFCCC reference number of the project activity	7110	
Version number of the PDD applicable to this monitoring report	04	
Version number of this monitoring report	01	
Completion date of this monitoring report	22/03/2021	
Monitoring period number	01 of 2nd Crediting Period	
Duration of this monitoring period	04/09/2019 – 02/03/2020	
Monitoring report number for this monitoring period	Not applicable	
Project participants	Energas Geracao de Energia Ltda. Limpebrás Resíduos Ltda. Asja Brasil Serviços para o Meio Ambiente Ltda. Numerco Limited	
Host Party	Brazil	
Applied methodologies and standardized baselines	ACM0001 – “Flaring or use of landfill gas” (version 18.1)	
Sectoral scopes	Sectoral scope 1 - Energy industries (renewable/non-renewable sources) Sectoral scope 13 - Waste handling and disposal	
Amount of GHG emission reductions or net anthropogenic GHG removals achieved by the project activity in this monitoring period	Amount achieved before 1 January 2013	Amount achieved from 1 January 2013
	0	36,867 tCO_2e
Amount of GHG emission reductions or net anthropogenic GHG removals estimated ex ante for this monitoring period in the PDD	62,968 tCO_2e	

SECTION A. Description of project activity

A.1. General description of project activity

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

The Project consists of a collection, transport and treatment system for landfill gas with production of electricity for self-consumption and incorporation to the national grid. Since the landfill gas major constituent is methane, whose GHG potential is 21 to 25 times the CO_2, the Project reduces the emission of GHG into the atmosphere by means of methane destruction in high temperature flare and electricity generation, and of displacement of electricity generated from fossil fuel sources.

Brief description of the installed technology and equipment

Uberlândia Landfill comprises two adjoining solid waste disposal sites (SWDS), named Landfill I and Landfill II, both owned by Limpebrás Resíduos Ltda. (Project Participant). The Landfill I started operating in July 1995 and stopped receiving waste in September 2010. The Landfill II started operating in October 2010 with approximately 18 years of lifetime. In this Project the Landfill I and the Landfill II were considered as a sole SDWS, since the area surrounding the two sites, including them, is owned and operated by Limpebrás Resíduos Ltda. and they are physically near enough to permit the joint operation. In fact, only a 27 m width road used exclusively for the landfilling operation separates the two sites, and the gas station and power plant of the project activity are installed on the roadside between the Landfill I and Landfill II.

The LFG is collected through vertical wells drilled in the waste mass or built during the waste landfilling (applicable for the Landfill II only) and is transported through a pipeline system connected to blowers towards the gas use section, where energy production and flare combustion sections are located.

Entering the gas use section, the LFG collected is treated from humidity and other impurities to be sent to the electricity generation sets and/or to the enclosed flare. The LFG preferably flows to the power house; therefore, the major part of the LFG collected is turned into electric energy. The enclosed flare section aims to safely combust the surplus of gas in case the LFG flow exceeds the maximum utilization capacity of the power house or it is in maintenance. Both uses leads to a complete destruction of the methane present in the LFG.

The electric energy produced from LFG is set both for the self-consumption of the plant and the supply to the grid. The total installed capacity of Project Activity was 1.426 MW composed by 1 single engine until 09/10/2012, when another identical engine was installed, so the plant came to operate with 2.852 MW of total installed capacity.

Relevant dates for the project activity

The Landfill I started operating in July of 1995 and stopped receiving waste in September 2010. During the 15 years of lifetime, it received around 2,100,000 tonnes of domestic waste, disposed in 150,000 m^2 of a total area of 300,000 m^2. The Landfill II started operating in October 2010 with 200,000 m^2 dedicated to disposal of waste, being able to receive till 4,500,000 m^3 of solid waste for an approximately 18 years of lifetime.

The Project's infrastructure construction started in May 2011 and the first LFG collection wells were drilled in the Landfill I by July 2011. The LFG aspiration and use for electricity generation and combustion in the enclosed flare started to be installed in August 2011. The flare combustion section became operational in January 2012, with 1 enclosed flare of 2,500 Nm^3/h of capacity.

The power plant was commissioned in February 2012 with 1 engine of 1.426 MW of installed capacity; it started operating in March 2012. In October 2012, a second 1.426 MW engine was added to the power plant which came to operate with 2.852 MW of total installed capacity from 09/10/2012 on.

Also in October 2012, the Project started to drill and connect LFG collection wells in the Landfill II.

CDM validation started in 23/06/2011, date of publication of the PDD in the UNFCCC's website for global stakeholder consultation, and was completed in 04/09/2012, registration date as CDM project activity with the reference number 7110. Only one previous CDM verification was conducted to date and CERs have been successfully issued on 16/10/2017.

Total emission reductions achieved in this monitoring period

In the monitoring period, from 04/09/2019 to 02/03/2020 (both dates included), the Project achieved 36,867 tCO2e.

A.2. Location of project activity

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Host Party(ies)

Brazil

Region/ State/ Province, etc.

Minas Gerais

City/ Town/ Community, etc.

Uberlândia

Physical/ Geographical location

The geographical coordinates of the Uberlândia Landfill are:
Latitude 18.878361° S
Longitude 48.318583° W

The figures below present the detailed location of the landfill:

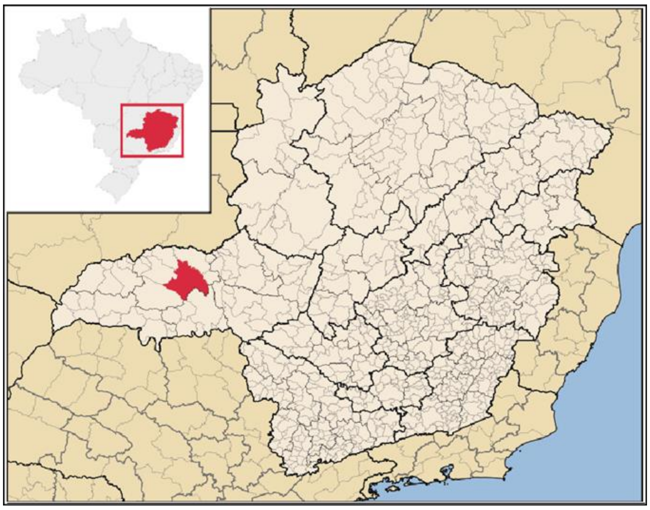

Figure 1 - Location of Minas Gerais State and Uberlândia.

Figure 2 - Location of the Landfill inside Uberlândia.

A.3. Parties and project participants

Parties involved	Project participants	Indicate if the Party involved wishes to be considered as project participant (Yes/No)
Brazil (host Party)	Energas Geracao de Energia Ltda. (Private entity) Limpebrás Resíduos Ltda. (Private entity) Asja Brasil Serviços para o Meio Ambiente Ltda. (Private entity)	No
Switzerland	Energas Geracao de Energia Ltda. (Private entity)	No
United Kingdom of Great Britain and Northern Ireland	Numerco Limited (Private entity)	No

A.4. References to applied methodologies and standardized baselines

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

- Large-scale Consolidated Methodology ACM0001: “Flaring or use of landfill gas” (Version 18.1)[1];
- TOOL04 Methodological tool: “Emissions from solid waste disposal sites” (Version 08.0)[2];
- TOOL05 Methodological tool: “Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation” (Version 03.0)[3];
- TOOL06 Methodological tool: “Project emissions from flaring” (Version 03.0)[4];
- TOOL08 Methodological tool: “Tool to determine the mass flow of a greenhouse gas in a gaseous stream” (Version 03.0)[5];
- TOOL09 Methodological tool: “Determining the baseline efficiency of thermal or electric energy generation systems” (Version 02.0)[6];
- TOOL10 Methodological Tool: “Tool to determine the remaining lifetime of equipment” (Version 01)[7];
- TOOL12 Methodological tool: “Project and leakage emissions from transportation of freight” (Version 01.1.0)[8];
- TOOL07 Methodological tool: “Tool to calculate the emission factor for an electricity system” (Version 07.0)[9];

[1] https://cdm.unfccc.int/methodologies/DB/Y88077XT5O83TZ2PYEZ36LFIAMAODR
[2] https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-04-v8.0.pdf
[3] https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-05-v3.0.pdf
[4] https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-06-v3.0.pdf
[5] https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-08-v3.0.pdf
[6] https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-09-v2.0.pdf
[7] https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-10-v1.pdf
[8] https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-12-v1.1.0.pdf
[9] https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-07-v7.0.pdf

- TOOL11 Methodological Tool: "Assessment of the validity of the original/current baseline and update of the baseline at the renewal of the crediting period" (Version 03.0.1)[10];
- TOOL02 Methodological tool: "Combined tool to identify the baseline scenario and demonstrate additionality" (Version 07.0)[11];
- TOOL03 Methodological tool: "Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion" (Version 03.0)[12].

A.5. Crediting period type and duration

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Choice of crediting period: 7 years and 0 months (renewable).
Crediting period from 04/09/2019 to 03/09/2026 (second period).

SECTION B. Implementation of project activity

B.1. Description of implemented project activity

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The Project's infrastructure construction started in May 2011 and the first LFG collection wells were drilled in the Landfill I by July 2011. The LFG aspiration and use for electricity generation and combustion in the enclosed flare started to be installed in August 2011. The flare combustion section became operational in January 2012, with 1 enclosed flare of 2,500 Nm^3/h of capacity. The power plant was commissioned in February 2012 with 1 engine of 1.426 MW of installed capacity; it started operating in March 2012. In October 2012, a second 1.426 MW engine was added to the power plant which came to operate with 2.852 MW of total installed capacity from 09/10/2012 on.

Also in October 2012, the Project started to drill and connect LFG collection wells in the Landfill II. The LFG preferably flows to the power house; therefore, the major part of the LFG collected is turned into electric energy. The enclosed flare section aims to safely combust the surplus of gas in case the LFG flow exceeds the maximum utilization capacity of the power house or it is in maintenance.

The project activity accomplished its CDM registration in 04/09/2012 with the reference number 7110. The first CDM/CER period for verification is from 04/09/2012 to 31/12/2015, both dates included. CERs were successfully issued on 16/10/2017. This monitoring report comprehends CERs generated during the 1st monitoring period of the second crediting period.

Events such planned and forced outages for change of equipment did not require corrective actions, since no emission reduction was claimed for the moments on which the plant was out of service. Normally, the changes of equipment are done using calibrated and certified devices and do not have impacts on the GHG emission reductions calculation. No emission reduction will be claimed for periods in which a failure in the equipment calibration program occurs.

All equipment exchanges during the present monitoring report are resumed on the table below; anyway, more detailed information was presented for each specific on the Section D.2. None of mentioned events impacts any applicability conditions stated in the applicable version the CDM methodology.

Table 1 – Equipment substitution during the monitored period.

Change date (dd/mm/yyyy)	Position at the plant	Old equipment serial number	New equipment serial number
10/02/2020	Flowmeter UG I	429085	411848

[10] https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-11-v3.0.1.pdf
[11] https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-02-v7.0.pdf
[12] https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-03-v3.pdf

10/02/2020	Flowmeter UG III	-	671684

B.2. Post-registration changes

B.2.1. Temporary deviations from the registered monitoring plan, applied methodologies, standardized baselines or other methodological regulatory documents

>>

Not applicable. This section is intentionally left blank.

B.2.2. Corrections

>>

Not applicable. This section is intentionally left blank.

B.2.3. Changes to the start date of the crediting period

>>

Not applicable. This section is intentionally left blank.

B.2.4. Inclusion of monitoring plan

>>

Not applicable. This section is intentionally left blank.

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

>>

Not applicable. This section is intentionally left blank.

B.2.6. Changes to project design

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In the first registered PDD of the 1st crediting period of the Project Activity, the indicative power output of the project activity was stated 2.8 MW, planned to be implemented in two phases; the first phase of 1.4 MW to occur in 2012 and the second phase of 1.4 MW in 2014.

During the 1st Crediting Period, a Post Registration Change was requested (PRC-7110-001)[13] and was approved on 19/02/2015. The request aimed at revising the power output and implementation schedule as follows: on March 2012, one generator of 1.426 MW was installed; and on October 2012, a second generator of 1.426 MW was installed, totalizing 2.852 MW of capacity.

B.2.7. Changes specific to afforestation or reforestation project activity

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Not applicable. This section is intentionally left blank.

SECTION C. Description of monitoring system

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

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

[13] https://cdm.unfccc.int/PRCContainer/DB/prcp470456806/view

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

1 DATA MONITORED

The monitoring procedures include:

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

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

2 DATA COLLECTED, FREQUENCY AND QUALITY CONTROL

Landfill gas flow:

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

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

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

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

Methane content in the landfill gas

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

The CH_4 analyzer is calibrated according to its calibration protocol.

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

Temperature of exhaust gas

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

The value of flare efficiency is correlated with the value of temperature of the exhaust gas. Flare efficiency is considered higher than zero only if the temperature in the exhaust gas is higher than 500°C for more than 40 minutes during the hour considered.

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

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

Electricity imported from and exported to power grid

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

Power Plant Working Hours

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

Emissions from flaring

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

Emission Factor

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

TDL

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

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

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

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

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

The regulatory requirement relating to LFG valid in the host country, contractual requirements, or requirements to address safety and odour concerns are monitored annually, in order to define the amount of methane in the LFG that would have been flared in the baseline.

<u>Possible failure: No electrical power</u>

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

The flow meter detects no landfill gas stream and does not count any CO_2e. No special actions are possible to avoid this.

3 MONITORING EQUIPMENT AND INSTALLATION

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

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

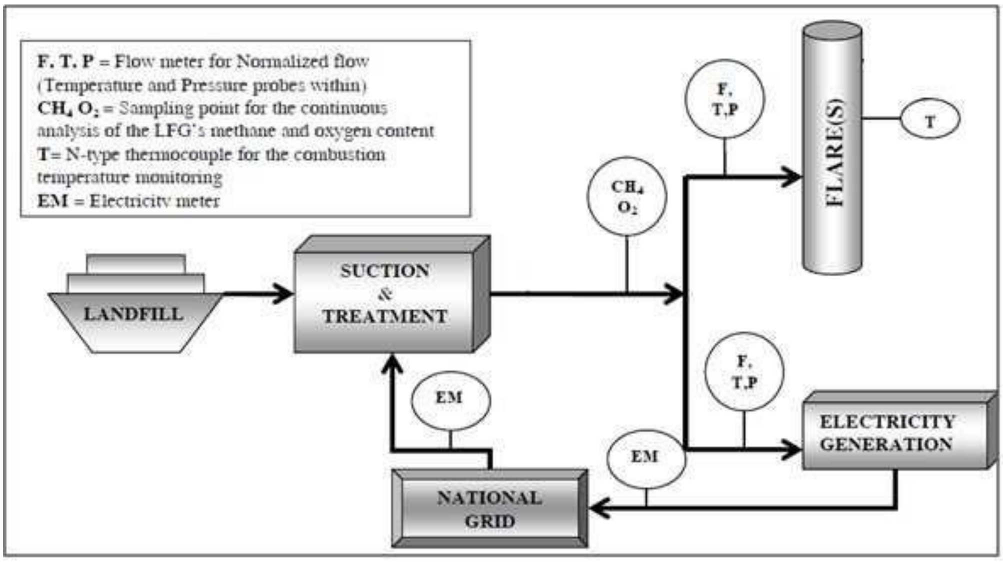

Figure 3 - Monitoring points.

4 CALCULATION OF THE AMOUNT OF ERs

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

5 MONITORING ORGANIZATION

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

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

– Emergency situation

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

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

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

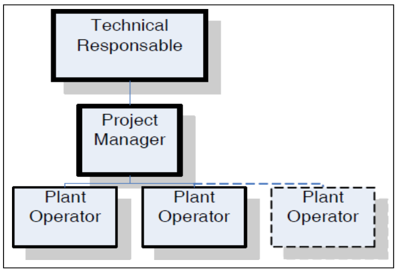

Figure 4 – Organization chart.

6 CALIBRATION

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

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

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

7 DATA MANAGEMENT SYSTEM

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

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

8 AUDIT REVIEW

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

SECTION D. Data and parameters

D.1. Data and parameters fixed ex ante

The following ex ante parameters, listed in the registered PDD, will not be used in this monitoring period and thus not presented in the tables below since have been not used in the calculation of emission reductions:

- Waste composition
- Efficiency of the LFG capture system that will be installed in the project activity (η_{PJ})
- Default value for model correction factor to account for model uncertainties ($\varphi_{default}$)
- Oxidation factor (reflecting the amount of methane from the considered SWDS that is oxidized in the soil (or other material covering the waste)) (OX)
- Fraction of methane in the SWDS gas (volume fraction) (F)
- Default value for the fraction of degradable organic carbon in MSW that decomposes in the SWDS ($DOC_{f,default}$)
- Fraction of methane captured at the SWDS and flared, combusted or used in another manner that prevents the emissions of methane to the atmosphere in year y (f_y)
- Methane correction factor ($MCF_{default}$)
- Fraction of degradable organic carbon in the waste type j (weight fraction) (DOC_j)
- Decay rate for waste type j (k_j)

Data/Parameter	OX_{top_layer}
Unit	Dimensionless
Description	Fraction of methane that would be oxidized in the top layer of the SWDS in the baseline
Source of data	Consistent with how oxidation is accounted for in the methodological tool “Emission from solid waste disposal sites”
Value(s) applied	0.1
Choice of data or measurement methods and procedures	Default value used, according to ACM0001
Purpose of data/parameter	Calculation of baseline emissions.
Additional comments	-

Data/Parameter	$EF_{grid,BM,y}$
Unit	tCO2/MWh
Description	Build margin emission factor of the Brazilian grid
Source of data	Brazilian DNA.
Value(s) applied	0.1370
Choice of data or measurement methods and procedures	The emission factor is calculated ex-ante, as described in B.6.3. of the registered PDD following the requirements of the “Tool to calculate the emission factor for an electricity system”.
Purpose of data/parameter	Calculation of baseline and project emissions.
Additional comments	-

Data/Parameter	GWP_{CH4}
Unit	t CO_2e/t CH_4
Description	Global warming potential of CH_4
Source of data	IPCC
Value(s) applied	25
Choice of data or measurement methods and procedures	Default value used, according to IPCC Fourth Assessment Report: Climate Change 2007, item 2.10.2: Direct Global Warming Potentials, Table 2.14.
Purpose of data/parameter	Calculation of baseline emissions.
Additional comments	-

Data/Parameter	R_u
Unit	Pa.m^3/kmol.K
Description	Universal ideal gases constant
Source of data	"*Tool to determine the mass flow of a greenhouse gas in a gaseous stream"*
Value(s) applied	8,314
Choice of data or measurement methods and procedures	Default value as per the applicable methodological tool.
Purpose of data/parameter	Calculation of baseline emissions.
Additional comments	-

<table>
<tr><td>Data/Parameter</td><td>$SPEC_{flare}$</td></tr>
<tr><td>Unit</td><td>Temperature - °C
Flow rate - Nm^3/h
Maintenance schedule - number of days</td></tr>
<tr><td>Description</td><td>Manufacturer’s flare specifications for temperature, flow rate and maintenance schedule</td></tr>
<tr><td>Source of data</td><td>Flare Manufacturer</td></tr>
<tr><td>Value(s) applied</td><td>
<table>
<tr><td>Flare model</td><td>2500 HT</td></tr>
<tr><td>Minimum flare temperature</td><td>850 ºC</td></tr>
<tr><td>Maximum flare temperature</td><td>1200 ºC</td></tr>
<tr><td>Minimum and maximum inlet flow rate</td><td>Minimum flow: 500 Nm^3/h *

Maximum flow: 2,500 Nm^3/h</td></tr>
<tr><td>Maximum duration in days between maintenance events</td><td>7 days[14]</td></tr>
</table>
</td></tr>
</table>

[14] The maximum duration in days between maintenance events has been chosen considering preventive maintenance program which defines the frequency for checking flare equipment situation every week.

Choice of data or measurement methods and procedures	Calculation of project emissions
Purpose of data/parameter	-
Additional comments	-

Data/Parameter	MM_i
Unit	kg/kmol
Description	Molecular mass of greenhouse gas i
Source of data	"Tool to determine the mass flow of a greenhouse gas in a gaseous stream"
Value(s) applied	<table><tr><td>Compound (i)</td><td>Structure</td><td>Molecular mass (kg / kmol)</td></tr><tr><td>Methane</td><td>CH_4</td><td>16.04</td></tr></table>
Choice of data or measurement methods and procedures	According to the applicable methodological tool.
Purpose of data/parameter	Calculation of baseline emissions.
Additional comments	-

Data/Parameter	MM_k
Unit	kg/kmol
Description	Molecular mass of gas *k*
Source of data	Tool to determine the mass flow of a greenhouse gas in a gaseous stream
Value(s) applied	<table><tr><td>Compound</td><td>Structure</td><td>Molecular mass (kg/kmol)</td></tr><tr><td>Nitrogen</td><td>N_2</td><td>28.01</td></tr></table>
Choice of data or measurement methods and procedures	According to "Tool to determine the mass flow of a greenhouse gas in a gaseous stream"
Purpose of data/parameter	Calculation of baseline emissions.
Additional comments	-

Data/Parameter	MM_{H2O}
Unit	kg/kmol
Description	Molecular mass of water
Source of data	Tool to determine the mass flow of a greenhouse gas in a gaseous stream
Value(s) applied	18.0152
Choice of data or measurement methods and procedures	According to "Tool to determine the mass flow of a greenhouse gas in a gaseous stream"
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	-

D.2. Data and parameters monitored

The following monitored parameters, listed in the registered PDD, will not be used in this monitoring period and thus not presented in the tables below since have been not used in the calculation of emission reductions:

- Average technical transmission and distribution losses for providing electricity to source j, in year y ($TDL_{j,y}$)

Data/Parameter	Management of SWDS
Unit	-
Description	Management of SWDS
Measured/calculated/ default	-
Source of data	- Original design of the landfill; - Technical specifications for the management of the SWDS;
Value(s) of monitored parameter	No modifications occurred during the monitored period.
Monitoring equipment	-
Measuring/reading/recording frequency	Annually
Calculation method (if applicable)	Project participants referred to the original design of the landfill to ensure that any practice to increase methane generation have been occurring prior to the implementation of the project activity Any change in the management of the SWDS after the implementation of the project activity should be justified by referring to technical or regulatory specifications.
QA/QC procedures	-
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	-

Data/Parameter	Status of biogas destruction device
Unit	-
Description	Operational status of biogas destruction devices
Measured/calculated/ default	Measured by Project Participant
Source of data	Flame detector
Value(s) of monitored parameter	-
Monitoring equipment	UV flame detector
Measuring/reading/recording frequency	Continuous
Calculation method (if applicable)	Not applicable
QA/QC procedures	-
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	-

Data/parameter:	$Maintenance_y$
Unit	Calendar dates
Description	Maintenance events completed in year y
Measured/calculated/default	-
Source of data	Project participants maintenance logs

Value(s) of monitored parameter	As per the applied maintenance practice for the project activity, general inspection services on the flares are performed daily. Performed maintenance and overhauling services in the flare are performed under by specialized technical service team under conformance with maintenance requirements for the flares (as established by equipment manufacturer) and as required by the ex-ante determined parameter SPECflare. Further details about the parameter SPECflare are included in Section D.1.
Monitoring equipment	Not applicable
Measuring/reading/recording frequency:	Daily
Calculation method (if applicable):	Not applicable
QA/QC procedures	Records must be kept in a maintenance log for two years beyond the life of the flare
Purpose of data/parameter	Calculation of baseline and project emissions when the flame is on[15].
Additional comments	Monitoring of this parameter is required for the case of enclosed flares and the project participant selects Option B to determine flare efficiency. These dates are required so that they can be compared to the maintenance schedule to check that maintenance events were completed within the minimum time between maintenance events specified by the manufacturer ($SPEC_{,flare}$).

Data/Parameter	$O_{pj,h}$
Unit	-
Description	Operation of the equipment that consumes the LFG
Measured/calculated/ default	Measured
Source of data	Measurements by Project participant using a device integrated with the operational software at the landfill gas plant.
Value(s) of monitored parameter	Please refer to the CERs calculation spreadsheet for the monitored parameters.
Monitoring equipment	Engine’s working hour counter meters
Measuring/reading/recording frequency	Monitoring frequency: continuous Recording frequency: every two minutes Aggregation frequency: hourly, daily, monthly

[15] When the maintenance is being carried out, neither baseline nor project emissions occurs since the LFG is not combusted and released to the atmosphere.

Calculation method (if applicable)	For each equipment unit j using the LFG monitor that the plant is operating in hour h by the monitoring any one or more of the following three parameters: (a) Temperature. Determine the location for temperature measurements and minimum operational temperature based on manufacturer's specifications of the burning equipment. Document and justify the location and minimum threshold in the PDD; (b) Flame. Flame detection system is used to ensure that the equipment is in operation; (c) Products generated. Monitor the generation of steam for the case of boilers and air-heaters and glass for the case of glass melting furnances. This option is not applicable to brick kilns. $Op_{j,h}$=0 when: (a) One of more temperature measurements are missing or below the minimum threshold in hour h (instantaneous measurements are made at least every minute); (b) Flame is not detected continuously in hour h (instantaneous measurements are made at least every minute); (c) No products are generated in the hour h. Otherwise, $Op_{j,h}$=1
QA/QC procedures	The calibration of this equipment is not applicable since it is a device integrated with the operational software at the landfill gas plant.
Purpose of data/parameter	Calculation of baseline emissions.
Additional comments	-

Data/Parameter	$V_{t,db}$
Unit	m^3/h
Description	Volumetric flow of the gaseous stream in time interval *t* on a dry basis
Measured/calculated/ default	Measured
Source of data	Flow meter
Value(s) of monitored parameter	Instant flow is continuously measured by a flow meter, one for the flare's feeding pipeline and one for each electricity generation equipment pipeline. Automatic measurement of the landfill gas temperature and pressure are made by probes connected to the flow meter. The flow is measured continuously in Nm3/h and data is aggregated hourly to summarize the Nm3 of LFG being delivered to the flaring and electricity generation sections, then monthly and yearly for reporting purposes. According to the Tool to determine the mass flow of a greenhouse gas in a gaseous stream, flow measurement on a dry basis is not doable for a wet gaseous stream. Therefore, it is necessary to demonstrate that the gaseous stream is dry by demonstrating that (one of the two options): a) The moisture content of the gaseous stream is less of equal to 0.05 kg H_2O/m^3 dry gas; or b) The temperature of the gaseous stream (T_t) is less than 60°C (333.15 K) at the flow measurement point. In the Project, the plant is design not to operate under temperatures greater than 60°C for security purposes; it is done through a temperature sensor installed at the hotter point of LFG pipeline, after the blowers. Please refer to the emission reductions calculation spreadsheet for the monitored values.

Monitoring equipment	Equipment used to monitor this parameter were manufactured by FCI and correspond to model ST 51 that possess an accuracy of +/- 1%. Specific information about the instruments used during the monitored period are detailed in a separate spreadsheet.
Measuring/reading/recording frequency	Monitoring frequency: continuous Recording frequency: every two minutes Aggregation frequency: hourly, daily, monthly
Calculation method (if applicable)	Not applicable.
QA/QC procedures	According to the manufacture' specifications, the flow meter requires external calibration every 18 months. The certificates applicable to the monitored parameters used during the monitored period are available with PPs and were provided to the DOE.
Purpose of data/parameter	Calculation of baseline emissions.
Additional comments	This parameter will be monitored in Option A of the tool "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" and applies for the determination of $F_{CH4,flared,y}$, $F_{CH4,EL,y}$ and $F_{CH4,NG,y}$.

Data/Parameter	$V_{t,wb}$
Unit	m^3/h
Description	Volumetric flow of the gaseous stream in time interval *t* on a wet basis
Measured/calculated/ default	Measured
Source of data	Flow meter
Value(s) of monitored parameter	Instant flow is continuously measured by a flow meter, one for the flare's feeding pipeline and one for each electricity generation equipment pipeline. Automatic measurement of the landfill gas temperature and pressure are made by probes connected to the flow meter. The flow is measured continuously in Nm^3/h and data is aggregated hourly to summarize the Nm3 of LFG being delivered to the flaring and electricity generation sections, then monthly and yearly for reporting purposes. According to the Tool to determine the mass flow of a greenhouse gas in a gaseous stream, flow measurement on a dry basis is not doable for a wet gaseous stream. Therefore, it is necessary to demonstrate that the gaseous stream is dry by demonstrating that (one of the two options): a) The moisture content of the gaseous stream is less of equal to 0.05 kg H_2O/m^3 dry gas; or b) The temperature of the gaseous stream (T_t) is less than 60°C (333.15 K) at the flow measurement point. In the Project, the plant is design not to operate under temperatures greater than 60°C for security purposes; it is done through a temperature sensor installed at the hotter point of LFG pipeline, after the blowers. Please refer to the emission reductions calculation spreadsheet for the monitored values.
Monitoring equipment	Equipment used to monitor this parameter were manufactured by FCI and correspond to model ST 51 that possess an accuracy of +/- 1%. Specific information about the instruments used during the monitored period are detailed in a separate spreadsheet.
Measuring/reading/recording frequency	Monitoring frequency: continuous Recording frequency: every two minutes Aggregation frequency: hourly, daily, monthly
Calculation method (if applicable)	Not applicable.
QA/QC procedures	According to the manufacture' specifications, the flow meter requires external calibration every 18 months. The certificates applicable to the monitored parameters used during the monitored period are available with PPs and were provided to the DOE.
Purpose of data/parameter	Calculation of baseline emissions.

Additional comments	This parameter will be monitored in Options B and C of the tool "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" and applies for the determination of $F_{CH4,flared,y}$, $F_{CH4,EL,y}$ and $F_{CH4,NG,y}$.

Data/Parameter	$v_{i,t,db}$
Unit	m^3 gas *i*/m^3 dry gas
Description	Volumetric fraction of greenhouse gas *i* in a time interval *t* in a dry basis
Measured/calculated/ default	Measured
Source of data	Continuous gas analyzer
Value(s) of monitored parameter	Please refer to the emission reductions calculation spreadsheet for the monitored values.
Monitoring equipment	Brand: Siemens Type: Ultramat 23 Accuracy: +/-1% for the CH_4 and 0.5% for the O_2 Serial Number: N1B8759
Measuring/reading/recording frequency	Monitoring frequency: continuous Recording frequency: every two minutes Aggregation frequency: hourly, daily, monthly
Calculation method (if applicable)	Not applicable.
QA/QC procedures	The supplier of the methane analyzer recommends calibrating the instrument every six or twelve months depending on the application. However, it has been decided to perform the calibration on a monthly basis in order to get a more conservative measure. The methane analyzer is calibrated every month by a trained plant operator and supervised by the Project Manager (PM). The plant operator applies the calibration procedure suggested by the manufacturer which is documented within the Plant Maintenance Manual. The internal calibration is registered on the respective form: "Formulario de calibração analisador fixo de biogás" – FO CAL/002. The plant operator and the PM have been trained in order to be qualified to carry out the calibration procedure correctly. All the training certificates are available at the plant. The process for calibration is performed by use of gas cylinders which are purchased from a certified gas supplier. The cylinders have a quality certificate that assures the quality of the calibration gases. The certificates applicable to the monitored period are available with PPs and were provided to the DOE.
Purpose of data/parameter	Calculation of baseline emissions.
Additional comments	This parameter will be monitored in Options B and E and may be monitored in Options A and D of the tool "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" (Version 03.0) and applies for the determination of $F_{CH4,flared,y}$, $F_{CH4,EL,y}$ and $F_{CH4,NG,y}$.

Data/Parameter	$v_{i,t,wb}$
Unit	m^3 gas *i*/m^3 wet gas
Description	Volumetric fraction of greenhouse gas *i* in a time interval *t* in a wet basis
Measured/calculated/ default	Measured
Source of data	Continuous gas analyzer
Value(s) of monitored parameter	Please refer to the emission reductions calculation spreadsheet for the monitored values.

Monitoring equipment	Brand: Siemens Type: Ultramat 23 Accuracy: +/-1% for the CH_4 and 0.5% for the O_2 Serial Number: N1B8759
Measuring/reading/recording frequency	Monitoring frequency: continuous Recording frequency: every two minutes Aggregation frequency: hourly, daily, monthly
Calculation method (if applicable)	Not applicable.
QA/QC procedures	The supplier of the methane analyzer recommends calibrating the instrument every six or twelve months depending on the application. However, it has been decided to perform the calibration on a monthly basis in order to get a more conservative measure. The methane analyzer is calibrated every month by a trained plant operator and supervised by the Project Manager (PM). The plant operator applies the calibration procedure suggested by the manufacturer which is documented within the Plant Maintenance Manual. The internal calibration is registered on the respective form: “Formulario de calibração analisador fixo de biogás” – FO CAL/002. The plant operator and the PM have been trained in order to be qualified to carry out the calibration procedure correctly. All the training certificates are available at the plant. The process for calibration is performed by use of gas cylinders which are purchased from a certified gas supplier. The cylinders have a quality certificate that assures the quality of the calibration gases. The certificates applicable to the monitored period are available with PPs and were provided to the DOE.
Purpose of data/parameter	Calculation of baseline emissions.
Additional comments	This parameter will be monitored in Options C and F and may be monitored in Options A and D of the “Tool to determine the mass flow of a greenhouse gas in a gaseous stream” (Version 03.0) and applies for the determination of $F_{CH4,flared,y}$, $F_{CH4,EL,y}$ and $F_{CH4,NG,y}$.

Data/Parameter	T_t
Unit	°C
Description	Temperature of the gaseous stream in time interval t
Measured/calculated/ default	Measured
Source of data	Temperature sensor
Value(s) of monitored parameter	Please refer to the emission reductions calculation spreadsheet for the monitored values.
Monitoring equipment	Measured continuously with temperature sensor installed at the hottest point of the LFG pipeline, just after the blowers, to ensure that the applicability condition related to the gaseous stream flow temperature being below 60°C is met. The equipment used is manufactured by Ecil and correspond to model Pt-100, which possesses an accuracy of 0.15 ºC + 0.002*T.
Measuring/reading/recording frequency	Monitoring frequency: continuous Recording frequency: every two Minutes Aggregation frequency: hourly, daily, monthly
Calculation method (if applicable)	Not applicable.
QA/QC procedures	External calibration is applied to this equipment annually. Calibration certificates applicable to the monitored period are available with PPs and were provided to the DOE.
Purpose of data/parameter	Calculation of baseline emissions.
Additional comments	As all parameters are converted to normal conditions during the monitoring process, this parameter is needed exclusively to monitor the temperature of the gaseous stream as demanded in the methodology applicability condition.

Data/Parameter	P_t
Unit	Pa
Description	Pressure of the gaseous stream in time interval t
Measured/calculated/ default	Measured.
Source of data	Measurements by Project participant using a pressure meter
Value(s) of monitored parameter	Please refer to the CER calculation spreadsheet for the monitored values.
Monitoring equipment	Pressure meter
Measuring/reading/recording frequency	Continuous
Calculation method (if applicable)	Not applicable.
QA/QC procedures	External calibration is applied to this equipment in accordance with the periodicity indicated by the manufacturer. Calibration certificates applicable to the monitored period are available with PPs and were provided to the DOE.
Purpose of data/parameter	Calculation of baseline emissions.
Additional comments	Provided all parameters are converted to normal conditions during the monitoring process, this parameter may not be needed except for moisture content determination and therefore it should be metered only when performing such measurements (with same frequency).

Data/Parameter	$P_{H2O,t,Sat}$
Unit	Pa
Description	Saturation pressure of H_2O at temperature T_t in time interval t
Measured/calculated/ default	-
Source of data	Provided by project participants
Value(s) of monitored parameter	-
Monitoring equipment	-
Measuring/reading/recording frequency	-
Calculation method (if applicable)	This parameter is solely a function of the gaseous stream temperature Tt and can be found at reference [1] for a total pressure equal to 101,325 Pa.
QA/QC procedures	-
Purpose of data/parameter	Calculation of baseline emissions.
Additional comments	[1] Fundamentals of Classical Thermodynamics; Gordon J. Van Wylen, Richard E. Sonntag and Borgnakke; 4º Edition 1994, John Wiley & Sons, Inc.

Data/Parameter	$Flame_m$
Unit	Flame on or Flame off
Description	Flame detection of flare in the minute m
Measured/calculated/ default	Measured
Source of data	Project Participant
Value(s) of monitored parameter	Please refer to the CER calculation spreadsheet for the monitored values.
Monitoring equipment	Measurements by project participants using a continuous Ultra Violet flame detector
Measuring/reading/recording frequency	Once per minute. Detection of flame recorded as a minute that the flame was on, otherwise recorded as a minute that the flame was off

Calculation method (if applicable)	-
QA/QC procedures	Equipment is maintained and calibrated in accordance with manufacturer's recommendations. Certificates applicable to the monitored period are available with PPs and were provided to the DOE.
Purpose of data/parameter	Calculation of baseline and project emissions when the flame is on.
Additional comments	When the flame is off, neither baseline nor project emissions occurs since the LFG is not combusted and instead released to the atmosphere

Data/Parameter	$T_{EG,m}$
Unit	°C
Description	Temperature in the exhaust gas of the enclosed flare in minute m
Measured/calculated/ default	Measured
Source of data	Type S thermocouple
Value(s) of monitored parameter	Please refer to the emission reductions calculation spreadsheet for the monitored values.
Monitoring equipment	Equipment used were manufactured by Ecil and correspond to thermocouples that withstands temperatures up to 1,600°C. The accuracy class of the instruments are of +/-1.5ºC or 0.25% of the temperature (the one which is greater).
Measuring/reading/recording frequency	Monitoring frequency: continuous Recording frequency: every two minutes Aggregation frequency: hourly, daily, monthly
Calculation method (if applicable)	Not applicable.
QA/QC procedures	External calibration is applied to this equipment annually. Calibration certificates applicable to the monitored period are available with PPs and were provided to the DOE.
Purpose of data/parameter	Calculation of project emissions.
Additional comments	-

Data/Parameter	$EC_{BL,k,y}$
Unit	MWh/yr
Description	Amount of electricity generated using LFG by the project activity in year y
Measured/calculated/ default	Measured
Source of data	Electricity meter
Value(s) of monitored parameter	Please refer to the CERs calculation spreadsheet for the monitored parameter.

Monitoring equipment	Data measured continuously with an electricity meter specifying the total amount of electricity exported in the time interval. In accordance with the local energy concessionaire CEMIG specifications, the electricity meter do not need regular maintenance to ensure its accuracy. The equipment has an accuracy of +/- 0.2%. Main Electricity Meter **Brand and type:** Schneider ION 8600C **Serial nº of equipment:** PT-1104A085-1 **Calibration frequency:** none **Calibration date [dd/mm/yyyy]:** 16/11/2011 **Calibration certificate nº:** CCM-210/2011 Standby Electricity Meter **Brand and type:** Schneider ION 8600C **Serial nº of equipment:** PT-1103B220-01 **Calibration frequency:** none **Calibration date [dd/mm/yyyy]:** 16/11/2011 **Calibration certificate nº:** CCM-211/2011
Measuring/reading/recording frequency	Monitoring frequency: continuous Recording and aggregation frequency: monthly (CEMIG's invoices emission frequency)
Calculation method (if applicable)	Not applicable.
QA/QC procedures	Electricity meter belongs to CEMIG, which is responsible for its maintenance.
Purpose of data/parameter	Calculation of baseline emissions.
Additional comments	Data will be archived electronically during the crediting period and two years after.

Data/Parameter	$EF_{grid,CM,y}$
Unit	tCO_2 /MWh
Description	CO_2 emission factor of the Brazilian grid electricity during the year y
Measured/calculated/ default	Calculated
Source of data	The data used to calculate the grid emission factor was taken from the Brazilian DNA[16].
Value(s) of monitored parameter	2019: 0.2323 tCO_2/MWh 2020: 0.2162 tCO_2/MWh
Monitoring equipment	Not applicable.
Measuring/reading/recording frequency	Annually.
Calculation method (if applicable)	The emission factor is calculated ex-post, as the weighted average of the dispatch data analysis OM (Operating Margin) and the BM (Build margin), as described in B.6.3. of the registered PDD
QA/QC procedures	Apply procedures in the "Tool to calculate the emission factor for an electricity system
Purpose of data/parameter	Calculation of baseline emissions.
Additional comments	-

Data/Parameter	$EF_{grid,OM,y}$
Unit	tCO_2 /MWh
Description	Operating margin emission factor of the Brazilian grid
Measured/calculated/ default	Calculated

[16] http://www.mct.gov.br (Accessed in 09/03/2021).

Source of data	The data used to calculate the grid emission factor was taken from the Brazilian DNA[17].
Value(s) of monitored parameter	2019: 0.5181 tCO_2/MWh 2020: 0.4536 tCO_2/MWh
Monitoring equipment	Not applicable.
Measuring/reading/recording frequency	Annually.
Calculation method (if applicable)	Not applicable. Data provided by the Brazilian DNA.
QA/QC procedures	Apply procedures in the "Tool to calculate the emission factor for an electricity system
Purpose of data/parameter	Calculation of baseline emissions.
Additional comments	-

Data/Parameter	$TDL_{k,y}$
Unit	-
Description	Average technical transmission and distribution losses for providing electricity to source k in year *y*
Measured/calculated/ default	Default
Source of data	TOOL05 – "Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation"
Value(s) of monitored parameter	20%
Monitoring equipment	Not applicable.
Measuring/reading/recording frequency	Annually. In the absence of data from the relevant year, most recent figures should be used, but not older than 5 years.
Calculation method (if applicable)	Please refer to the Section E.1 of this document.
QA/QC procedures	Internal Audits are going to be performed in order to ensure correct monitoring of this parameter.
Purpose of data/parameter	Calculation of baseline emissions and project emissions.
Additional comments	According to Option 2: default value as 20% from TOOL05 – "Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation". In the case of the project, $TDL_{k,y}$ = $TDL_{j,y}$.

Data/Parameter	$EC_{PJ, j, y}$
Unit	MWh
Description	Quantity of electricity consumed by the project electricity consumption source *j* in year *y*
Measured/calculated/ default	Measured
Source of data	Electricity meter
Value(s) of monitored parameter	Please refer to the CERs calculation spreadsheet for the monitored values.

[17] http://www.mct.gov.br (Accessed in 09/03/2021).

Monitoring equipment	Data measured continuously with an electricity meter specifying the total amount of electricity exported in the time interval. In accordance with the local energy concessionaire CEMIG specifications, the electricity meter do not need regular maintenance to ensure its accuracy. The equipment has an accuracy of +/- 0.2%. Main Electricity Meter **Brand and type:** Schneider ION 8600C **Serial nº of equipment:** PT-1104A085-1 **Calibration frequency:** none **Calibration date [dd/mm/yyyy]:** 16/11/2011 **Calibration certificate nº:** CCM-210/2011 Standby Electricity Meter **Brand and type:** Schneider ION 8600C **Serial nº of equipment:** PT-1103B220-01 **Calibration frequency:** none **Calibration date [dd/mm/yyyy]:** 16/11/2011 **Calibration certificate nº:** CCM-211/2011
Measuring/reading/recording frequency	Monitoring frequency: continuous Recording and aggregation frequency: monthly (CEMIG's invoices emission frequency)
Calculation method (if applicable)	Not applicable.
QA/QC procedures	Electricity meter belongs to CEMIG, which is responsible for its maintenance.
Purpose of data/parameter	Calculation of project emissions.
Additional comments	Data will be archived electronically during the crediting period and two years after

D.3. Implementation of sampling plan

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Not Applicable. This section is intentionally left in blank.

SECTION E. Calculation of emission reductions or net anthropogenic removals

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

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The table below shows the baseline emissions calculated for the current monitoring period.

	BE,y	BEEC,y	BECH4,y	FCH4PJ,y	FCH4BL,y	FCH4flared,y	FCH4EL,y	% CH4	FCH4 sentflare,y	ECBL	Total methane for Group generators	Total methane to Flare	FCH4RG,t	PEflare,y
	tCO2	tCO2	tCO2	tCH4	tCH4	tCH4	tCH4	%	tCH4	MWh	Nm³CH4	Nm³CH4	kg	tCO2
From 04/09/2019	2,656	211	2,445	111	2	0.0	111	40.0%	11.0	735	154,742	15,339	10,983	274
10/2019	5,134	241	4,893	222	4	2.3	219	47.0%	104.6	840	306,498	146,048	104,570	2,556
11/2019	4,959	199	4,760	216	4	48.4	167	48.2%	173.9	693	233,819	242,847	173,879	3,138
12/2019	7,253	447	6,806	309	5	14.3	294	50.4%	26.6	1,555	410,993	37,121	26,578	308
01/2020	9,600	495	9,105	413	7	0.8	412	49.0%	92.7	1,725	575,265	129,448	92,685	2,296
02/2020	6,701	451	6,249	283	5	2.4	281	48.8%	151.4	1,572	392,256	211,498	151,433	3,725
Until 02/03/2020	568	36	532	24	0	0.0	24	50.7%	5.7	125	33,677	7,961	5,700	142

The baseline emission was calculated according to the following formula:

$$BE_y = BE_{CH4,y} + BE_{EC,y} + BE_{HG,y} + BE_{NG,y}$$

Where:

BE_y = Baseline emissions in year *y* (t CO_2e/yr)
$BE_{CH4,y}$ = Baseline emissions of methane from the SWDS in year *y* (t CO_2e/yr)
$BE_{EC,y}$ = Baseline emissions associated with electricity generation in year *y* (t CO_2/yr)

$BE_{HG,y}$ = Baseline emissions associated with heat generation in year *y* (t CO_2/yr)
$BE_{NG,y}$ = Baseline emissions associated with natural gas use in year *y* (t CO_2/yr)

As the project flares LFG and generates electricity, the $BE_{HG,y} = 0$ and $BE_{NG,y} = 0$.

Therefore, $BE_y = BE_{CH4,y} + BE_{EC,y}$

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

$$BE_{CH4} = \left(\left(1 - OX_{top\_layer}\right) \times F_{CH4,PJ,y} - F_{CH,BL,y}\right) \times GWP_{CH4}$$

Where:

$BE_{CH4,y}$ = Baseline emissions of LFG from the SWDS in year *y* (t CO_2e/yr)
OX_{top_layer} = Fraction of methane in the LFG that would be oxidized in the top layer of the SWDS in the baseline (dimensionless)
$F_{CH4,PJ,y}$ = Amount of methane in the LFG which is flared and/or used in the project activity in year *y* (t CH_4/yr)
$F_{CH4,BL,y}$ = Amount of methane in the LFG that would be flared in the baseline in year *y* (t CH_4/yr)
GWP_{CH4} = Global warming potential of CH_4 (t CO_2e/t CH_4)

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

During the crediting period, the $\mathbf{F_{CH4,PJ,y}}$ will be determined as follows:

$$F_{CH4,PJ,y} = F_{CH4,flared,y} + F_{CH4,EL,y} + F_{CH4,HG,y} + F_{CH4,NG,y}$$

Where:

$F_{CH4,PJ,y}$ = Amount of methane in the LFG which is flared and/or used in the project activity in year y (tCH_4/yr)
$F_{CH4,flared,y}$ = Amount of methane in the LFG which is destroyed by flaring in year y (t CH_4/yr)
$F_{CH4,EL,y}$ = Amount of methane in the LFG which is used for electricity generation in year y (t CH_4/yr)
$F_{CH4,HG,y}$ Amount of methane in the LFG which is used for heat generation in year y (t CH_4/yr)
$F_{CH4,NG,y}$ = Amount of methane in the LFG which is sent to the natural gas distribution network and/or dedicated pipeline and/or to the trucks in year y (t CH_4/yr)

As the project flares LFG and generates electricity, the $F_{CH4,HG,y} = 0$ and $F_{CH4,NG,y.} = 0$. Thus, the equation is:

$$F_{CH4,PJ,y} = F_{CH4,flared,y} + F_{CH4,EL,y}$$

$F_{CH4,EL,y}$ is determined using the “Tool to determine the mass flow of a greenhouse gas in a gaseous stream” and monitoring the working hours of the power plant(s), boiler(s), air heater(s), glass melting furnace(s) and kiln(s), so that no emission reduction are claimed for methane destruction during non-working hours. This is taken into account by monitoring the hours that the equipment utilizing the LFG is operating in year *y* ($Op_{j,h,y}$).

The following requirements apply:

a. As per the gaseous stream tool, if the LFG is used for multiple purposes (e.g. flaring or energy generation), and all methane destruction devices are verified to be operational (e.g.

by means of flame detectors records, energy generated), a single flow meter may be used to record the flow into multiple destruction devices. The destruction efficiency of the least efficient among the destruction devices shall be used as the destruction efficiency for all destruction devices monitored by this flow meter. If there are any periods for which one or more destruction devices are not operational, paragraph 5 (a) and (b) of the Appendix of the "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" tool shall be followed;

b. CH_4 is the greenhouse gas for which the mass flow should be determined;

c. The simplification offered for calculating the molecular mass of the gaseous stream is valid (equations (3) or (17) in the tool);

d. The mass flow should be calculated on an hourly basis for each hour *h* in year *y*;

e. The mass flow calculated for hour *h* is 0 if the equipment is not working in hour *h* ($Op_{j,h}$=not working), the hourly values are then summed to a yearly unit basis.

The amount of methane destroyed by flaring ($F_{CH4,flared,y}$) will be determined as follows:

$$F_{CH4,flared,y} = F_{CH4,sent\_flare,y} - \frac{PE_{flare,y}}{GWP_{CH4}}$$

Where:

$F_{CH4,flared,y}$	=	Amount of methane in the LFG which is destroyed by flaring in year y (t CH_4/yr)
$F_{CH4,sent\_flare,y}$	=	Amount of methane in the LFG which is sent to the flare in year y (t CH_4/yr)
$PE_{flare,y}$	=	Project emissions from flaring of the residual gas stream in year y (t CO_2e/yr)
GWP_{CH4}	=	Global warming potential of CH_4 (t CO_2e/t CH_4)

$F_{CH4,sent\_flare,y}$ will be determined directly using the “Tool to determine the mass flow of a greenhouse gas in a gaseous stream”, applying the requirements described below. The tool shall be applied to the gaseous stream flowing in the LFG delivery pipeline to each flare.

According to “Tool to determine the mass flow of a greenhouse gas in a gaseous stream” the following options will be considered for the present project activity:

- Option A (Volume flow in dry basis and volumetric fraction in dry basis) when the temperature of the gaseous stream is less than 60ºC (333.15 K) at the flow measurement point

  And

- Option B (Volume flow in wet basis and volumetric fraction in dry basis) when the temperature of the gaseous stream is higher than 60ºC (333.15 K) at the flow measurement point.

Option A

Flow measurement on a dry basis is not doable for a wet gaseous stream. Therefore, it is necessary to demonstrate that the gaseous stream is dry to use this option. The demonstration will be made as following:

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

The mass flow of greenhouse gas i ($F_{i,t}$) is determined as follows:

$$F_{i,t} = V_{t,db} * v_{i,t,db} * \rho_{i,t}$$

With

$$\rho_{i,t} = \frac{P_t * MM_i}{R_u * T_t}$$

Where:
$F_{i,t}$ = Mass flow of greenhouse gas *i* in the gaseous stream in time interval *t* (kg gas/h)
$V_{t,db}$ = Volumetric flow of the gaseous stream in time interval *t* on a dry basis (m^3 dry gas/h)
$v_{i,t,db}$ = Volumetric fraction of greenhouse gas *i* in the gaseous stream in a time interval *t* on a dry basis (m^3 gas *i*/m^3 dry gas)
$\rho_{i,t}$ = Density of greenhouse gas i in the gaseous stream in time interval *t* (kg gas *i*/m^3 gas *i*)
P_t = Absolute pressure of the gaseous stream in time interval *t* (Pa)
MM_i = Molecular mass of greenhouse gas *i* (kg/kmol)
R_u = Universal ideal gases constant (Pa.m^3/kmol.K)
T_t = Temperature of the gaseous stream in time interval *t* (K)

If it cannot be demonstrated that the gaseous stream is dry, then the flow measurement should be assumed to be on a wet basis and the option B should be applied instead.

Option B

The mass flow of greenhouse gas *i* ($F_{i,t}$) is determined using equations used to Option A. The volumetric flow of the gaseous stream in time interval *t* on a dry basis ($V_{t,db}$) is determined by converting the measured volumetric flow from wet basis to dry basis as follows:

$$V_{t,db} = V_{t,wb}/(1 + v_{H2O,t,db})$$

Where:
$V_{t,db}$ = Volumetric flow of the gaseous stream in time interval *t* on a dry basis (m^3 dry gas/h)
$V_{t,wb}$ = Volumetric flow of the gaseous stream in time interval *t* on a wet basis (m^3 wet gas/h)
$v_{H2O,t,db}$ = Volumetric fraction of H_2O in the gaseous stream in time interval *t* on a dry basis (m^3 H_2O/m^3 dry gas)

The volumetric fraction of H_2O in time interval *t* on a dry basis ($v_{H2O,t,db}$) is estimated according to following equation.

$$v_{H2O,t,db} = \frac{m_{H2O,t,db} * MM_{t,db}}{MM_{H2O}}$$

Where:
$v_{H2O,t,db}$ = Volumetric fraction of H_2O in the gaseous stream in time interval *t* on a dry basis (m^3 H_2O/m^3 dry gas)
$m_{H2O,t,db}$ = Absolute humidity in the gaseous stream in time interval *t* on a dry basis (kg H_2O/kg dry gas)
$MM_{t,db}$ = Molecular mass of the gaseous stream in time interval *t* on a dry basis (kg dry gas/kmol dry gas)
MM_{H2O} = Molecular mass of H_2O (kg H_2O/kmol H_2O)

The absolute humidity of th e gaseous stream ($m_{H2O,t,db}$) will be determined using Option 2 (simplified calculation without measurement of the moisture content):

Option 2: Simplified calculation without measurement of the moisture content

This option provides a simple and conservative approach to determine the absolute humidity by assuming the gaseous stream is dry or saturated depending on which is the conservative situation[18].

Concerning the project activity, the conservative situation will be to assume that the gaseous stream is saturated, then $m_{H2O,t,db}$ is assumed to equal the saturation absolute humidity ($m_{H2O,t,db,sat}$) and calculated using the following equation.

$$m_{H2O,t,db,Sat} = \frac{p_{H2O,t,Sat} * MM_{H2O}}{(P_t - p_{H2O,t,Sat}) * MM_{t,db}}$$

Where:

$m_{H2O,t,db,sat}$ = Saturation absolute humidity in time interval *t* on a dry basis (kg H_2O/kg dry gas)
$p_{H20,t,Sat}$ = Saturation pressure of H_2O at temperature Tt in time interval t (Pa)
T_t = Temperature of the gaseous stream in time interval *t* (K)
P_t = Absolute pressure of the gaseous stream in time interval *t* (Pa)
MM_{H2O} = Molecular mass of H_2O (kg H_2O/kmol H_2O)
$MM_{t,db}$ = Molecular mass of the gaseous stream in a time interval *t* on a dry basis (kg dry gas/kmol dry gas)

Parameter $MM_{t,db}$ is estimated using the following equation.

$$MM_{t,db} = \sum_{k} (v_{k,t,db} * MM_k)$$

Where:

$MM_{t,db}$ = Molecular mass of the gaseous stream in time interval *t* on a dry basis (kg dry gas/kmol dry gas)
$v_{k,t,db}$ = Volumetric fraction of gas *k* in the gaseous stream in time interval *t* on a dry basis (m^3 gas k/m^3 dry gas)
MM_k = Molecular mass of gas *k* (kg/kmol)
k = All gases, except H_2O, contained in the gaseous stream (e.g. N_2 and CH_4,). See available simplification below

The determination of the molecular mass of the gaseous stream ($MM_{t,db}$) requires measuring the volumetric fraction of all gases (*k*) in the gaseous stream. However as a simplification, in the case of the project activity, the volumetric fraction of the methane that is a greenhouse gas and considered in the emission reduction calculation in the underlying methodology must be monitored and the difference to 100% may be considered as pure nitrogen. The simplification is not acceptable if it is differently specified in the underlying methodology.

$PE_{flare,y}$ shall be determined using the methodological tool “Project emissions from flaring – version 02.0.0”. If LFG is flared through more than one flare, then $PE_{flare,y}$ is the sum of the emissions for each flare determined separately.

[18] An assumption that the gaseous stream is saturated is conservative for the situation that the mass flow of greenhouse gas *i* is underestimated (applicable for calculating baseline emissions). Conversely, an assumption that the gas stream is dry is conservative for the situation that the greenhouse gas *i* is overestimated (applicable for calculating project emissions).

To determine the project emissions from flaring gases was used the tool “Project emissions from flaring – version 02.0.0”. The project emissions calculation procedure is given in the following steps:

STEP 1: Determination of the methane mass flow of the residual gas;
STEP 2: Determination of the flare efficiency;
STEP 3: Calculation of project emissions from flaring.

Step 1: Determination of the methane mass flow in the residual gas

The “Tool to determine the mass flow of a greenhouse gas in a gaseous stream” shall be used to determine the following parameter:

Parameter	SI Unit	Description
$F_{CH4,m}$	kg	Mass flow of methane in the residual gaseous stream in the minute m

The following requirements apply:

- The gaseous stream tool shall be applied to the residual gas;
- The flow of the gaseous stream shall be measured continuously;
- CH4 is the greenhouse gas i for which the mass flow should be determined;
- The simplification offered for calculating the molecular mass of the gaseous stream is valid (equations 3 and 17 in the tool); and
- The time interval t for which mass flow should be calculated is every minute m

$F_{CH4,m}$, which is measured as the mass flow during minute m, shall then be used to determine the mass of methane in kilograms fed to the flare in minute m ($F_{CH4,RG,m}$). $F_{CH4,m}$ shall be determined on a dry basis.

The option chosen for the “Tool to determine the mass flow of a greenhouse gas in a gaseous stream” by the project participant is option A. However, during the project operational monitoring, If not demonstrated that the temperature of the gaseous stream (T_t) is less than 60ºC (dry basis), then the flow measurement should be assumed to be on a wet basis and the option B should be applied instead.

Step 2: Determination of flare efficiency

According to “Project emissions from flaring”, the flare efficiency for enclosed flares is calculated as follows:

<u>Enclosed flares</u>

In the case of enclosed flares, project participants may choose between the following two options to determine the flare efficiency for minute *m* ($n_{flare,m}$).

Option A: Apply a default value for flare efficiency

Option B: Measure the flare efficiency.

The project participant has chosen Option A.

For enclosed flares that are defined as low height flares, which is the case of the project activity, the flare efficiency in the minute m ($n_{flare,m}$) shall be adjusted, as a conservative approach, by subtracting 0.1 from the efficiency as determined in Option A. For example, the default value applied should be 80%, rather than 90%.

Option A: Default value

The flare efficiency for the minute m ($n_{flare,m}$) is 90% when the following two conditions are met to demonstrate that the flare is operating:

(1) The temperature of the flare ($T_{EG.m}$) and the flow rate of the residual gas to the flare ($F_{RG,m}$) is within the manufacturer's specification for the flare ($SPEC_{flare}$) in minute m; and

(2) The flame is detected in minute m ($Flame_m$).

Otherwise $n_{flare,m}$ is 0%.

Step 3: Calculation of project emissions from flaring

Project emissions from flaring are calculated as the sum of emissions for each minute *m* in year *y,* based on the methane mass flow in the residual gas ($F_{CH4,RG,m}$) and the flare efficiency ($\eta_{flare,m}$), as follows:

$$PE_{flare\,y} = GWP_{CH4} \times \sum_{m=1}^{525600} F_{CH4,RG,m} \times \left(1 - \eta_{flare\,m}\right) \times 10^{-3}$$

Where:

$PE_{flare,y}$	=	Project emissions from flaring of the residual gas in year *y* (tCO_2e)
GWP_{CH4}	=	Global warming potential of methane valid for the commitment period (tCO_2e/tCH_4)
$F_{CH4,RG,m}$	=	Mass flow of methane in the residual gas in the minute *m* (kg)
$\eta_{flare,m}$	=	Flare efficiency in minute m

Table 2 – Parameters[19] used in the Tool "Project emissions from flaring"

Parameter	Description	Value	Unit
P_{ref}	Atmospheric pressure at reference conditions	101,325	Pa
R_u	Universal ideal gas constant	8,314	$Pa.m^3/kmol.K$
T_{ref}	Temperature at reference conditions	273.15	K
GWP_{CH4}	Global warming potential of methane valid for the commitment period	25[20]	tCO_2/tCH_4
$\rho_{CH4,n}$	Density of methane at reference conditions	0.716	kg/m^3

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

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

Table 3 - Cases for determining methane captured and destroyed in the baseline

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

[19] As the Option B.1 of the tool "*Project emissions from flaring (Version 02.0.0)*" has been adopted to calculate the flare efficiency, the molecular mass parameters are not mentioned.

[20] Value for the 2nd commitment period updated according to COP/MOP decisions

Case 2	Yes	No
Case 3	No	Yes
Case 4	Yes	Yes

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

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

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

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

$$F_{CH4,BL,y} = \max \{F_{CH4,BL,R,y} ; F_{CH4,BL,sys,y}\}$$

Where:

$F_{CH4,BL,R,y}$	=	Amount of methane in the LFG which is flared in the baseline due to a requirement in year *y* (tCH_4/yr)
$F_{CH4,BL,sys,y}$	=	Amount of methane in the LFG that would be flared in the baseline in year *y* for the case of an existing LFG capture system (tCH_4/yr)

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

According to Case 2 procedures:

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

$$F_{CH4,BL,R,y} = 0$$

According to Case 3 procedures:

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

$$F_{CH4,BL,sys,y} = F_{CH4,hist,y}$$

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

$$F_{CH4,hist,y} = \frac{F_{CH4,BL,x-1}}{F_{CH4,x-1}} \cdot F_{CH4,PJ,y}$$

Where:

$F_{CH4,hist,y}$	=	Historical amount of methane in the LFG which is captured and destroyed (tCH_4/yr)
$F_{CH4,BL,x-1}$	=	Historical amount of methane in the LFG which is captured and destroyed in the year prior to the implementation of the project activity (tCH_4/yr)

$F_{CH4,x-1}$	=	Amount of methane in the LFG generated in the SWDS in the year prior to the implementation of the project activity (tCH_4/yr)
$F_{CH4,PJ,y}$	=	Amount of methane in the LFG which is captured in the project activity in year y (tCH_4/yr)

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

$$F_{CH4,BL,x-1} = MD_{BL} \ . \ F_{CH4,x-1}$$

Where:

$F_{CH4,BL,x-1}$	=	Historical amount of methane in the LFG which is captured and destroyed in the year prior to the implementation of the project activity (tCH_4/yr)
MD_{BL}	=	Methane destruction efficiency in the baseline (-)
$F_{CH4,x-1}$	=	Amount of methane in the LFG generated in the SWDS in the year prior to the implementation of the project activity (tCH_4/yr)

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

As per the studies, a collection efficiency of 85% was attributed to the passive systems, what the authors acknowledge to be a conservative approach, not reflecting the reality of existent passive systems commonly used in Brazil, and the sampled average MD_{BL} for those projects was 0.0176 and weighted average MD_{BL} was 0.0040 or, respectively, 1.76% and 0.40%. Regarding that the use of the sampled average MD_{BL} from the cited study is more conservative, for Uberlândia landfills I and II a methane destruction efficiency of 1.76% will be used for estimating the $F_{CH4,BL,x-1}$.

Therefore, the equation is updated to:

$$F_{CH4,BL,x-1} = 1.76\% \ . \ F_{CH4,x-1}$$

The equation is then updated to:

$$F_{CH4,hist,y} = \frac{1.76\% \ . \ F_{CH4,x-1}}{F_{CH4,x-1}} \ . \ F_{CH4,PJ,y}$$

Or

$$F_{CH4,hist,y} = 1.76\% \ . \ F_{CH4,PJ,y}$$

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

$$F_{CH4,BL,y} = 1.76\% \ . \ F_{CH4,PJ,y}$$

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

The baseline emissions associated with electricity generation in year y ($BE_{EC,y}$) are calculated using the "Methodological tool: Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation".

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

Where:

$BE_{EC,y}$	=	Baseline emissions from electricity generation in year *y* (tCO2/yr)
$EC_{BL,k,y} = EG_{PJ,y}$	=	Net amount of electricity generated using LFG in year y (MWh/yr)
$EF_{EL,k,y}$[21]	=	Emission factor for electricity generation for source *k* in year *y* (tCO2/MWh)
$TDL_{k,y}$	=	Average technical transmission and distribution losses for providing electricity to source *k* in year *y*.

Emission Factor calculation

The project emissions derived from fossil fuels used for electricity consumption from grid connected power plants are estimated and guided using the “Methodological tool: Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation”. For the determination of the emission factor for electricity generation ($EF_{EL,j/k/l,y}$), the scenario A “Electricity consumption from the grid” was used. The combined margin emission factor was calculated by the “Tool to calculate the emission factor for an electricity system”, as follows:

Step 1. Identify the relevant electric power system

For the purpose of determining the electricity emission factors, a project electricity system is defined by the spatial extent of the power plants that are physically connected through transmission and distribution lines to the project activity (e.g. the renewable power plant location or the consumers where electricity is being saved) and that can be dispatched without signification transmission constraints.

The Brazilian DNA published an official delineation of the project electricity system in Brazil, considering a national interconnected system.[22]

Step 2. Choose whether to include off-grid power plants in the project electricity system (optional)

Option I: Only grid power plants are included in the calculation.

The Brazilian DNA is responsible for calculating the emission factors and it is not included in calculation the off-grid power plants.

Step 3. Select a method to determined the operating margin (OM)

The calculation of the operating margin emission factor ($EF_{grid,OM,y}$) is based on one of the following methods:

a) Simple OM, or
b) Simple adjusted OM, or
c) Dispatch data analysis OM, or
d) Average OM.

[21] According to the “*Tool to calculate project or leakage CO2 emissions from fossil fuel combustion*”, $EF_{EL,k,y} = EF_{grid,CM,y}$

[22] According to Brazilian DNA Resolution n.8 published on 26/05/2008.

The Brazilian DNA is responsible for calculating the OM emission factor in Brazil. It uses the method c) Dispatch data analysis OM.

For the dispatch data analysis OM, it is necessary to use the year in which the project activity displaces grid electricity and to update the emission factor annually during monitoring.

Step 4. Calculate the operating margin emission factor according to the selected method

The dispatch data analysis OM emission factor ($EF_{grid,OM\text{-}DD,y}$) is determined based on the power units that are actually dispatched at the margin during each hour h where the project is displacing electricity. This approach is not applicable to historical data and, thus, requires annual monitoring of $EF_{grid,OM\text{-}DD,y}$.

Method chosen c) Dispatch data analysis OM.

The emission factor is calculated as follows:

$$EF_{grid,OM-DD,y} = \frac{\sum_{h} EG_{PJ,h} \cdot EF_{EL,DD,h}}{EG_{PJ,y}}$$

Where:

$EF_{grid,OM\text{-}DD,y}$	=	Dispatch data analysis operating margin CO_2 emission factor in year *y* (tCO_2/MWh)
$EG_{PJ,h}$	=	Electricity displaced by the project activity in hour *h* m of year *y* (MWh)
$EF_{EL,DD,h}$	=	CO_2 emission factor for power units in the top of the dispatch order in hour *h* in year *y* (tCO_2/MWh)
$EG_{PJ,y}$	=	Total electricity displaced by the project activity in year *y* (MWh)
h	=	hours in year y in which the project activity is displacing grid electricity
y	=	Year in which the project activity is displacing grid electricity

The $EF_{grid,OM,}$ is displayed on the Brazilian DNA website.

Step 5. Calculate the build margin (BM) emission factor

The Brazilian DNA is responsible for calculating the BM emission factor in Brazil.

In terms of vintage of data, project participants can choose between one of the following two options:

Option 1: For the first crediting period, calculate the build margin emission factor *ex-ante* based on the most recent information available on units already built for sample group m at the time of CDM-PDD submission to the DOE for validation. For the second crediting period, the build margin emission factor should be updated based on the most recent information available on units already built at the time of submission of the request for renewal of the crediting period to the DOE. For the third crediting period, the build margin emission factor calculated for the second crediting period should be used. This option does not require monitoring the emission factor during the crediting period.

Option 2: For the first crediting period, the build margin emission factor should be updated annually, ex-post, including those units built up to the year of registration of the project activity or, if information up to the year of registration is not yet available, including those units built up to the latest year for which information is available. For the second crediting period, the build margin factor shall be calculated ex-ante, as described in option 1 above. For the third crediting period, the build margin emission factor calculated for the second crediting period should be used.

The *Option 2* was chosen for the proposed project.

The build margin emissions factor is the generation-weighted average emission factor (tCO_2/MWh) of all power units m during the most recent year y for which power generation data is available, calculated as follows:

$$EF_{grid,BM,y} = \frac{\sum_m EG_{m,y} \times EF_{EL,m,y}}{\sum_m EG_{m,y}}$$

Where:

$EF_{grid,BM,y}$	=	Build margin CO_2 emission factor in year y ($t CO_2/MWh$)
$EG_{m,y}$	=	Net quantity of electricity generated and delivered to the grid by power unit m in year y (MWh)
$EF_{EL,m,y}$	=	CO_2 emission factor of power unit m in year y ($t CO_2/MWh$)
m	=	Power units included in the build margin
y	=	Most recent historical year for which electricity generation data is available

The $EF_{grid,BM}$ is displayed on the Brazilian DNA website.

Step 6. Calculate the combined margin emissions factor

The option a) weighted average CM was used to calculate the combined margin (CM).

$$EF_{grid,CM,y} = EF_{grid,OM,y} \times w_{OM} + EF_{grid,BM,y} \times w_{BM}$$

The default weights are as follows: w_{OM} = 0.25 and w_{BM} = 0.75, fixed for the second crediting period.

The build margin CO_2 emission factor is ex-ante.

The operating margin CO_2 emission factor is ex-post.

Therefore, the combined margin CO_2 emission factor will be ex-post.

Data used to calculate the grid emission factor was taken from publicly information available in the Brazilian DNA's website. The below table presents the results of the applicable combined margin CO_2 emission factor.

Table 4 – CO_2 emission factor of the electricity grid during the monitored period.

Year	Grid Emission Factor (tCO_2/MWh)
2019	0.2323
2020	0.2162

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

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The table below shows the project emissions calculated for the current monitoring period.

	PE,y	PEEC1	PEEC2	ECPJ1	ECPJ2
	tCO2	tCO2	tCO2	MWh	MWh
From 04/09/2019	0.17	0.17	0.00	0.58	0.00
10/2019	0.15	0.15	0.00	0.52	0.00
11/2019	1.46	1.46	0.00	5.10	0.00
12/2019	0.46	0.46	0.00	1.59	0.00
01/2020	0.12	0.12	0.00	0.42	0.00
02/2020	0.08	0.08	0.00	0.29	0.00
Until 02/03/2020	0.00	0.00	0.00	0.00	0.00

Project emissions:

$$PE_y = PE_{EC,y} + PE_{FC,y} + PE_{DT,y} + PE_{SP,y}$$

Where:

PE_y = Project emissions in year *y* (t CO_2/yr)

$PE_{EC,y}$ = Emissions from consumption of electricity due to the project activity in year *y* (t CO_2/yr)

$PE_{FC,y}$ = Emissions from consumption of fossil fuels due to the project activity, for purpose other than electricity generation, in year *y* (t CO_2/yr)

$PE_{DT,y}$ = Emissions from the distribution of compressed/liquefied LFG using trucks, in year y (t CO_2/yr)

$PE_{SP,y}$ = Emissions from the supply of LFG to consumers through a dedicated pipeline, in year y (t CO_2/yr)

The parameter $PE_{DT,y}$, $PE_{FC,y}$ and $PE_{SP,y}$ are not used in the calculation of project emissions since there is no distribution of compressed/liquefied LFG using trucks, no supply of LFG to consumers through a dedicated pipeline as well as no project emission from consumption of fossil fuels due to the project activity, for purpose other than electricity generation in the project activity. Then, $PE_{DT,y}$, $PE_{FC,y}$ and $PE_{SP,y} = 0$.

Calculation of $PE_{EC,y}$ – project emission from consumption of electricity

According to "*Methodological tool: Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation*", version 03.0 the project emission from consumption of electricity will be from one source:

- $PE_{EC1,y}$ - Grid (Brazilian interconnected electric system);

Thus,

$$PE_{EC,y} = PE_{EC1,y}$$

$PE_{EC1,y}$ - Project emission from electricity consumption from the grid

As electricity will be consumed from the grid, the option A1 of the scenario A was chosen, as follows:

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

Thus, the project emission is calculated as following:

$$PE_{EC1,y} = EC_{PJ1,y} \times EF_{grid,CM,y} \times (1 + TDL_y)$$

Where:

$EC_{PJ1,y}$	= quantity of electricity consumed from the grid by the project activity during the year y (MWh);
$EF_{grid,CM,y}$	= the emission factor for the grid in year y (tCO_2/MWh);
TDL_y	= 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.

Calculation of $PE_{FC,y}$ – Emissions from consumption of fossil fuels due to the project activity, for purpose other than electricity generation

There is no project emission from consumption of fossil fuels due to the project activity, for purpose other than electricity generation.

Therefore, $PE_{FC,y} = 0$

E.3. Calculation of leakage emissions

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Not applicable. In accordance with the ACM0001 version 18.1, no leakage effects need to be accounted.

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

	Baseline GHG emissions or baseline net GHG removals (t CO_2e)	Project GHG emissions or actual net GHG removals (t CO_2e)	Leakage GHG emissions (t CO_2e)	GHG emission reductions or net anthropogenic GHG removals (t CO_2e)		
				Before 01/01/2013	From 01/01/2013	Total amount
Total	36,870	3	0	0	36,867	36,867

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

Amount achieved during this monitoring period (t CO_2e)	Amount estimated ex ante for this monitoring period in the PDD (t CO_2e)
36,867	62,968

E.5.1. Explanation of calculation of "amount estimated ex ante for this monitoring period in the PDD"

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Emission reductions estimated ex-ante for this monitoring period in the PDD were calculated summing the amount estimated for 2019 and proportionally for the year 2020 considering 62 days (from January 1st until March 2nd).

E.6. Remarks on increase in achieved emission reductions

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Not applicable. In fact, the amount of emission reductions achieved during the monitored period are 41% lower than the amount previously estimated in the registered PDD.

E.7. Remarks on scale of small-scale project activity

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Not applicable. This section is intentionally left blank.

Document information

Version	Date	Description
07.0	31 May 2019	Revision to: • Ensure consistency with version 02.0 of the “CDM project standard for project activities” (CDM-EB93-A04-STAN); • Add a section on remarks on the observance of the scale limit of small-scale project activity during the crediting period; • Add "changes specific to afforestation or reforestation project activity" as a possible post-registration changes; • Clarify the reporting of net anthropogenic GHG removals for A/R project activities between two commitment periods; • Make editorial improvements.
06.0	7 June 2017	Revision to: • Ensure consistency with version 01.0 of the “CDM project standard for project activities” (CDM-EB93-A04-STAN); • Make editorial improvements.
05.1	4 May 2015	Editorial revision to correct version numbering.
05.0	1 April 2015	Revisions to: • Include provisions related to delayed submission of a monitoring plan; • Provisions related to the Host Party; • Remove reference to programme of activities; • Overall editorial improvement.
04.0	25 June 2014	Revisions to: • Include the Attachment: Instructions for filling out the monitoring report form (these instructions supersede the "Guideline: Completing the monitoring report form" (Version 04.0)); • Include provisions related to standardized baselines; • Add contact information on a responsible person(s)/ entity(ies) for completing the CDM-MR-FORM in A.6 and Appendix 1; • Change the reference number from *F-CDM-MR* to *CDM-MR-FORM*; • Editorial improvement.
03.2	5 November 2013	Editorial revision to correct table in page 1.
03.1	2 January 2013	Editorial revision to correct table in section E.5.
03.0	3 December 2012	Revision required to introduce a provision on reporting actual emission reductions or net GHG removals by sinks for the period up to 31 December 2012 and the period from 1 January 2013 onwards (EB 70, Annex 11).
02.0	13 March 2012	Revision required to ensure consistency with the "Guidelines for completing the monitoring report form" (EB 66, Annex 20).
01.0	28 May 2010	EB 54, Annex 34. Initial adoption.

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