



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	Oeste de Caucaia Landfill Project Activity	
UNFCCC reference number of the project activity	10261	
Version number of the PDD applicable to this monitoring report	5	
Version number of this monitoring report	1	
Completion date of this monitoring report	27/11/2020	
Monitoring period number	2	
Duration of this monitoring period	22/12/2017 – 23/09/2020	
Monitoring report number for this monitoring period	1	
Project participants	GNR Fortaleza Valorização de Biogás Ltda.	
Host Party	Brazil	
Applied methodologies and standardized baselines	ACM0001: Flaring or use of landfill gas	
Sectoral scopes	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	880,572 tCO ₂ e
Amount of GHG emission reductions or net anthropogenic GHG removals estimated ex ante for this monitoring period in the PDD	1,431,429 tCO ₂ e ¹	

¹ Calculated using the PDD estimation of emission reductions to be achieved in 2017 (497,834 tCO₂e) times the number of days in this monitoring period for this year (10 days) divided by the number of days in the year, plus emission reductions estimated in 2018 (510,572 tCO₂e), 2019 (519,375 tCO₂e) and 2020 (531,649 tCO₂e) times the number of days in this monitoring period for this year (267 days) divided by the number of days in the year under the crediting period (366 days).

SECTION A. Description of project activity

A.1. General description of project activity

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The primary objective of the Oeste de Caucaia Landfill Project Activity is to prevent greenhouse gases emissions by the Oeste de Caucaia Landfill through the capture, purification and injection of the landfill gas into a distribution grid, displacing the use of natural gas. The Oeste de Caucaia - Ecofor landfill is a municipal solid waste (MSW) disposal site located in Caucaia, Brazil.

The landfill is owned by the municipality of Caucaia and is operated since 2003 by ECOFOR under a 20-year concession. A passive LFG capture system was operational before the implementation of the CDM Project Activity. GNR Fortaleza Valorização de Biogás Ltda. is the project activity implementer. Applying the state-of-the-art on LFG capture technology, a collecting system was installed to avoid the free emission of methane to the atmosphere. A detailed description of the equipment is provided in Section B.1.

The captured LFG is sent to the upgrading facility before being injected to the natural gas distribution grid of CEGÁS – Companhia de Gás do Ceará (local natural gas supplier). CEGÁS will receive the upgraded gas from Oeste de Caucaia Landfill Project through a natural gas distribution grid, therefore mixing it with natural gas. This type of project, *i.e.*, landfill gas upgrading to natural gas and injection into a natural gas distribution grid is not usual in Brazil.

This monitoring report covers the period from 22/12/2017 to 23/09/2020, from when the LFG upgrade plant became operational until the most recent data available at the conclusion of the report. Currently, only the first phase of the project – which consists of a processing capacity of LFG equivalent to 7,500 Nm³/h - has been implemented.

The total emission reductions achieved during this monitored period is **880,572 tCO₂e**.

A.2. Location of project activity

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The Oeste de Caucaia Landfill is located in the municipality of Caucaia, Ceará state, north-eastern region of Brazil (Figure 1). The geographic coordinates (Figure 2) of the site where the project has been implemented are:

Latitude: 3°47'20.29"South
Longitude: 38°40'24.99"West



Figure 1 - Caucaia location (Source: <http://pt.wikipedia.org>)

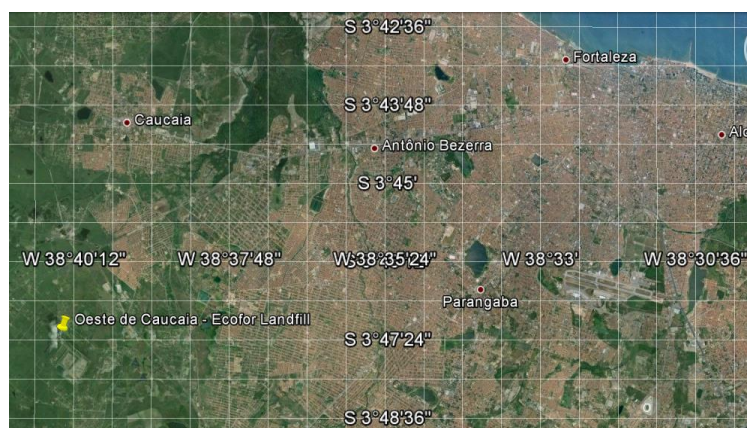


Figure 2 - Oeste de Caucaia Landfill location (Source: adapted from Google Earth)

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	Private entity – GNR Fortaleza Valorização de Biogás Ltda.	No

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A.4. References to applied methodologies and standardized baselines

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Oeste de Caucaia Landfill Project Activity applies the ACM0001 methodology – “Flaring or use of landfill gas”² (version 15.0.0) and the following methodological tools:

- TOOL06 - “Project emissions from flaring” (version 02.0.0)³;
- TOOL05 - “Tool to calculate baseline, project and/or leakage emissions from electricity consumption” (version 01)⁴;
- TOOL07 - “Tool to calculate the emission factor for an electricity system” (version 4.0)⁵;
- TOOL03 - “Tool to calculate project or leakage CO2 emissions from fossil fuel combustion” (version 02)⁶;
- TOOL04 - “Emissions from solid waste disposal sites” (version 07.0)⁷;

² Available at: <<https://cdm.unfccc.int/methodologies/DB/JPYB4DYQUXQPZLBDVPHA87479EMY9M>>. Accessed on: 06/10/2020.

³ Available at: <https://cdm.unfccc.int/methodologies/PAMethodologies/tools/am-tool-06-v3.0.pdf/history_view>. Accessed on: 06/10/2020.

⁴ Available at: <https://cdm.unfccc.int/methodologies/PAMethodologies/tools/am-tool-05-v3.0.pdf/history_view>. Accessed on: 06/10/2020.

⁵ Available at: <https://cdm.unfccc.int/methodologies/PAMethodologies/tools/am-tool-07-v7.0.pdf/history_view>. Accessed on: 06/10/2020.

⁶ Available at: <https://cdm.unfccc.int/methodologies/PAMethodologies/tools/am-tool-03-v3.pdf/history_view>. Accessed on: 06/10/2020.

- TOOL02 - “Combined tool to identify the baseline scenario and demonstrate additionality” (version 05.0.0)⁸;
- TOOL08 - “Tool to determine the mass flow of a greenhouse gas in a gaseous stream” (version 02.0.0)⁹;
- TOOL09 - “Tool to determine the baseline efficiency of thermal or electric energy generation systems” (version 01)¹⁰;
- TOOL10 - “Tool to determine the remaining lifetime of equipment” (version 01)¹¹;
- TOOL12 - “Project and leakage emissions from transportation of freight” (version 01.1.0)¹²;
- TOOL11 - “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)¹³.

The “Tool to determine the baseline efficiency of thermal or electric energy generation systems”, “Tool to determine the remaining lifetime of equipment” and the methodological tool “Project and leakage emissions from transportation of freight” are not applicable to the project activity, and therefore are not used. Similarly, the methodological tool “Assessment of the validity of the original/current baseline and update of the baseline at the renewal of the crediting period” was not used since the PDD corresponds to the first crediting period of the proposed CDM Project Activity.

A.5. Crediting period type and duration

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Renewable

The crediting period corresponding to the monitoring period covered in this monitoring report goes from 22/04/2016 to 22/04/2023.

SECTION B. Implementation of project activity

B.1. Description of implemented project activity

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As per the registered PDD, Oeste de Caucaia Landfill Project Activity was implemented in phases. To date only the phase I has been operational.

In summary, the technology applied by the project consists of:

- Gas extraction wells with wellhead flow control and monitoring;
- A wellfield gas conveyance system (“laterals” and “header”);
- A Gas Station and an upgrading gas facility;
- A flaring system; and,
- A pipeline to inject the upgraded gas into the natural gas distribution grid.

Collecting System

The Oeste de Caucaia Landfill Project involved the perforation of new vertical wells as well as the installation of wellheads on top of them to collect the LFG emitted directly to the atmosphere in the baseline. An example of wellhead and the detail of its construction are shown in Figure 3.

⁷ Available at: <https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-04-v8.0.pdf/history_view>. Accessed on: 06/10/2020.

⁸ Available at: <https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-02-v7.0.pdf/history_view>. Accessed on: 06/10/2020.

⁹ Available at: <https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-08-v3.0.pdf/history_view>. Accessed on: 06/10/2020.

¹⁰ Available at: <https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-09-v3.0.pdf/history_view>. Accessed on: 06/10/2020.

¹¹ Available at: <https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-10-v1.pdf/history_view>. Accessed on: 06/10/2020.

¹² Available at: <https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-12-v1.1.0.pdf/history_view>. Accessed on: 06/10/2020.

¹³ Available at: <https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-11-v3.0.1.pdf/history_view>. Accessed on: 06/10/2020.

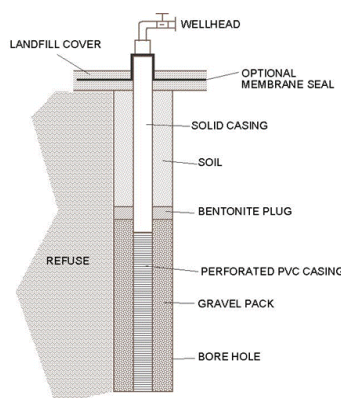


Figure 3 – Internal detail of a well and wellhead (source: USEPA, 1996¹⁴)

New wells have been drilled in order to guarantee the efficiency of the controlled drainage of the landfill as well as of the LFG collection. Phase 1 involved the installation of 22 vertical wells and 64 horizontal extraction wells¹⁵.

Flow-control and monitoring wellheads are employed at every gas extraction well, to allow precise regulation/adjustment of the gas flow at each well. Gas quality monitoring and flow adjustment is important to ensure that the system is “balanced” (i.e. gas extraction matches gas production so that atmospheric air is not introduced into the landfill).

A network of LFG header piping connects the horizontal collectors and vertical extraction wells, and direct the LFG to the LFG processing plant or (if the plant is down or there is excess LFG) the blower and flaring station for methane destruction.

The collection system became operational in 10/12/2015¹⁶.

Gas Station and Upgrading gas facility

The Gas Station is the facility where the gas is suctioned from the landfill and where the gas receives the proper treatment, depending on the final use of the gas. Usually, the Gas Station is composed by blowers and condensate knock-outs. The project has 2 blowers, with a capacity of 5,000Nm³/hour each (Table 1).

Table 1 – Technical specification of the blowers.

Blowers (SP-203/204)	# of Units	2
	Manufacturer	Jonh Zink
	Model	12604
	Serial number	0514110-37597 0514109-37597
	Maximum capacity	5365 Nm ³ /h

¹⁴ USEPA – United States Environmental Agency; *Turning a Liability into an Asset: a Landfill Gas-to-Energy Project Development Handbook*; LMOP – Landfill Methane Outreach Program, 1996

¹⁵ In accordance with the gas capture project by Landtec, in a corporate presentation of provided by project owner

¹⁶ In accordance with in accordance with the environmental permit SEMACE No. 70/2015 which authorized the entry into operation of the system.

Prior to the injection of the landfill gas to the natural gas distribution grid, it is treated in the upgrading facility, where most of the non-methane gases are removed from the stream. The project activity processing capacity is 7,500 Nm³/h (Phase I is operational).

The gas station and the upgrading facility became operational in 12/2015 and in 12/2017, respectively.

Flare System

Whenever LFG exceeds the processing capacity of the purification plant or the plant is not operational the gas is sent to the flaring system. The project has one open flare, with a capacity of 8,200 Nm³/hour (Table 2). In order to ensure safety and, depending on the project performance, two more flares may be installed at the project site.

Table 2 – Technical specification of the flare.

Flare	Manufacturer	John Zink
	Type	Elevated Flare
	Commissioning date	10/12/2015
	Model	ZEF 16"X45'
	Serial number	BF – 9149501
	Year of manufacturing	2014
	Nominal gas flow	LFG 8,200 Nm ³ /h
		Upgraded LFG 4,100 Nm ³ /h
	Minimum methane content	LFG 50 - 60%
		Upgraded LFG 97%
	Lowest operation temperature	100 °F

The flare system became operational in 12/2015¹⁷.

Upgraded gas pipeline

The upgraded gas is transported to the injection point through a pipeline. Within the landfill area the gas is collected using a *Flex Steel* pipeline. From the landfill border until CEGÁS pipeline (consumer), a *Carbon Steel* pipeline is used. This technology reduces the environmental impacts observed in a conventional mechanical construction once less machines are used during its construction.

Gas pipeline became fully operational in 12/2017, when CEGAS started to distribute the upgraded biogas produced by the project.

Most of this monitoring period the system has been in normal operation. There were a few days with significant down period and those were listed in a separate spreadsheet and have no impact on the methodology applicability. In addition to that, the National Agency of Petroleum, Natural Gas and Biofuels (ANP) also oversees the delivery of gas from the plant to CEGAS. In this way, plant shutdown events are also reported to the agency. The reports forwarded to the ANP were made available to the DOE during the project verification.

This monitoring report refers to the first monitoring period of the project. Therefore, no CERs have been issued.

¹⁷ In accordance with in accordance with the environmental permit SEMACE No. 70/2015 which authorized the entry into operation of the system.

B.2. Post-registration changes

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

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Three deviations from the registered monitoring plan are requested during this monitoring period. The requests are detailed below.

Deviation 1

In the registered monitoring plan described in the PDD, the parameter $v_{i,t,db}$ (volumetric fraction of greenhouse gas CH₄ in the LFG), which is applied on calculation of project and baseline emissions, is continuously measured by a gas analyser (on dry basis), and it is aggregated hourly (at least). This procedure is also in line with “Tool to determine the mass flow of a greenhouse gas in a gaseous stream” (Version 02.0.0) applied to Project “Oeste de Caucaia Landfill Project Activity”.

Nevertheless, as informed by project owner, the gas analyser that should provide the measurement was not operational from 01/10/2018 (08h:08min) to 23/09/2020 (11h:26 min) and the parameter could not be monitored in accordance with monitoring plan.

According to CDM project standard for project activities, version 02.0, paragraph 231, CDM validation and verification standard for project activities, version 02.0, paragraph 283 and in order to apply conservative assumptions or discount factors to the calculations to the extent required to ensure that emission reductions will not be overestimated as a result of the temporary deviation for the requested monitoring period, the conservative procedure will be elaborated as follows:

- A temporary deviation is proposed in order to provide this parameter using an alternative method. This parameter was calculated during this period, based on the amount of biomethane sold to consumer (CEGAS) and its respective fraction of methane, both data described on sales invoices.
- The calculation of methane fraction in the LFG obtained from the amount of biomethane sold to CEGAS is coherent, once it is assumed that the amount of methane is not modified during the process of biogas upgrading. The increase of the volumetric fraction of methane in the outlet gas occurs only due to the removal of other gases from its original composition, such as N₂, CO₂ and H₂S.
- This assumption was based on the design operation of “Oeste de Caucaia Landfill Project Activity”, which is illustrated by Figure 4, where it is possible to verify that the collected LFG that is directed to gas meter [D] passes through the upgrading process [C] and then it is sold to CEGAS [E] and injected in the natural gas pipeline.

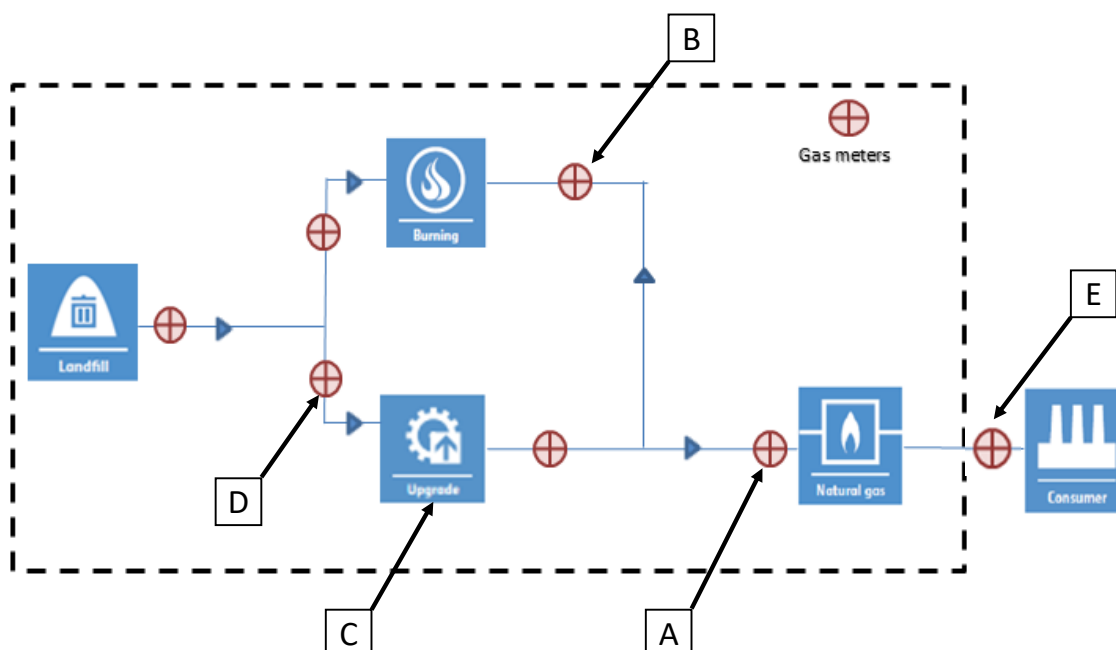


Figure 4 – Monitoring equipment of the project activity.

- The formula applied on calculation of volumetric fraction of greenhouse gas CH₄ in the LFG (vi,t,db) is described below:

$$vi, t, db_LFG = \frac{Vt, db_biomethane \times vi, t, db_biomethane}{Vt, db_LFG}$$

<i>vi, t, db_LFG</i>	[Calculated]	= Volumetric fraction of greenhouse gas CH ₄ in the LFG in time interval t on a dry basis (%)
<i>Vt, db_biomethane</i>	[A] + [B]	= Volumetric flow of the gaseous stream Biomethane in time interval t on a dry basis (Nm ³ /h)
<i>vi, t, db_biomethane</i>	[C]	= Volumetric fraction of greenhouse gas CH ₄ in the Biomethane in time interval t on a dry basis (%)
<i>Vt, db_LFG</i>	[D]	= Volumetric flow of the gaseous stream LFG in time interval t on a dry basis (Nm ³ /h)

Deviation 2

From the entire monitoring period, the parameter “Flame detection of flare in the minute m” (Flamem) was not implemented for the flare line and thus, not registered not the supervisory system.

According to CDM project standard for project activities, version 02.0, paragraph 231, CDM validation and verification standard for project activities, version 02.0, paragraph 283 and in order to apply conservative assumptions or discount factors to the calculations to the extent required to ensure that emission reductions will not be overestimated as a result of the temporary deviation for the requested monitoring period, the conservative procedure will be elaborated as follows:

- It has been demonstrated that the flare is equipped with valves on the input gas line that close automatically if the device becomes non- operational. Thus, if LFG flow is registered for the flare line, then the LFG flow is combusted by this destruction device.

- As per flare operational description provided by manufacturer, the gas flows to the pilot device and a spark is generated to ignite the pilot flame and the automatic mode attempts to light the pilot three times.
- At the end of these attempts, if pilot flame is not ignited, "Pilot Failure" lamp will be illuminated and the operator will have to press the reset push-button to restart the unit.
- Upon proving the pilot flame, the automatic block valve is opened and the gas blower is started allowing gas flow to the flare.

Deviation 3

In the registered monitoring plan described in the PDD, the parameter Tt (Temperature of the gaseous stream in time interval t), which is applied on calculation of project and baseline emissions, is continuously measured by temperature sensor meter, and it is aggregated hourly (at least). This procedure is also in line with "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" (Version 02.0.0) applied to Project "Oeste de Caucaia Landfill Project Activity". Nevertheless, as informed by project owner, the temperature sensor meter that should provide the measurement was not operational during the entire months 12/2017, 01/2018, 02/2018 and 09/2020 and the parameter could not be monitored in accordance with monitoring plan.

According to CDM project standard for project activities, version 02.0, paragraph 231, CDM validation and verification standard for project activities, version 02.0, paragraph 283 and in order to apply conservative assumptions or discount factors to the calculations to the extent required to ensure that emission reductions will not be overestimated as a result of the temporary deviation for the requested monitoring period, the conservative procedure will be elaborated as follows:

- As stated in the "Tool to determine the mass flow of a greenhouse gas in a gaseous stream", it is necessary to demonstrate that the gaseous stream is dry or wet by demonstrating that the temperature of the gaseous stream (Tt) is less than 60°C (dry basis) or higher than 60°C (wet basis) at the flow measurement point.
- For the deviation period, since it was not possible to demonstrate if the gaseous stream is dry or wet, it was conservatively adopted a temperature of 70°C (wet basis, being above the highest LFG temperature registered during the entire monitoring period) and thus, converting the measured volumetric flow from wet basis to dry basis, as defined in Option B of the "Tool to determine the mass flow of a greenhouse gas in a gaseous stream".

B.2.2. Corrections

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Not applicable. This section is intentionally left blank.

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

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Not applicable. This section is intentionally left blank.

B.2.4. Inclusion of monitoring plan

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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

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Not applicable. This section is intentionally left blank.

B.2.6. Changes to project design

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Along with this verification, it is being proposed a project design change in the registered PDD. A new PDD version (version 5, dated 20/11/2020) is being submitted along with this Monitoring Report (ISSUANCE TRACK).

The post-registration change consisted of adding one more site to the proposed CDM Project Activity corresponding to the landfill expansion. This amendment is foreseen in paragraph 241. (f) of the CDM Project Standard.

The amount of waste deposited at the project site was also updated according to the most recent data monitored by the project proponent, which were not available during the validation of the Project Activity. No significant difference can be observed with respect to the information provided in the first registered version of the PDD, but emission reductions were revised accordingly. Nonetheless, this update resulted in a more conservative ex-ante estimative, since there will be no increase in the *ex-ante* estimated LFG generation 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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The monitoring of project activity will follow the requirements established in ACM0001 and referred tools. All data monitored will be available at the time of the verification and will be archived electronically for two years after the end of the crediting period or the last issuance of CERs, whichever occurs later.

The project is equipped with meters which collect the following data:

- (i) Landfill gas (LFG) sent to flare;
- (ii) LFG sent to the upgrading system;
- (iii) Biomethane resulted from upgrading process; and,
- (iv) Biomethane which does not reach the required parameters to be delivered to the NG distribution system and, for this reason, is flared.

Since the flow meters already measures the volumetric flow rate of the residual gas at normal conditions, the parameters Temperature of the landfill gas (T) and Pressure of the landfill gas (P) have not been measured for normalizing purposes.

The below table presents the main technical characteristics of the monitoring equipment.

Table 3 – Technical specification of the monitoring equipment.

Type	Manufacturer	Model	Serial number	Range
LFG Flow inlet to Biomethane	ABB	FMT500-IG	V14224-002961	0 - 24,000 Nm ³ /h
LFG Flow inlet direct to Flare	ABB	FMT500-IG	V14224-002969	1 - 24,000 Nm ³ /h
Biomethane Flow inlet return to Flare	ABB	FMT500-IG	V14224-002962	2 - 24,000 Nm ³ /h
LFG Temperature	WARME	WTT-6001	TI.3244	0 - 80°C
LFG Pressure	ROSEMOUNT	3051	2593163	0 - 500 mbar
Methane Fraction in LFG	ABB	PGC-1000	T170268182	0-100%

However, whenever for a certain period a delay in the calibration of measuring equipment was observed, the procedures defined in paragraph 369 of the CDM validation and verification standard for project activities were adopted. The errors and uncertainties applied in the relevant monitoring period are presented below:

Table 4 - Calibration information of project's equipment and discount applied.

Instrument	TAG	Manufacturer	Model	Serial number	Starting period	Finishing period	Calibration frequency	Date of Calibration	Validity	Error used in data discount (%)
LFG Flow inlet to Biomethane	FIT 215	ABB	FMT500-IG	V14224-002961	22/12/2017	31/09/2020	3 years	05/12/2017	04/12/2020	0,00%
LFG Flow inlet direct to Flare	FIT 206	ABB	FMT500-IG	V14224-002969	22/12/2017	31/09/2020	3 years	05/12/2017	04/12/2020	0,00%
Biomethane Flow inlet return to Flare	FIT 510	ABB	FMT500-IG	V14224-002962	22/12/2017	31/09/2020	3 years	05/12/2017	04/12/2020	0,00%
LFG Temperature	TE 210	WARME	WTT-6001	TI.3244	22/12/2017	31/09/2020	3 years	14/07/2017	13/07/2020	0.1 C + 0.05% Reading
LFG Pressure	PIT 210	ROSEMOUNT	3051	2593163	22/12/2017	31/09/2020	3 years	06/09/2017	05/09/2020	0,04%
Methane Fraction in LFG	Ecometano - GNR	ABB	PGC-1000	T170268182	22/12/2017	22/10/2018	1 year	10/11/2017	09/11/2018	-
		ABB	PGC-1000	T170268182	23/10/2018	06/05/2019	1 year	23/10/2018	22/10/2019	-
		ABB	PGC-1000	T170268182	07/05/2019	05/02/2020	1 year	07/05/2019	06/06/2020	-
		ABB	PGC-1000	T170268182	06/02/2020	10/08/2020	6 months	06/02/2020	05/02/2020	1,00%
		ABB	PGC-1000	T170268182	11/08/2020	13/10/2020	6 months	11/08/2020	10/02/2021	-
		ABB	PGC-1000	T170268182	14/10/2020	31/09/2020	6 months	14/10/2020	13/04/2021	-
Electricity meter	-	LandiGyr	E750	5858329	22/12/2017	31/09/2020	5 years	ENEL responsibility		-

SECTION D. Data and parameters

D.1. Data and parameters fixed ex ante

ACM0001

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 "Emissions from solid waste disposal sites"
Value(s) applied	0.1
Choice of data or measurement methods and procedures	As per the applicable tool
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	Applicable to section 5.4.1. of the registered PDD (baseline emissions of methane from the SWDS, BE _{CH₄,y})

Data/Parameter	GWP _{CH₄}
Unit	tCO _{2e} /tCH ₄
Description	Global Warming Potential of CH ₄
Source of data	IPCC
Value(s) applied	25 for the second commitment period. Shall be updated according to any future COP/MOP decisions
Choice of data or measurement methods and procedures	As per the applicable methodology
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	-

Data/Parameter	NCV _{CH₄}
Unit	TJ/tCH ₄
Description	Net calorific value of methane at reference conditions
Source of data	Technical literature

Value(s) applied	0.0504
Choice of data or measurement methods and procedures	As per the applicable methodology
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	-

Data/Parameter	η_{PJ}
Unit	Dimensionless
Description	Efficiency of the LFG capture system that will be installed in the project activity
Source of data	-
Value(s) applied	50%.
Choice of data or measurement methods and procedures	Default value provided by the applicable methodology
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	Applicable to Step A.1.1

Tool Emissions from solid waste disposal sites

Data/Parameter	Φ_{default}
Unit	-
Description	Default value for the model correction factor to account for model uncertainties
Source of data	-
Value(s) applied	0.75
Choice of data or measurement methods and procedures	As per the applicable methodological tool " <i>Emissions from solid waste disposal sites</i> ". This parameter is used to determine the baseline emissions following the procedures related to <i>Application A</i> . Further, the project is located at Caucaia municipality (next to Fortaleza), Ceará state (northeast region of Brazil) which possesses humid/wet weather conditions ¹⁸ : MAT = 26.6°C MAP = 1.643mm. Therefore, the value correspondent to this condition as presented in Table 3 of the methodology is chosen.
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	As per Table 3 since the project participants have chosen to apply Option 1 to determine this parameter.

Data/Parameter	f_y
Unit	-
Description	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
Source of data	ACM0001
Value(s) applied	0

¹⁸ The climatic conditions are based on long-term averages from 1973 to 1990 and were taken from EMBRAPA - Brazilian Agricultural Research Company, available at <http://www.bdclima.cnpem.embrapa.br/resultados/balanco.php?UF=&COD=43>.

Choice of data or measurement methods and procedures	In accordance with the ACM0001 methodology this value is to be assigned since the amount of LFG that would have been captured and destroyed is already accounted for in Equation 2 (of the registered PDD). As per the applicable methodological tool <i>"Emissions from solid waste disposal sites"</i> , for application A, this parameter is determined once for the crediting period ($f_y = f$).
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	-

Data/Parameter	OX
Unit	-
Description	Oxidation factor (reflecting the amount of methane from SWDS that is oxidized in the soil or other material covering the waste)
Source of data	Based on an extensive review of published literature on this subject, including the IPCC 2006 Guidelines for National Greenhouse Gas Inventories
Value(s) applied	0
Choice of data or measurement methods and procedures	As per the applicable methodological tool <i>"Emissions from solid waste disposal sites"</i>
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	As per the AM_CLA_0259 clarification request final response, it was opted not to account for this effect while determining the ex-ante estimative of baseline emissions.

Data/Parameter	F
Unit	-
Description	Fraction of methane in the SWDS gas (volume fraction)
Source of data	IPCC 2006 Guidelines for National Greenhouse Gas Inventories
Value(s) applied	0.5
Choice of data or measurement methods and procedures	As per the applicable methodological tool <i>"Emissions from solid waste disposal sites"</i>
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	Upon biodegradation, organic material is converted to a mixture of methane and carbon dioxide.

Data/Parameter	DOC _{f,default}
Unit	Weight fraction
Description	Default value for the fraction of degradable organic carbon (DOC) in MSW that decomposes in the SWDS
Source of data	IPCC 2006 Guidelines for National Greenhouse Gas Inventories"
Value(s) applied	0.5
Choice of data or measurement methods and procedures	The proposed project activity corresponds to <i>Application A</i> described in the applicable methodological tool <i>"Emissions from solid waste disposal sites"</i> . Therefore, in accordance with the requirements set out by tool, the default value was chosen.
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	This factor reflects the fact that some of the degradable organic carbon does not degrade, or degrades very slowly, in the SWDS.

Data/Parameter	MCF _{default}
Unit	-
Description	Methane correction factor

Source of data	IPCC 2006 Guidelines for National Greenhouse Gas Inventories
Value(s) applied	1.0
Choice of data or measurement methods and procedures	The proposed project activity matches <i>Application A</i> described in the tool " <i>Emissions from solid waste disposal sites</i> ". The Oeste de Caucaia Lanfill meets the criteria of managed SWDS. Hence, the value corresponding to anaerobic managed solid waste disposal sites is chosen.
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	-

Data/Parameter	DOC _j														
Unit	-														
Description	Fraction of degradable organic carbon in the waste type <i>j</i> (weight fraction)														
Source of data	IPCC 2006 Guidelines for National Greenhouse Gas Inventories (adapted from Volume 5, Tables 2.4 and 2.5)														
Value(s) applied	<table border="1"> <thead> <tr> <th>DOC_j (% wet waste)</th><th>Waste type <i>j</i></th></tr> </thead> <tbody> <tr> <td>43%</td><td>Wood and wood products</td></tr> <tr> <td>40%</td><td>Pulp, paper and cardboard</td></tr> <tr> <td>15%</td><td>Food, food waste, beverages and tobacco</td></tr> <tr> <td>24%</td><td>Textiles</td></tr> <tr> <td>20%</td><td>Garden, yard and park waste</td></tr> <tr> <td>0%</td><td>Glass, plastic, metal, other inert waste</td></tr> </tbody> </table>	DOC _j (% wet waste)	Waste type <i>j</i>	43%	Wood and wood products	40%	Pulp, paper and cardboard	15%	Food, food waste, beverages and tobacco	24%	Textiles	20%	Garden, yard and park waste	0%	Glass, plastic, metal, other inert waste
DOC _j (% wet waste)	Waste type <i>j</i>														
43%	Wood and wood products														
40%	Pulp, paper and cardboard														
15%	Food, food waste, beverages and tobacco														
24%	Textiles														
20%	Garden, yard and park waste														
0%	Glass, plastic, metal, other inert waste														
Choice of data or measurement methods and procedures	Values for MSW, as per Table 6 of the methodological tool " <i>Emissions from solid waste disposal sites</i> ".														
Purpose of data/parameter	Calculation of baseline emissions														
Additional comments	-														

Data/Parameter	k _j																
Unit	1/yr																
Description	Decay rate for the waste type <i>j</i>																
Source of data	IPCC 2006 Guidelines for National Greenhouse Gas Inventories (adapted from Volume 5, Table 3.3)																
Value(s) applied	<table><tr><th colspan="2">Waste type <i>j</i></th><th><i>k_j</i></th></tr><tr><td rowspan="2">Slowly degrading</td><td>Pulp, paper, cardboard (other than sludge), textiles</td><td>0.07</td></tr><tr><td>Wood, wood products and straw</td><td>0.035</td></tr><tr><td>Moderately degrading</td><td>Other (non-food) organic putrescible garden and park waste</td><td>0.17</td></tr><tr><td>Rapidly degrading</td><td>Food, food waste, sewage sludge, beverages and tobacco</td><td>0.40</td></tr></table>			Waste type <i>j</i>		<i>k_j</i>	Slowly degrading	Pulp, paper, cardboard (other than sludge), textiles	0.07	Wood, wood products and straw	0.035	Moderately degrading	Other (non-food) organic putrescible garden and park waste	0.17	Rapidly degrading	Food, food waste, sewage sludge, beverages and tobacco	0.40
Waste type <i>j</i>		<i>k_j</i>															
Slowly degrading	Pulp, paper, cardboard (other than sludge), textiles	0.07															
	Wood, wood products and straw	0.035															
Moderately degrading	Other (non-food) organic putrescible garden and park waste	0.17															
Rapidly degrading	Food, food waste, sewage sludge, beverages and tobacco	0.40															
Choice of data or measurement methods and procedures	As per Table 7 of the methodological tool “Emissions from solid waste disposal sites”.																
Purpose of data/parameter	Calculation of baseline emissions																
Additional comments	The project is located at Caucaia municipality (next to Fortaleza), Ceará state (northeast region of Brazil) which possesses humid/wet weather conditions ¹⁸ : MAT = 26.6°C MAP = 1.643mm																

Data/Parameter	W _x
Unit	T
Description	Total amount of waste disposed in a SWDS in year <i>x</i>
Source of data	Data from ECOFOR, which manages the landfill
Value(s) applied	Large amount of data. Please refer to the CERs calculation spreadsheet

Choice of data or measurement methods and procedures	ECOFOR is the institution responsible for waste management of the landfill.
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	This parameter does not need to be monitored during the crediting period since it corresponds to Application A of the methodological tool " <i>Emissions from solid waste disposal sites</i> ".

"Tool to determine the mass flow of a greenhouse gas in a gaseous stream"

Data/Parameter	Ru
Unit	Pa.m ³ /kmol.K
Description	Universal ideal gases constant
Source of data	As per the applicable tool
Value(s) applied	8,314
Choice of data or measurement methods and procedures	-
Purpose of data/parameter	Calculation of project emissions
Additional comments	Used for $F_{CH_4, sent_flare, y}$ and $F_{CH_4, NG, y}$ following Options C and A, respectively.

Data/Parameter	MM _i
Unit	kg/kmol
Description	Molecular mass of greenhouse gas <i>i</i>
Source of data	Tool
Value(s) applied	16.04 (for methane)
Choice of data or measurement methods and procedures	-
Purpose of data/parameter	Calculation of project emissions
Additional comments	Used for $F_{CH_4, sent_flare, y}$ and $F_{CH_4, NG, y}$ following Options C and A, respectively

Data/Parameter	MM _k
Unit	kg/kmol
Description	Molecular mass of gas <i>k</i> (<i>k</i> = N ₂)
Source of data	As per the tool
Value(s) applied	28.01
Choice of data or measurement methods and procedures	According to ACM0001, the simplification offered in the tool for calculating the molecular mass of the gaseous stream (MM _{t, db}) is valid. Thus, the volumetric fraction of the greenhouse gas (CH ₄) is considered and the difference to 100% is considered as pure nitrogen.
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	Not used in the case of the proposed project activity.

Data/Parameter	Pn
Unit	Pa
Description	Total pressure at normal conditions
Source of data	As per the tool
Value(s) applied	101,325
Choice of data or measurement methods and procedures	-

Purpose of data/parameter	Calculation of baseline and project emissions
Additional comments	Used for $F_{CH4, sent_flare, y}$ following Option C.

Data/Parameter	Tn
Unit	K
Description	Temperature at normal conditions
Source of data	As per the tool
Value(s) applied	273.15
Choice of data or measurement methods and procedures	-
Purpose of data/parameter	Calculation of baseline and project emissions
Additional comments	Used for $F_{CH4, sent_flare, y}$ following Option C.

“Tool to calculate the emission factor for an electricity system”

Data/Parameter	$FC_{i,m,y}$, $FC_{i,y}$, $FC_{i,k,y}$, $FC_{i,n,y}$ and $FC_{i,n,h}$
Unit	mass or volume unit
Description	Amount of fuel type i consumed by power plant/unit m , k or n (or in the project electricity system in case of $FC_{i,y}$) in year y or hour h
Source of data	Official publications (data from ONS), IPCC default values and default values provided by the “Tool to calculate the emission factor for an electricity system”
Value(s) applied	Large amount of data. Please refer to the emission factor calculation spreadsheet which is attached to the PDD.
Choice of data or measurement methods and procedures	The <i>ex-ante</i> calculation vintage of this parameter was chosen as per the procedures of the “Tool to calculate the emission factor for an electricity system”.
Purpose of data/parameter	Calculation of the project emissions due to electricity consumption
Additional comments	For methodological choices details, please refer to section E.6.1. of the registered PDD.

Data/Parameter	$EF_{CO2,i,y}$ and $EF_{CO2,m,i,y}$
Unit	tCO ₂ /GJ
Description	CO ₂ emission factor of fossil fuel type i used in power unit m in year y
Source of data	IPCC default values at the lower limit of the uncertainty at a 95% confidence interval as provided in table 1.4 of Chapter1 of Vol. 2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories
Value(s) applied	Large amount of data. Please refer to the emission factor calculation spreadsheet which is attached to the PDD.
Choice of data or measurement methods and procedures	As per the recommendation of the “Tool to calculate the emission factor for an electricity system”. IPCC default values are being used since this information is neither provided by fuel suppliers nor regional and/or local default values are publicly available.
Purpose of data/parameter	Calculation of the project emissions due to electricity consumption
Additional comments	-

Data/Parameter	$EG_{m,y}$ and $EG_{k,y}$
Unit	MWh
Description	Net electricity generated by power plant/unit m or k in year y
Source of data	Official publications. Data from the Electric System National Operator was used.
Value(s) applied	Large amount of data. Please refer to the emission factor calculation spreadsheet which is attached to the PDD.

Choice of data or measurement methods and procedures	Once for each crediting period using the most recent three historical years for which data is available at the time of submission of the PDD to the DOE for validation (<i>ex-ante</i> option).
Purpose of data/parameter	Calculation of the project emissions due to electricity consumption
Additional comments	For methodological choices details, please refer to section E.6.1. of the registered PDD

Data/Parameter	$\eta_{m,y}$
Unit	-
Description	Average net energy conversion efficiency of power unit <i>m</i> in year <i>y</i>
Source of data	Default values provided in Annex 1 of the <i>"Tool to calculate the emission factor for an electricity system"</i>
Value(s) applied	Large amount of data. Please refer to the emission factor calculation spreadsheet which is attached to the PDD.
Choice of data or measurement methods and procedures	As per the recommendation of the <i>"Tool to calculate the emission factor for an electricity system"</i> .
Purpose of data/parameter	Calculation of the project emissions due to electricity consumption
Additional comments	For methodological choices details, please refer to section E.6.1. of the registered PDD

Data/Parameter	$EF_{grid,OM-adj,y}$
Unit	tCO ₂ /MWh
Description	Simple adjusted operating margin CO ₂ emission factor in year <i>y</i>
Source of data	Official publications (data from ONS), IPCC default values and default values provided by the <i>"Tool to calculate the emission factor for an electricity system"</i>
Value(s) applied	0.3612
Choice of data or measurement methods and procedures	The <i>ex-ante</i> calculation vintage of this parameter was chosen as per the procedures of the <i>"Tool to calculate the emission factor for an electricity system"</i> .
Purpose of data/parameter	Calculation of the project emissions due to electricity consumption
Additional comments	For methodological choices details, please refer to section E.6.1. of the registered PDD

Data/Parameter	$EF_{BM,2013}$
Unit	tCO ₂ /MWh
Description	Build Margin CO ₂ emission factor in year <i>y</i>
Source of data	Official publications (data from ONS), IPCC default values and default values provided by the <i>"Tool to calculate the emission factor for an electricity system"</i>
Value(s) applied	0.2850
Choice of data or measurement methods and procedures	The <i>ex-ante</i> calculation vintage of this parameter was chosen as per the procedures of the <i>"Tool to calculate the emission factor for an electricity system"</i> .
Purpose of data/parameter	Calculation of the project emissions due to electricity consumption
Additional comments	For methodological choices details, please refer to section E.6.1. of the registered PDD

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:

- Volumetric fraction of greenhouse gas i in a time interval t on a wet basis ($v_{i,t,wb}$);
- Quantity of fuel type i combusted in process j during the year y ($FC_{i,j,y}$), when i corresponds to any fossil fuel used to generate electricity since electricity consumed by the plant is from the grid;
- Weighted average net calorific value of fuel type i in year y ($NCV_{i,y}$), when i corresponds to any fossil fuel used to generate electricity since electricity consumed by the plant is from the grid;
- Weighted average CO₂ emission factor of fuel type i in year y ($EF_{CO_2,i,y}$), when i corresponds to any fossil fuel used to generate electricity since electricity consumed by the plant is from the grid;

ACM0001

Data/Parameter	Management of SWDS
Unit	-
Description	Management of SWDS
Measured/calculated/default	-
Source of data	Use different sources of data: - Original design of the landfill; - Technical specifications for the management of the SWDS; - Local or national regulations
Value(s) of monitored parameter	-
Monitoring equipment	-
Measuring/reading/recording frequency	Annually
Calculation method (if applicable)	-
QA/QC procedures	Project participants should refer 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
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	-

Data/Parameter	Op _{j,h}
Unit	-
Description	Operation of the equipment that consumes the LFG

Measured/calculated/default	<p>In the context of the proposed project activity, equipment unit j using <i>the LFG</i> consists of the LFG upgrading facility and a flare. Hence, the following parameters are to be used to ensure that the plant is operating in hour h:</p> <p><u>For the LFG upgrading facility</u></p> <ul style="list-style-type: none"> Products generated. Monitor the generation of upgraded LFG which is sold to the consumer. This information can be cross-checked with invoices; <p><u>For the flaring system</u></p> <ul style="list-style-type: none"> Flame. Flame detection system is used to ensure that the equipment is in operation; <p>$Op_{j,h}=0$ when:</p> <ul style="list-style-type: none"> No products are generated in the hour h Flame is not detected continuously in hour h (instantaneous measurements are made at least every minute); <p>Otherwise, $Op_{j,h}=1$</p>
Source of data	Project Participants
Value(s) of monitored parameter	The CERs calculation spreadsheet includes all records of measurement data of this parameter during the considered monitoring period.
Monitoring equipment	-
Measuring/reading/recording frequency	Hourly
Calculation method (if applicable)	Not applicable
QA/QC procedures	Flow meters and flame detectors shall be subject to a regular maintenance and testing regime to ensure accuracy. Calibration shall be according to manufacturers' specifications. Accuracy of the flow meters and flame detectors is described in the monitoring tables of parameters $V_{t,db}$ and $Flame_m$, respectively.
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	This is monitored to ensure methane destruction is claimed for methane used in the upgrading LFG facility when it is operational

Data/Parameter	$EG_{EC,y}$
Unit	MWh
Description	Amount of electricity consumed by the project activity in year y
Measured/calculated/default	Measured
Source of data	Electricity meters
Value(s) of monitored parameter	The CERs calculation spreadsheet includes all records of measurement data of this parameter during the considered monitoring period.
Monitoring equipment	<p>Manufacturer: Landis Gyr Model: E750 Serial Number: 5858329 Accuracy class: C/D Meter calibration and maintenance under the responsibility of the local electricity distribution company.</p>
Measuring/reading/recording frequency	Continuously, aggregated at least annually
Calculation method (if applicable)	-
QA/QC procedures	Electricity meter will be subject to regular maintenance and testing to ensure accuracy. The calibration periodicity will be in accordance with the manufacturer recommendation. The accuracy of the equipment, as per the manufacturer specification is 1% (Accuracy class 1%).
Purpose of data/parameter	Calculation of project emissions

Additional comments	This parameter is required for calculating project emissions from electricity consumption due to an alternative waste treatment process t ($PE_{EC,y}$) using the “Tool to calculate baseline, project and/or leakage emissions from electricity consumption”. In accordance with ACM0001, this parameter is equivalent to $EC_{PJ,k,y}$ in the tool.
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“Tool to determine the mass flow of a greenhouse gas in a gaseous stream”

Data/Parameter	V _{t,db}							
Unit	m ³ dry gas/h							
Description	Volumetric flow of the gaseous stream in time interval <i>t</i> on a dry basis							
Measured/calculated/default	Measured							
Source of data	Onsite measurements							
Value(s) of monitored parameter	The CERs calculation spreadsheet includes all records of measurement data of this parameter during the considered monitoring period.							
Monitoring equipment	Instrument	TAG	Manufacturer	Model	Serial number	Calibration frequency	Date of Calibration	Validity
	LFG Flow inlet to Biomethane	FIT 215	ABB	FMT500-IG	V14224-002961	3 years	05/12/2017	04/12/2020
	LFG Flow inlet direct to Flare	FIT 206	ABB	FMT500-IG	V14224-002969	3 years	05/12/2017	04/12/2020
	Biomethane Flow inlet return to Flare	FIT 510	ABB	FMT500-IG	V14224-002962	3 years	05/12/2017	04/12/2020
Measuring/reading/recording frequency	Continuous, aggregated at least hourly.							
Calculation method (if applicable)	-							
QA/QC procedures	Periodic calibration against a primary device provided by an independent accredited laboratory is mandatory. Calibration and frequency of calibration is according to manufacturer's specification.							
Purpose of data/parameter	Calculation of baseline and project emissions							
Additional comments	This parameter will be monitored in Option A, in order to calculate <i>F_{CH4,NG}</i> and <i>F_{CH4,sent_flare,y}</i> (including upgraded gas that does not reach specifications to be sent to the NG pipeline).							

Data/Parameter	V _{t,wb}																																							
Unit	m ³ wet gas/h																																							
Description	Volumetric flow of the gaseous stream in time interval <i>t</i> on a wet basis																																							
Measured/calculated/default	Measured																																							
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Measuring/reading/recording frequency	Continuous, aggregated at least hourly.																																							
Calculation method (if applicable)	-																																							
QA/QC procedures	Periodic calibration against a primary device provided by an independent accredited laboratory is mandatory. Calibration and frequency of calibration is according to manufacturer's specification.																																							
Purpose of data/parameter	Calculation of baseline and project emissions																																							
Additional comments	This parameter will be monitored in Option B, in order to calculate $F_{CH4,sent_flare,y}$ (LFG flared).																																							

Data/Parameter	$V_{i,t,db}$																																														
Unit	m ³ gas /m ³ dry gas																																														
Description	Volumetric fraction of greenhouse gas i in time interval t on a dry basis																																														
Measured/calculated/default	Measured																																														
Source of data	Onsite measurement																																														
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Measuring/reading/recording frequency	Continuous, aggregated at least hourly.																																														
Calculation method (if applicable)	-																																														
QA/QC procedures	Calibration should include zero verification with an inert gas (e.g. N ₂) and at least one reading verification with a standard gas (single calibration gas or mixture calibration gas). All calibration gases must have a certificate provided by the manufacturer and must be under their validity period.																																														
Purpose of data/parameter	Calculation of baseline and project emissions																																														
Additional comments	This parameter will be monitored in Option A, in order to calculate $F_{CH_4,NG}$ and $F_{CH_4,sent_flare,y}$ (upgraded gas that does not reach specifications to be sent to the NG pipeline).																																														

Data/Parameter	T_t																
Unit	K																
Description	Temperature of the gaseous stream in time interval t																
Measured/calculated/default	Measured																
Source of data	Onsite measurements																
Value(s) of monitored parameter	The CERs calculation spreadsheet includes all records of measurement data of this parameter during the considered monitoring period.																
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Measuring/reading/recording frequency	Continuous, aggregated at least hourly.																
Calculation method (if applicable)	-																
QA/QC procedures	Periodic calibration against a primary device provided by an independent accredited laboratory is mandatory. Calibration and frequency of calibration is according to manufacturer's specifications																
Purpose of data/parameter	Calculation of baseline and project emissions																
Additional comments	<p>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). However, if the applicability condition related to the gaseous stream flow temperature being below 60°C is adopted, this parameter must be monitored continuously to assure the applicability condition is met.</p> <p>Applicable to Options A and B in order to determine $F_{CH_4,NG}$ and $F_{CH_4,sent_flare,y}$ parameters, respectively.</p>																

Data/Parameter	P _t																							
Unit	Pa																							
Description	Pressure of the gaseous stream in time interval <i>t</i>																							
Measured/calculated/default	Measured																							
Source of data	Onsite measurements																							
Value(s) of monitored parameter	The CERs calculation spreadsheet includes all records of measurement data of this parameter during the considered monitoring period.																							
Monitoring equipment	<table><tr><th>Instrument</th><th>TAG</th><th>Manufacturer</th><th>Model</th><th>Serial number</th><th>Calibration frequency</th><th>Date of Calibration</th><th>Validity</th></tr><tr><td>LFG Pressure</td><td>PIT 210</td><td>ROSEMOUNT</td><td>3051</td><td>2593163</td><td>3 years</td><td>06/09/2017</td><td>05/09/2020</td></tr></table>								Instrument	TAG	Manufacturer	Model	Serial number	Calibration frequency	Date of Calibration	Validity	LFG Pressure	PIT 210	ROSEMOUNT	3051	2593163	3 years	06/09/2017	05/09/2020
Instrument	TAG	Manufacturer	Model	Serial number	Calibration frequency	Date of Calibration	Validity																	
LFG Pressure	PIT 210	ROSEMOUNT	3051	2593163	3 years	06/09/2017	05/09/2020																	
Measuring/reading/recording frequency	Continuous, aggregated at least hourly.																							
Calculation method (if applicable)	-																							
QA/QC procedures	Periodic calibration against a primary device must be performed periodically and records of calibration procedures must be kept available as well as the primary device and its calibration certificate. Pressure transducers (either capacitive or resistive) must be calibrated monthly.																							
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). Applicable to Option A and B in order to determine <i>F_{CH4,NG}</i> and <i>F_{CH4,sent_flare,y}</i> parameters, respectively.																							

“Project emissions from flaring”

Data/Parameter	Flame _m
Unit	Flame on or Flame off
Description	Flame detection of flare in the minute m
Measured/calculated/default	The CERs calculation spreadsheet includes all records of measurement data of this parameter during the considered monitoring period.
Source of data	Project participants
Value(s) of monitored parameter	The CERs calculation spreadsheet includes all records of measurement data of this parameter during the considered monitoring period.
Monitoring equipment	Flame detector
Measuring/reading/recording frequency	Once per minute. Detection of flame recorder 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 shall be maintained and calibrated in accordance with manufacturer's recommendations. It will be replaced after 10,000 operating hours. The spectral range of the equipment is 190 – 270nm and its maximum sensitivity is 210 ± 10 nm.
Purpose of data/parameter	Calculation of project emissions
Additional comments	-

“Tool to calculate baseline, project and/or leakage emissions from electricity consumption”

Data/Parameter	$TDL_{project,y}$
Unit	%
Description	Average technical transmission and distribution losses for providing electricity to source j in year y

Measured/calculated/default	Default
Source of data	ANEEL Report ¹⁹
Value(s) of monitored parameter	2017: 13.95 % 2018: 14.44 % 2019: 16.02 %
Monitoring equipment	-
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)	-
QA/QC procedures	-
Purpose of data/parameter	Calculation of project emissions
Additional comments	Official source is used. Aneel is the Brazilian electricity regulatory agency. Data from 2020 is not available. Hence, information from 2019 (most recent figure) is used to calculate project emissions due to electricity consumption during 2020.

“Tool to determine project emissions from fossil fuel combustion”

Data/Parameter	$FC_{i,j,y}$
Unit	kg/yr
Description	Quantity of fuel type i combusted in process j during the year y ($i = \text{LPG}$)
Measured/calculated/default	Measured
Source of data	Sales receipt
Value(s) of monitored parameter	The CERs calculation spreadsheet includes all records of measurement data of this parameter during the considered monitoring period.
Monitoring equipment	Internal records related to LPG purchase
Measuring/reading/recording frequency	At every purchase of LPG
Calculation method (if applicable)	-
QA/QC procedures	The consistency of metered fuel consumption quantities is to be cross-checked by an annual energy balance that is based on purchased quantities and stock changes. Where the purchased fuel invoices can be identified specifically for the CDM project, the metered fuel consumption quantities should also be cross-checked with available purchase invoices from the financial records.
Purpose of data/parameter	Calculation of project emissions
Additional comments	Conservatively, it shall be considered that all LPG purchase will be used.

Data/Parameter	$NCV_{i,y}$
Unit	GJ/kg
Description	Weighted average net calorific value of fuel type i in year y ($i = \text{LPG}$)
Measured/calculated/default	Default
Source of data	Brazilian Energy Balance

¹⁹ Publicly available in Portuguese at https://www.aneel.gov.br/metodologia-distribuicao/-/asset_publisher/e2INtBH4EC4e/content/perdas/654800?inheritRedirect=false&redirect=http%3A%2F%2Fwww.aneel.gov.br%2Fmetodologia-distribuicao%3Fp_p_id%3D101_INSTANCE_e2INtBH4EC4e%26p_p_lifecycle%3D0%26p_p_state%3Dnormal%26p_p_mode%3Dview%26p_p_col_id%3Dcolumn-2%26p_p_col_pos%3D3%26p_p_col_count%3D4

Value(s) of monitored parameter	0.0465
Monitoring equipment	-
Measuring/reading/recording frequency	Review appropriateness of values annually
Calculation method (if applicable)	-
QA/QC procedures	Verify if the value is within the uncertainty range of the IPCC default values as provided in Table 1.2, Vol. 2 of the 2006 IPCC Guidelines. If the values fall below this range collect additional information from the testing laboratory to justify the outcome or conduct additional measurements. The laboratories in a), b) or c) should have ISO17025 accreditation or justify that they can comply with similar quality standards.
Purpose of data/parameter	Calculation of project emissions from fossil fuel consumption for the flare ignition.
Additional comments	Option c) is used since a liquid fuel is considered and is based on well documented reliable sources (<i>i.e.</i> Brazilian Energy Balance). Information used with the purpose of calculating expected emission reductions is in accordance with the values provided in 2006 IPCC Guidelines.

Data/Parameter	EF _{CO₂,i,y}
Unit	tCO ₂ /GJ
Description	Weighted average CO ₂ emission factor of fuel type <i>i</i> in year <i>y</i> (<i>i</i> = LPG)
Measured/calculated/default	Default
Source of data	d) IPCC default values at the upper limit of the uncertainty at 95% confidence interval as provided in Table 1.2 of Chapter 1 of Vol.2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories
Value(s) of monitored parameter	0.0656
Monitoring equipment	-
Measuring/reading/recording frequency	Any future revisions of the IPCC Guidelines should be taken into account.
Calculation method (if applicable)	-
QA/QC procedures	Not applicable since IPCC default value is used.
Purpose of data/parameter	Calculation of project emissions
Additional comments	-

Data/Parameter	EF _{CO₂,i,y}
Unit	tCO ₂ /TJ
Description	Weighted average CO ₂ emission factor of fuel type <i>i</i> in year <i>y</i> (<i>i</i> = natural gas)
Measured/calculated/default	Default
Source of data	IPCC default values at the upper limit of the uncertainty at 95% confidence interval as provided In Table 1.2 of Chapter 1 of Vol.2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories
Value(s) of monitored parameter	58.3
Monitoring equipment	-
Measuring/reading/recording frequency	Any future revisions of the IPCC Guidelines should be taken into account.
Calculation method (if applicable)	-

QA/QC procedures	-
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	Option d) is used since the source mentioned in option a) is not available. Further the fuel considered – i.e. natural gas - is not liquid. Therefore, option c) could not be used. This parameter is used to determine $EF_{CO_2,NG,y}$ from ACM0001. Following the procedures of the methodology, it is to be determined using the “Tool to determine project emissions from fossil fuel combustion”.

D.3. Implementation of sampling plan

>>

Not applicable. This section is intentionally left 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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This section describes the methods used for the calculation of baseline emissions. As per the requirements, sample calculations for all formulae used are provided considering baseline emissions achieved by the CDM Project Activity during 01/2018.

The table below summarizes the results of baseline emissions calculated for the monitoring period.

	DEVIATION applied	BE _y	BE _{CH4,y}	BE _{NG,y}	FCH4PJ,y	FCH4BL,y	FCH4flared,y	FCH4NG,y	% CH4	FCH4 sentflare,y	Total methane for Consumer	Total methane to Flare	FCH4RG,t	PE _{flare,y}
	(yes/no)	tCO ₂	tCO ₂	tCO ₂	tCH ₄	tCH ₄	tCH ₄	tCH ₄	%	tCH ₄	Nm ³ CH ₄	Nm ³ CH ₄	kg	tCO ₂
12/2017	Yes	4,799	4,282	517	245	49	68.8	176	60.1%	137.5	245,449	191,843	137,513	1,719
01/2018	Yes	8,846	7,964	882	455	91	154.8	300	59.9%	309.6	418,931	431,897	309,584	3,870
02/2018	Yes	5,094	4,501	593	257	51	55.4	202	59.6%	110.8	281,577	154,519	110,760	1,384
03/2018	Yes	13,783	12,374	1,409	707	141	227.6	479	59.4%	455.3	668,875	635,177	455,295	5,691
04/2018	Yes	12,141	10,634	1,507	608	122	94.6	513	59.8%	189.2	715,741	263,972	189,215	2,365
05/2018	Yes	18,920	16,563	2,357	946	189	144.3	802	60.1%	288.6	1,119,091	402,670	288,634	3,608
06/2018	Yes	30,397	26,187	4,210	1,496	299	63.8	1,433	59.5%	127.6	1,998,650	177,989	127,583	1,595
07/2018	Yes	39,149	33,589	5,560	1,919	384	27.1	1,892	59.5%	54.3	2,639,835	75,692	54,256	678
08/2018	Yes	33,540	28,761	4,779	1,643	329	17.0	1,626	59.5%	34.1	2,269,034	47,562	34,092	426
09/2018	Yes	33,082	28,349	4,733	1,620	324	9.2	1,611	58.8%	18.4	2,247,143	25,619	18,364	230
10/2018	Yes	9,025	7,769	1,256	444	89	16.3	428	47.2%	32.6	596,541	45,524	32,632	408
11/2018	Yes	25,037	21,465	3,572	1,227	245	11.0	1,216	47.8%	22.0	1,695,867	30,628	21,954	274
12/2018	Yes	27,315	23,414	3,901	1,338	268	10.4	1,328	49.6%	20.8	1,852,091	28,976	20,770	260
01/2019	Yes	27,311	23,406	3,905	1,337	267	8.6	1,329	49.5%	17.2	1,853,930	23,932	17,155	214
02/2019	Yes	21,903	18,768	3,135	1,072	214	5.4	1,067	49.4%	10.8	1,488,656	15,024	10,769	135
03/2019	Yes	22,633	19,524	3,109	1,116	223	57.6	1,058	50.2%	115.3	1,476,053	160,798	115,260	1,441
04/2019	Yes	31,351	26,914	4,437	1,538	308	27.8	1,510	49.7%	55.7	2,106,752	77,651	55,660	696
05/2019	Yes	28,184	24,181	4,003	1,382	276	19.3	1,362	49.8%	38.6	1,900,748	53,910	38,643	483
06/2019	Yes	32,012	27,420	4,592	1,567	313	4.0	1,563	49.4%	8.1	2,180,292	11,232	8,051	101
07/2019	Yes	33,455	28,753	4,702	1,643	329	42.6	1,600	49.7%	85.3	2,232,674	118,968	85,276	1,066
08/2019	Yes	23,878	20,455	3,423	1,169	234	4.0	1,165	47.9%	8.0	1,625,112	11,149	7,992	100
09/2019	Yes	34,196	29,367	4,830	1,678	336	34.4	1,644	48.8%	68.8	2,293,074	96,029	68,833	860
10/2019	Yes	34,982	30,150	4,832	1,723	345	78.5	1,644	48.6%	157.0	2,294,065	218,966	156,955	1,962
11/2019	Yes	33,305	28,532	4,773	1,630	326	5.8	1,625	46.0%	11.7	2,266,401	16,275	11,666	146
12/2019	Yes	33,570	28,774	4,796	1,644	329	12.1	1,632	45.9%	24.2	2,276,948	33,827	24,247	303
01/2020	Yes	23,576	20,260	3,317	1,158	232	29.0	1,129	32.7%	57.9	1,574,682	80,796	57,915	724
02/2020	Yes	30,845	26,494	4,351	1,514	303	33.3	1,481	47.2%	66.5	2,065,714	92,786	66,509	831
03/2020	Yes	36,419	31,205	5,214	1,783	357	8.6	1,775	47.5%	17.2	2,475,605	24,035	17,229	215
04/2020	Yes	30,000	25,710	4,290	1,469	294	9.0	1,460	43.2%	18.0	2,037,037	25,089	17,984	225
05/2020	Yes	36,723	31,461	5,262	1,798	360	6.9	1,791	48.4%	13.8	2,498,391	19,257	13,803	173
06/2020	Yes	32,710	28,033	4,677	1,602	320	10.0	1,592	47.6%	20.0	2,220,811	27,933	20,023	250
07/2020	Yes	34,573	29,623	4,950	1,693	339	8.1	1,685	47.3%	16.1	2,350,258	22,465	16,103	201
08/2020	Yes	30,449	26,094	4,355	1,491	298	8.8	1,482	45.4%	17.7	2,067,842	24,679	17,690	221
09/2020	Yes	21,796	18,685	3,112	1,068	214	8.7	1,059	47.3%	17.4	1,477,364	24,309	17,425	218

Baseline emissions for the proposed project activity are determined according to the following equation:

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

Equation 1

Where,

BE_y	=	Baseline emissions in year y (t CO ₂ e/yr)
$BE_{CH_4,y}$	=	Baseline emissions of methane from the SWDS in year y (t CO ₂ e/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)

Baseline emissions associated with heat generation in year y ($BE_{HG,y}$) and electricity generation in year y ($BE_{EC,y}$) are not applicable to the proposed project activity.

Sample calculation:

$$BE_y = BE_{CH_4,y} + BE_{NG,y}$$

$$BE_y = 7,964 + 882 = 8,846 \text{ tCO}_2\text{e}$$

Baseline emissions of methane from the SWDS ($BE_{CH_4,y}$) are determined, based on the amount of methane that is captured under the project activity and the amount that would be captured and destroyed in the baseline (such as due to regulations). In addition, the effect of methane oxidation that is present in the baseline and absent in the project is taken into account²⁰.

$$BE_{CH_4,y} = ((1 - OX_{top_layer}) \times F_{CH_4PJ,y} - F_{CH_4BL,y}) \times GWP_{CH_4} \quad \text{Equation 2}$$

Where,

$BE_{CH_4,y}$	=	Baseline emissions of methane from the SWDS in year y (t CO ₂ e/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)
$F_{CH_4,PJ,y}$	=	Amount of methane in the LFG which is flared and/or used in the project activity in year y (t CH ₄ /yr)
$F_{CH_4,BL,y}$	=	Amount of methane in the LFG that would be flared in the baseline in year y (t CH ₄ /yr)
GWP_{CH_4}	=	Global warming potential of CH ₄ (t CO ₂ e/t CH ₄)

Sample calculations

$$BE_{CH_4,y} = ((1 - OX_{top_layer}) \times F_{CH_4,PJ,y} - F_{CH_4,BL,y}) \times GWP_{CH_4}$$

$$BE_{CH_4,y} = ((1 - 0.1) \times 455 - 91) \times 25 = 7,964 \text{ tCO}_2\text{e}$$

During the crediting period, $F_{CH_4,PJ,y}$ is determined as the sum of the quantities of methane flared and forwarded to the natural gas distribution network, considering the following equation:

$$F_{CH_4,PJ,y} = F_{CH_4,flared,y} + F_{CH_4,EL,y} + F_{CH_4,HG,y} + F_{CH_4,NG,y} \quad \text{Equation 3}$$

Where,

$F_{CH_4,PJ,y}$	=	Amount of methane in the LFG which is flared and/or used in the project activity in year y (tCH ₄ /yr)
$F_{CH_4,flared,y}$	=	Amount of methane in the LFG which is destroyed by flaring in year y (tCH ₄ /yr)
$F_{CH_4,EL,y}$	=	Amount of methane in the LFG which is used for electricity generation in year y

²⁰ OX_{top_layer} is the fraction of the methane in the LFG that would oxidize in the top layer of the SWDS in the absence of the project activity. Under the project activity, this effect is reduced as a part of the LFG is captured and does not pass through the top layer of the SWDS. This oxidation effect is also accounted for in the methodological tool "Emissions from solid waste disposal sites". In addition to this effect, the installation of a LFG capture system under the project activity may result in the suction of additional air into the SWDS. In some cases, such as with a high suction pressure, the air may decrease the amount of methane that is generated under the project activity. However, in most circumstances where the LFG is captured and used this effect was considered to be very small, as the operators of the SWDS have in most cases an incentive to maintain a high methane concentration in the LFG. For this reason, this effect is neglected as a conservative assumption.

(tCH₄/yr)

$F_{CH4,HG,y}$ = Amount of methane in the LFG which is used for heat generation in year y (tCH₄/yr)
 $F_{CH4,NG,y}$ = Amount of methane in the LFG which is sent to the natural gas distribution network and/or to the trucks in year y (tCH₄/yr)

In the case of the project activity, $F_{CH4,HG,y}$ and $F_{CH4,EL,y}$ are zero since neither heat nor electricity will be generated using the biogas.

Sample calculations

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

$$F_{CH4,PJ,y} = 155 + 300 = 455 \text{ tCO}_2\text{e}$$

The determination of $F_{CH4,NG,y}$ is done using the “Tool to determine the mass flow of a greenhouse gas in a gaseous stream”. Since the proposed project activity is under conception and it is not known if temperature/pressure will be hourly monitored in all metering points, the PDD presents the most possible scenario for biogas and methane monitoring. In spite of the options chosen at the time of the project verification, monitoring will be followed according to ACM0001 and the “Tool to determine the mass flow of a greenhouse gas in a gaseous stream”.

Then, the most plausible scenario for $F_{CH4,NG,y}$ determination is **Option A** of the Tool (*i.e.*, biogas mass flow and volumetric fraction of methane measured in dry basis). Then, $F_{CH4,NG,y} = F_{i,t}$.

While considering this option, it is necessary to demonstrate that the gaseous stream is dry by:

- Measuring the moisture content of the gaseous stream ($C_{H_2O,t,db,n}$) and demonstrate that this is less or equal to 0.05 kg H₂O/m³ dry gas; or
- Demonstrating that the temperature of the gaseous stream (T_t) is less than 60°C (333.15 K) at the flow measurement point.

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 corresponding option available in the tool should be applied instead.

$$E_{i,t} = V_{t,db} \times v_{i,t,db} \times \rho_{i,t} \quad \text{Equation 4}$$

And:

$$\rho_{i,t} = \frac{P_t \times MM_i}{R_u \times T_t} \quad \text{Equation 5}$$

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 (m³ wet gas/h);
 $v_{i,t,db}$ = Volumetric fraction of greenhouse gas i in the gaseous stream in time interval t on a dry basis (m³ gas i / m³ dry gas);
 $\rho_{i,t}$ = Density of greenhouse gas i in the gaseous stream in time interval t (kg gas i / m³ 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.m³/kmol.K);
 T_t = Temperature of the gaseous stream in time interval t (K).

$F_{CH4,flared,y}$ is determined as the difference between the amount of methane supplied to the flare(s) and any methane emissions from the flare(s), as follows:

$$F_{CH4,flared,y} = F_{CH4,sent_flare,y} - \frac{PE_{flare,y}}{GWP_{CH4}} \quad \text{Equation 6}$$

Where,

- $F_{CH4,flared,y}$ = Amount of methane in the LFG which is destroyed by flaring in year y (t CH₄/yr)
 $F_{CH4,sent_flare,y}$ = Amount of methane in the LFG which is sent to the flare in year y (t CH₄/yr)
 $PE_{flare,y}$ = Project emissions from flaring of the residual gas stream in year y (t CO₂e/yr)
 GWP_{CH4} = Global warming potential of CH₄ (t CO₂e/t CH₄)

$F_{CH4, sent_flare, y}$ is determined directly using the “Tool to determine the mass flow of a greenhouse gas in a gaseous stream”, applying the requirements described above where the gaseous stream the tool shall be applied to is the LFG delivery pipeline to the flare.

To calculate $F_{CH4, sent_flare, y}$ for the flare, **Option C** is the most plausible monitoring scenario (i.e., LFG and volumetric fraction of methane measured in wet basis). Then, $F_{CH4, sent_flare, y} = F_{i, t}$.

$$F_{i, t} = V_{t, wb, n} \times v_{i, t, wb} \times \rho_{i, n} \quad \text{Equation 7}$$

And:

$$\rho_{i, n} = \frac{P_n \times MM_i}{R_u \times T_n} \quad \text{Equation 8}$$

Where:

$F_{i, t}$	=	Mass flow of greenhouse gas i in the gaseous stream in time interval t (kg gas/h);
$V_{t, wb, n}$	=	Volumetric flow of the gaseous stream in time interval t on a wet basis at normal conditions (m ³ wet gas/h);
$v_{i, t, wb}$	=	Volumetric fraction of greenhouse gas i in the gaseous stream in time interval t on a wet basis (m ³ gas i / m ³ wet gas);
$\rho_{i, n}$	=	Density of greenhouse gas i in the gaseous stream at normal conditions (kg gas i / m ³ wet gas i);
P_n	=	Absolute pressure at normal conditions (Pa);
T_n	=	Temperature at normal conditions (K);
MM_i	=	Molecular mass of greenhouse gas i (kg/kmol);
R_u	=	Universal ideal gases constant (Pa.m ³ /kmol.K).

The following equation should be used to convert the volumetric flow of the gaseous stream from actual conditions to normal conditions of temperature and pressure:

$$V_{t, wb, n} = V_{t, wb} \times [(T_n / T_t) \times (P_t / P_n)] \quad \text{Equation 9}$$

Where:

$V_{t, wb, n}$	=	Volumetric flow of the gaseous stream in a time interval t on a wet basis at normal conditions (m ³ wet gas/h);
$V_{t, wb}$	=	Volumetric flow of the gaseous stream in time interval t on a wet basis (m ³ wet gas/h);
P_t	=	Pressure of the gaseous stream in time interval t (Pa);
T_t	=	Temperature of the gaseous stream in time interval t (K);
P_n	=	Absolute pressure at normal conditions (Pa);
T_n	=	Temperature at normal conditions (K).

It is important mentioning that the upgraded gas that does not reach specifications to be delivered in the NG pipeline will be flared. For the determination of biogas resulted from the upgrade system return that will be flared, Option A is the most plausible scenario to be applied (volume flow of biomethane and volumetric flow of methane measured in dry basis) following equations 4 and 5 above.

Project Emissions from flaring:

Project emissions are related to the amount of methane not destroyed in the flare and are determined following the procedures of the methodological tool “Project emissions from flaring”. The project is equipped with an open flare. In this sense, Oeste de Caucaia Landfill Project adopts the default flare efficiency. The calculation of flare efficiency will be made by the following steps:

STEP 1: Determination of the methane mass flow of the residual gas;

The mass flow of methane in the residual gaseous stream in the minute m ($F_{CH_4,m}$) will be determined using the procedures set out by the “Tool to determine the mass flow of a greenhouse gas in a gaseous stream” and 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 .

$F_{CH_4,m}$, 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 ($F_{CH_4,RG,m}$). This parameter corresponds to $F_{CH_4,sent_flare,y}$. Therefore, the same methodological approaches apply to both parameters (Option C of the tool described above).

However, the upgraded gas, which does not reach quality specifications to be delivered into the NG pipeline, will be flared. In this case, Option A of the tool will be applied as explained above. Please refer to methodological explanations for the ex-post determination of $F_{CH_4,sent_flare,y}$ and monitoring equipment in section B.7.3.

STEP 2: Determination of flare efficiency

The Oeste de Caucaia Landfill Project installed an open flare. Therefore, in accordance with the methodological tool, the flare efficiency in the minute m ($\eta_{flare,m}$) is 50% when the flame is detected in minute m (Flame_m), otherwise $\eta_{flare,m}$ is 0%.

STEP 3: Calculation of project emissions from flaring

Project emissions from flaring are calculated as the sum of emissions from each minute m in year y , based on the methane flow rate in the residual gas ($F_{CH_4,RG,m}$) and the flare efficiency ($\eta_{flare,m}$), as follows:

$$PE_{flare,y} = GWP_{CH_4} \times \sum_{m=1}^{525600} F_{CH_4,RG,m} \cdot (1 - \eta_{flare,m}) \times 10^{-3} \quad \text{Equation 10}$$

Where,

- $PE_{flare,y}$ = Project emissions from flaring of the residual gas stream in year y (tCO₂e)
 GWP_{CH_4} = Global Warming Potential (tCO₂e/tCH₄) valid for the commitment period
 $F_{CH_4,RG,m}$ = Mass flow of methane in the residual gas in the minute m (kg)
 $\eta_{flare,m}$ = Flare efficiency in the minute m

Sample calculation

$$PE_{flare,y} = GWP_{CH_4} \times \sum F_{CH_4,RG,m} \times (1 - \eta_{flare,m}) \cdot 10^{-3}$$

$$PE_{flare,y} = 25 \times 309,584 \times (1 - 0.5) \cdot 10^{-3} = 3,870 \text{ tCO}_2\text{e}$$

Baseline emissions associated with natural gas use (BE_{NG,y})

BE_{NG,y} is estimated as follows:

$$BE_{NG,y} = 0.0504 \times F_{CH_4,NG,y} \times EF_{CO_2,NG,y} \quad \text{Equation 11}$$

Where,

$BE_{NG,y}$ = Baseline emissions associated with natural gas use in year y (t CO₂/yr)

$EF_{CO_2,NG,y}$ = Average CO₂ emission factor of natural gas in the natural gas network or in trucks in year y (tCO₂/TJ)

$F_{CH_4,NG,y}$ = Amount of methane in the LFG which is sent to the natural gas distribution network or in trucks in year y (tCH₄/yr)

$EF_{CO_2,NG,y}$ is determined using the “Tool to calculate project or leakage CO₂ emissions from fossil fuel combustion”.

Sample calculation

$$BE_{NG,y} = 0.0504 * F_{CH_4NG,y} * EF_{CO_2,NG,y}$$

$$BE_{NG,y} = 0.0504 * 300 * 58.3 = 882 \text{ tCO}_2e$$

Finally, the determination of the amount of methane in the LFG that would be flared in the baseline ($F_{CH_4,BL,y}$) is calculated following the provisions of Case 3 of the ACM0001, as per the registered PDD. In accordance with the ACM0001 methodology, under Case 3, $F_{CH_4,BL,y} = F_{CH_4,BL,sys,y}$ and the following equation applies:

$$F_{CH_4,BL,sys,y} = 0.2 * F_{CH_4,PJ,y}$$

Equation 12

Sample calculation

$$F_{CH_4,BL,sys,y} = F_{CH_4,BL,y} = 0.2 * F_{CH_4,PJ,y}$$

$$F_{CH_4,BL,y} = 0.2 * 455 = 91 \text{ tCO}_2e$$

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

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This section describes the methods used for the calculation of project emissions. As per the requirements, sample calculations for all formulae used are provided considering project emissions occurring as a consequence of the implementation of the CDM Project Activity during 01/2018.

The table below summarizes the results of project emissions calculated for the monitoring period.

	DEVIATION applied	PE _y	PEEC1	PEFC _j	ECPJ1	FC _{i,j}
	(yes/no)	tCO ₂	tCO ₂	tCO ₂	MWh	Kg
12/2017	Yes	177.82	177.82	0.0000	483.00	0.00
01/2018	Yes	292.86	292.86	0.0001	792.00	45.00
02/2018	Yes	150.87	150.87	0.0000	408.00	0.00
03/2018	Yes	210.03	210.03	0.0000	568.00	0.00
04/2018	Yes	204.11	204.11	0.0000	552.00	0.00
05/2018	Yes	373.47	373.47	0.0000	1010.00	0.00
06/2018	Yes	366.81	366.81	0.0000	992.00	0.00
07/2018	Yes	384.56	384.56	0.0000	1040.00	0.00
08/2018	Yes	460.00	460.00	0.0000	1244.00	0.00
09/2018	Yes	436.70	436.70	0.0000	1181.00	0.00
10/2018	Yes	417.10	417.10	0.0000	1128.00	0.00
11/2018	Yes	414.88	414.88	0.0000	1122.00	0.00
12/2018	Yes	388.26	388.26	0.0000	1050.00	0.00
01/2019	Yes	467.45	467.45	0.0000	1247.00	0.00
02/2019	Yes	393.23	393.23	0.0000	1049.00	0.00
03/2019	Yes	430.71	430.71	0.0000	1149.00	0.00
04/2019	Yes	441.21	441.21	0.0000	1177.00	0.00
05/2019	Yes	447.21	447.21	0.0003	1193.00	90.00
06/2019	Yes	479.82	479.82	0.0000	1280.00	0.00
07/2019	Yes	507.56	507.56	0.0000	1354.00	0.00
08/2019	Yes	497.44	497.44	0.0000	1327.00	0.00
09/2019	Yes	473.45	473.45	0.0000	1263.00	0.00
10/2019	Yes	490.31	490.31	0.0000	1308.00	0.00
11/2019	Yes	480.57	480.57	0.0000	1282.00	0.00
12/2019	Yes	503.81	503.81	0.0000	1344.00	0.00
01/2020	Yes	525.70	525.70	0.0000	1402.40	0.00
02/2020	Yes	482.30	482.30	0.0000	1286.62	0.00
03/2020	Yes	541.34	541.34	0.0000	1444.12	0.00
04/2020	Yes	498.09	498.09	0.0000	1328.74	0.00
05/2020	Yes	524.11	524.11	0.0000	1398.15	0.00
06/2020	Yes	481.48	481.48	0.0001	1284.44	45.00
07/2020	Yes	495.65	495.65	0.0001	1322.23	45.00
08/2020	Yes	495.65	495.65	0.0000	1322.23	0.00
09/2020	Yes	495.65	495.65	0.0000	1322.23	0.00

Sources of project emissions are electricity and fossil fuel consumption, as presented in the equation below:

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

Equation 13

Where,

$PE_{EC,y}$ = Emissions from consumption of electricity due to the project activity in year y (t CO₂/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 CO₂/yr);

$PE_{DT,y}$ = Emissions from the distribution of compressed/liquefied LFG using trucks, in year y (t CO₂/yr).

The proposed project activity will not make use of trucks to distribute compressed/liquefied LFG. On the contrary, it will inject the purified LFG directly into the natural gas distribution grid. Therefore, there are no project emissions associated with the distribution of compressed/liquefied LFG using trucks and $PE_{DT,y}$ is **zero**.

Sample calculation

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

$$PE_y = 292.86 + 0.0001 = 292 \text{ tCO}_2\text{e}$$

The project emissions from electricity consumption ($PE_{EC,y}$) is calculated following the procedures set out by the “*Tool to estimate the baseline, project and/or leakage emissions from electricity consumption*”. During the crediting period, electricity is purchased from the grid and is consumed for the operation of the active LFG collection system and LFG upgrading facility.

Therefore, Option **A.1** of the “*Tool to calculate baseline, project and/or leakage emissions from electricity consumption*” is used. Under this option, project emissions from consumption of electricity from the grid are calculated based on the power consumed by the project activity and the emission factor of the grid, adjusted for transmission losses, using the following formula:

$$PE_{EC,grid,y} = \sum_j EC_{PJ,j,y} \times EF_{EL,j,y} \times (1 + TDL_{j,y}) \quad \text{Equation 14}$$

Where,

- $PE_{EC,grid,y}$ = Project emissions from electricity consumption from the grid by the project activity during the year y (tCO₂/year);
- $EC_{PJ,y}$ = Quantity of electricity consumed by the project electricity consumption source j in year y (MWh)
- $EF_{EL,j,y}$ = Emission factor for electricity generation for source j in year y (tCO₂/MWh)
- $TDL_{j,y}$ = Average technical transmission and distribution losses for providing electricity to source j in year y
- j = Sources of electricity consumption in the project

The Emission Factor for electricity consumed from the grid was determined according to the procedures of the “*Tool for calculation of emission factor for electricity systems*” and is fixed as per the registered PDD. The transmission and distribution losses were updated considering the most recent information made publicly available by ANEEL.

Sample calculation

$$PE_{EC,grid,y} = EC_{PJ,y} * EF_{EL,j,y} * (1 + TDL_{j,y})$$

$$PE_{EC,grid,y} = 792 * 0.3231 * (1 + 14.4\%) = 292 \text{ tCO}_2e$$

Emissions from consumption of fossil fuels ($PE_{FC,y}$)

Project emissions resulting from combustion of fossil fuels are related to LPG consumption for flare ignition. This source of project emission is determined in accordance with procedures of the “*Tool to calculate project or leakage emissions from fossil fuel combustion*” using the following formulae:

$$PE_{FC,j,y} = \text{SUM}(FC_{i,j,y} * COEF_{i,y}) \quad \text{Equation 15}$$

Where,

- $PE_{FC,j,y}$ = Are the CO₂ emissions from fossil fuel combustion in process j during the year y (tCO₂/yr);
- $FC_{i,j,y}$ = Is the quantity of fuel type i combusted in process j during the year y (mass or volume unit/yr);
- $COEF_{i,y}$ = Is the CO₂ emission coefficient of fuel type i in year y (tCO₂/mass or volume unit)
- i = Are the fuel types combusted in process j during the year y

Sample calculation

$$PE_{FC,j,y} = \text{SUM}(FC_{i,j,y} * COEF_{i,y})$$

$$PE_{FC,j,y} = \text{SUM}(45 * ((0.0465 * 0.0656) / 1000)) = 0.0001 \text{ tCO}_2e$$

E.3. Calculation of leakage emissions

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According to ACM0001 there is no need to account for leakage. Hence, $LE_y = 0 \text{ tCO}_2\text{e}$

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

	Baseline GHG emissions or baseline net GHG removals (t CO ₂ e)	Project GHG emissions or actual net GHG removals (t CO ₂ e)	Leakage GHG emissions (t CO ₂ e)	GHG emission reductions or net anthropogenic GHG removals (t CO ₂ e)		
				Before 01/01/2013	From 01/01/2013	Total amount
Total	895,002	14,430	0	0	880,572	880,572

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 ₂ e)	Amount estimated ex ante for this monitoring period in the PDD (t CO ₂ e)
880,572	1,431,429

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

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Calculated using the PDD estimation of emission reductions to be achieved in 2017 (497,834 tCO₂e) times the number of days in this monitoring period for this year (10 days) divided by the number of days in the year, plus emission reductions estimated in 2018 (510,572 tCO₂e), 2019 (519,375 tCO₂e) and 2020 (531,649 tCO₂e) times the number of days in this monitoring period for this year (267 days) divided by the number of days in the year under the crediting period (366 days).

E.6. Remarks on increase in achieved emission reductions

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Not applicable. This section is intentionally left blank.

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

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Not applicable. This section is intentionally left blank.

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Document information

<i>Version</i>	<i>Date</i>	<i>Description</i>
07.0	31 May 2019	Revision to: <ul style="list-style-type: none"> • 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: <ul style="list-style-type: none"> • 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: <ul style="list-style-type: none"> • 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: <ul style="list-style-type: none"> • 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 <i>F-CDM-MR</i> to <i>CDM-MR-FORM</i>; • 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).

<i>Version</i>	<i>Date</i>	<i>Description</i>
01.0	28 May 2010	EB 54, Annex 34. Initial adoption.