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	3	
Completion date of this monitoring report	19/05/2021	
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	1,081,131 tCO_2e
Amount of GHG emission reductions or net anthropogenic GHG removals estimated ex ante for this monitoring period in the PDD	1,431,429 tCO_2e[1]	

[1] Calculated using the PDD estimation of emission reductions to be achieved in 2017 (497,834 tCO_2e) 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 tCO_2e), 2019 (519,375 tCO_2e) and 2020 (531,649 tCO_2e) 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

>>

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 Nm^3/h - has been implemented.

The total emission reductions achieved during this monitored period is **1,081,131 tCO2e.**

A.2. Location of project activity

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The Oeste de Caucaia Landfill is located 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

This monitoring report was developed and reviewed by:

Consultancy	Project Proponent (Project Participant)
BENG	GNR Fortaleza Valorização de Biogás Ltda
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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

>>
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.

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[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.

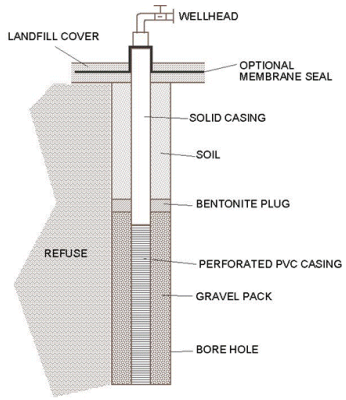

Figure 3 – Internal detail of a well and wellhead (source: USEPA, 1996[14])

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 wells[15].

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 10/12/2015[16].

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 Nm³/h

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).

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.

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 Nm^3/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 ºF

The flare system became operational in 12/2015[17].

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

>>
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 in dry basis), 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 equipment has two sensors that measures both the methane fraction in the LFG in the inlet of the plant and the methane fraction in the biomethane produced by the plant. 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 sensor responsible for reading the methane fraction in the LFG was not operational from 21/09/2018 (10h:52min) to 23/09/2020 (23h:59 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 a statistical analysis using conservative assumptions defining a non-overestimated conservative choice of Default Data.
- The statistical analysis took into consideration two sample periods (range of data). One period before the interruption of $v_{i,t,db}$ readings (from 22/12/2017 at 15h:24m to 21/09/2018 10h:51m – inside the monitored period) and another period after the interruption of $v_{i,t,db}$ readings (from 22/10/2020 at 08h:21m to 01/05/2021 00h:00m – outside the monitoring period). Both sample periods had the equipment responsible for measuring the $v_{i,t,db}$ (gas analyser in dry basis) proper calibrated.
- Since a range of data was used, the conservative default data has been calculated assuming a range that represents the lower 95% confidence limits of a normally distributed dataset. The Microsoft Excel © formulae "PERCENTILE" has been used taking into account (i) the sample periods range of data and (ii) the interval percentile value (k) of 2.5%.
- The result of this statistical analysis returned a conservative default value of 58.318962% of CH_4 in LFG and has been used to replace missing $v_{i,t,db}$ (volumetric fraction of greenhouse gas CH4 in the LFG in dry basis) data throughout the Deviation 1 period.
- The result is also not overestimated, since it is lower than the sample average (59.197308% CH_4 in LFG) and sample median (59.21520% CH_4 in LFG).

Deviation 2

From the entire monitoring period, the parameter "Flame detection of flare in the minute m" ($Flame_m$) 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.

The deviation described above is conservative, because it could be demonstrated, according to the manufacturer’s specifications, that although the parameter was not formally recorded, the gas flow is automatically blocked by the system when the flame is not lit. In other words, if any flow is registered, the flame is on.

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 the parameter could not be monitored in accordance with monitoring plan. Also, for the month 08/2020, not operational from 28/08/2020 (11h:23m) to 31/08/2020 (23h:59m) 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 78.473 °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”.

The deviation described above is conservative because the gas flow rate was actually adjusted and considered the highest temperature measured in the periods when the equipment was in operation. Furthermore, the deviation was applied to only four out of the thirty-four months included in the current monitoring report.

B.2.2. Corrections

>>
Not applicable. This section is intentionally left blank.

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

>>
Not applicable. This section is intentionally left blank.

B.2.4. Inclusion of monitoring plan

>>
Not applicable. This section is intentionally left blank.

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

>>
Along with this verification, it is being proposed a post registration change in the registered monitoring plan of the registered PDD (ISSUANCE TRACK). A new PDD version (version 5, dated 15/02/2021) aiming at revising Section B.6.1 in order to include additional options to determine the mass flow of gases containing methane depending on the properties (e.g. temperature, humidity, among others) of the monitored gas flow (i.e. LFG or biomethane).
The inclusion of other options provided by the tool that were not considered in the registered version of the PDD, mainly Option B, sought to increase consistency between the PDD and the operational reality of the project.
This modification corresponds to item c), paragraph 1 of the Project Standard Appendix:

> *"(c) Changes to the monitoring of a registered CDM project activity that have no material impact on the applicability of the applied methodologies or the other applied methodological regulatory documents, or the accuracy and completeness of the monitoring;"*

As a consequence, Sections B.6.2. and B.7.1 were updated following the requirements of the tool *"Tool to determine the mass flow of a greenhouse gas in a gaseous stream"* as detailed below:
For fixed parameters (Section B.6.2.)

- R_u and MM_i: exclusion of the mention of the use of the parameter for the calculation of project emissions and "additional comments", as per the tool;
- MM_k: exclusion of "additional comments" since this parameter may be applicable to monitored data;
- MM_{H2O}: inclusion of the parameter that may be applicable for circumstances when additional options used to determine the mass flow of gases containing methane, listed in the revised version of the PDD, are used;
- P_n *and* T_n*:* exclusion of "additional comments", as per the tool

For monitored parameters (Section B.7.1.)

- Vt,wb: revision of additional comments to include option B;
- Vt,db, and V_i,t,db: revision of additional comments to increase consistency with the provisions of the tool;
- $v_{i,t,wb}$: revised additional comments to increase consistency between the tool and the applicable options listed in the revised version of the PDD
- $P_{H2O,t,Sat}$: inclusion of the parameter , as per the applicable tool;
- Tt and Pt: revision of additional comments aiming at excluding specific mention to the gas flow monitored.

It should be noted that there is no increase in capacity of the LFG capture system or addition of new equipment that increases its capacity to upgrade the captured landfill gas. Hence, these revisions neither influences the applicability of the methodology nor the additionality and scale of the project.

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 15/02/2021) is being submitted along with this Monitoring Report (ISSUANCE TRACK).

The post-registration change consists of an update of the existent landfill area from what was described in the registered PDD. This amendment is foreseen 1 (d) the CDM Project Standard Appendix:

> *"(d) Changes to the project design of a registered CDM project activity that do not adversely impact any of the following:*
>
> *(i) The applicability and application of the applied methodologies, the applied standardized baselines and the other applied methodological regulatory documents with which the project activity has been registered;*
>
> *(ii) The additionality of the project activity;*
>
> *(iii) The scale of the project activity."*

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. Residues started to be deposited in the new area in 2020 but no significant difference can be observed with respect to the information provided in the first registered version of the PDD. 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.

In this sense, the revision neither influences the applicability of the methodology nor the additionality and scale of the project, as determined in the provisions of the applicable paragraph of the Project Standard.

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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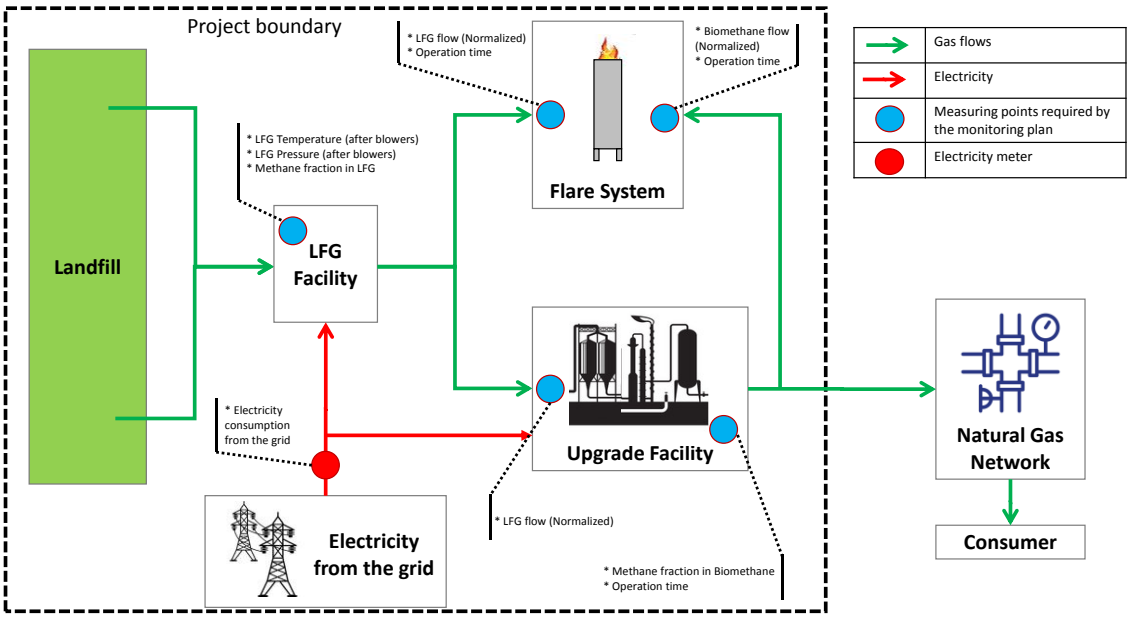
The monitoring equipment and their location are presented in below.



Obs 1: All flow meters measures stream flows at normal condition automatically according to meters specification
Obs 2: Methane fraction in LFG and in Biomethane are measured by the same gas analyzer equipment

The monitoring of project activity followed the requirements established in ACM0001 and referred tools. All data monitored was made 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) Methane fraction in 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.
(v) Electricity consumption

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 - 80ºC
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.

					Monitored Period		Calibration						
Instrument	TAG	Manufacturer	Model	Serial number	Starting period	Finishing period	Calibration frequency	Date of Calibration	Validity	Error used in data discount (%)	Calibration coverage status	Maximum permissible error from manufacturer (%)	Error identified in the delayed calibration test (%)
LFG Flow inlet to Biomethane	FIT 215	ABB	FMT500-IG	V14224-002961	22/12/2017	23/09/2020	3 years	05/12/2017	04/12/2020	-	**ok**		
LFG Flow inlet direct to Flare	FIT 206	ABB	FMT500-IG	V14224-002969	22/12/2017	23/09/2020	3 years	05/12/2017	04/12/2020	-	**ok**		
Biomethane Flow inlet return to Flare	FIT 510	ABB	FMT500-IG	V14224-002962	22/12/2017	23/09/2020	3 years	05/12/2017	04/12/2020	-	**ok**		
LFG Temperature	TE 210	WARME	WTT-6001	TI.3243	22/12/2017	13/07/2020	3 years	14/07/2017	13/07/2020	-	**ok**		
					12/01/1900	23/09/2020		11/11/2020	10/11/2023	0.52%	**error**	0.1 C + 0.05% Reading	0.52%
LFG Pressure	PIT 210	ROSEMOUNT	3051	2593164	22/12/2017	05/09/2020	3 years	06/09/2017	05/09/2020	-	**ok**		
					06/09/2020	23/09/2020		04/11/2020	03/11/2023	0.08%	**error**	0.04%	0.08%
Methane Fraction in LFG	Ecometano - GNR	ABB	PGC-1000	T170268182	22/12/2017	22/10/2018	1 year	10/11/2017	09/11/2018	-	**ok**		
		ABB	PGC-1000	T170268182	23/10/2018	06/05/2019	1 year	23/10/2018	22/10/2019	-	**ok**		
		ABB	PGC-1000	T170268182	07/05/2019	05/02/2020	1 year	07/05/2019	06/06/2020	-	**ok**		
		ABB	PGC-1000	T170268182	06/02/2020	05/08/2020	6 months	06/02/2020	05/08/2020		**ok**		
		ABB	PGC-1000	T170268182	06/08/2020	10/08/2020	6 months	Not performed		1.00%	**error**	1.00%	0.09%
		ABB	PGC-1000	T170268182	11/08/2020	13/10/2020	6 months	11/08/2020	10/02/2021	-	**ok**		
		ABB	PGC-1000	T170268182	14/10/2020	23/09/2020	6 months	14/10/2020	13/04/2021	-	**ok**		
Electricity meter	-	Not provided by electricity distribution company Meter not under control of the PP		ID# 4262353	22/12/2017	31/12/2017	5 years	Electricity distribution company resposability		-	**ok**		
		SCHNEIDER	ION 8650	MW-1709A919-02	01/01/2018	17/02/2018				0.20%	**ok**	0.2%	0.06%
					18/02/2018	23/09/2020							

SECTION D. Data and parameters

D.1. Data and parameters fixed ex ante

>>

The following ex ante parameters, which are listed in the registered PDD, were not used in this monitoring period in order to calculate the emission reductions by the project activity and, therefore, are not presented in the tables below:

- Total amount of waste disposed in a SWDS in year x (W_x)
- Efficiency of the LFG capture system that will be installed in the project activity (η_{PJ})
- Default value for model correction factor to account for model uncertainties ($\varphi_{default}$)
- Fraction of methane captured at the SWDS and flared, combusted or used in another manner that prevents the emissions of methane to the atmosphere in year y (f_y)
- Oxidation factor (reflecting the amount of methane from the considered SWDS that is oxidized in the soil (or other material covering the waste)) (OX)
- Fraction of methane in the SWDS gas (volume fraction) (F)
- Default value for the fraction of degradable organic carbon in MSW that decomposes in the SWDS ($DOC_{f,default}$)
- Methane correction factor ($MCF_{default}$)
- Fraction of degradable organic carbon in the waste type j (weight fraction) (DOC_j)
- Decay rate for the waste type j (k_j)
- 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 ($FC_{i,m,y}$, $FC_{i,y}$, $FC_{i,k,y}$, $FC_{i,n,y}$ and $FC_{i,n,h}$)
- CO_2 emission factor of fossil fuel type i used in power unit m in year y ($EF_{CO2,i,y}$ and $EF_{CO2,m,i,y}$)
- Net electricity generated by power plant/unit m or k in year y ($EG_{m,y}$ and $EG_{k,y}$)
- Average net energy conversion efficiency of power unit m in year y ($\eta_{m,y}$)

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	t_{CO2e}/t_{CH4}
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/t_{CH4}
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	-

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

Data/Parameter	R_u
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 baseline emissions
Additional comments	-

Data/Parameter	MM_i
Unit	kg/kmol
Description	Molecular mass of greenhouse gas *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 baseline emissions
Additional comments	-

Data/Parameter	MM_k
Unit	kg/kmol
Description	Molecular mass of gas *k (k = 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	-

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

Data/Parameter	P_n
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	-

Data/Parameter	T_n
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	-

"Tool to calculate the emission factor for an electricity system"

Data/Parameter	$EF_{grid,OM-adj,y}$
Unit	tCO_2/MWh
Description	Simple adjusted operating margin CO_2 emission factor in year *y*
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	0.3612
Choice of data or measurement methods and procedures	The *ex-ante* 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	$EF_{BM,2013}$
Unit	tCO_2/MWh
Description	Build Margin CO_2 emission factor in year *y*
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	0.2850
Choice of data or measurement methods and procedures	The *ex-ante* 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

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 CO_2 emission factor of fuel type *i* in year *y* ($EF_{CO2,i,y}$), when *i* corresponds to any fossil fuel used to generate electricity since electricity consumed by the plant is from the grid;

ACM0001

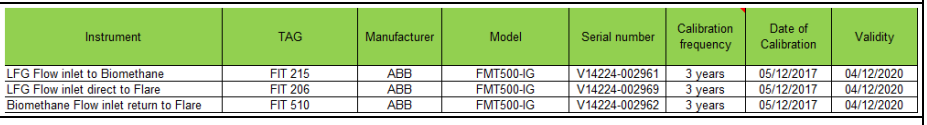
Data/Parameter	Management of SWDS
Unit	-
Description	Management of SWDS
Measured/calculated/ default	-
Source of data	- Environmental Impact Assessment - Environmental Permits: LO Nº081/2016 and its renewal request; and, LO Nº 76/2020, issued on 15/09/2020, valid through 14/06/2026
Value(s) of monitored parameter	-
Monitoring equipment	-
Measuring/reading/recording frequency	Annually
Calculation method (if applicable)	-
QA/QC procedures	Project participants referred to the original design of the landfill (as described in the Environmental Impact Assessment) and compared to the latest issued environmental permits to ensure that management of the landfill has not changed aiming at increasing methane generation after the implementation of the project activity.
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	In the context of the proposed project activity, equipment unit *j* using *the LFG* 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*: *For the LFG upgrading facility* • Products generated. Monitor the generation of upgraded LFG which is sold to the consumer. This information was cross-checked against data from the supervisory system; *For the flaring system* • Flame. Flame detection system is used to ensure that the equipment is in operation; $Op_{j,h}$=0 when: • No products are generated in the hour h • Flame is not detected continuously in hour h (instantaneous measurements are made at least every minute); Otherwise, $Op_{j,h}$=1
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	Valve directing the product to CEGAS network and flame detectors are subject to a regular maintenance and testing regime to ensure equipment is functioning well.
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	*From 1 December 2017 until 31 December 2017* Manufacturer: - Model: - Identification Number: 4262353 Accuracy class: C/D Meter calibration and maintenance under the responsibility of the local electricity distribution company. Information about the meter was not made available. From 1 January 2018 on Manufacturer: SCHNEIDER Model: ION8650 Serial Number: MW-1709A919-02 Accuracy class: C/D Meter calibration and maintenance under the responsibility of the local electricity distribution company. Calibrated on 18 February 2018, valid for 5 years.
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 0,2% (Accuracy class 0,2%).
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.

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

Data/Parameter	$V_{t,db}$
Unit	m³ dry gas/h
Description	Volumetric flow of the gaseous stream in time interval *t* 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	
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

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

Data/Parameter	$V_{t,wb}$
Unit	m^3 wet gas/h
Description	Volumetric flow of the gaseous stream in time interval *t* on a wet 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 is monitored in Option B and C.

Data/Parameter	$v_{i,t,db}$
Unit	m^3 gas *i*/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
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 Methane Fraction in LFG / Ecometano - GNR / ABB / PGC-1000 / T170268182 / 1 year / 10/11/2017 / 09/11/2018 ABB / PGC-1000 / T170268182 / 1 year / 23/10/2018 / 22/10/2019 ABB / PGC-1000 / T170268182 / 1 year / 07/05/2019 / 06/06/2020 ABB / PGC-1000 / T170268182 / 6 months / 06/02/2020 / 05/02/2020 ABB / PGC-1000 / T170268182 / 6 months / 11/08/2020 / 10/02/2021 ABB / PGC-1000 / T170268182 / 6 months / 14/10/2020 / 13/04/2021
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 and B.

Data/Parameter	$v_{i,t,wb}$
Unit	m^3 gas *i*/m^3 wet gas
Description	Volumetric fraction of greenhouse gas *i* in a time interval *t* on a wet basis
Measured/calculated/ default	Measured
Source of data	Onsite measurement
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 rowspan="6">Methane Fraction in LFG</td><td rowspan="6">Ecometano - GNR</td><td>ABB</td><td>PGC-1000</td><td>T170268182</td><td>1 year</td><td>10/11/2017</td><td>09/11/2018</td></tr><tr><td>ABB</td><td>PGC-1000</td><td>T170268182</td><td>1 year</td><td>23/10/2018</td><td>22/10/2019</td></tr><tr><td>ABB</td><td>PGC-1000</td><td>T170268182</td><td>1 year</td><td>07/05/2019</td><td>06/06/2020</td></tr><tr><td>ABB</td><td>PGC-1000</td><td>T170268182</td><td>6 months</td><td>06/02/2020</td><td>05/02/2020</td></tr><tr><td>ABB</td><td>PGC-1000</td><td>T170268182</td><td>6 months</td><td>11/08/2020</td><td>10/02/2021</td></tr><tr><td>ABB</td><td>PGC-1000</td><td>T170268182</td><td>6 months</td><td>14/10/2020</td><td>13/04/2021</td></tr></table>
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 Options C and may be monitored in Option A.

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.
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 rowspan="2">LFG Temperature</td><td rowspan="2">TE 210</td><td rowspan="2">WARME</td><td rowspan="2">WTT-6001</td><td rowspan="2">TI.3243</td><td rowspan="2">3 years</td><td>14/07/2017</td><td>13/07/2020</td></tr><tr><td>11/11/2020</td><td>10/11/2023</td></tr></table>
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	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 60ºC is adopted, this parameter must be monitored continuously to assure the applicability condition is met. Applicable to Options A and C of the tool.

Data/Parameter	P_t
Unit	Pa
Description	Pressure 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.

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>2593164</td><td>3 years</td><td>06/09/2017 04/11/2020</td><td>05/09/2020 03/11/2023</td></tr></table>
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 C of the tool.

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

"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 ± 10nm.
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[18]
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 9most 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* = 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)	-

[18] 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

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* = LPG)
Measured/calculated/ default	Default
Source of data	Brazilian Energy Balance 2020 Year 2019[19]
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.e.* 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* in year *y* (*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.

[19] Publicly available, both in English and in Portuguese, at: <https://www.epe.gov.br/sites-pt/publicacoes-dados-abertos/publicacoes/PublicacoesArquivos/publicacao-479/topico-528/BEN2020_sp.pdf>.

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* in year *y* (*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 $EF_{CO2,NG,y}$ 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

>>
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	BECH4,y	BENG,y	FCH4PJ,y	FCH4BL,y	FCH4flared,y	FCH4NG,y	% CH4	FCH4 sentflare,y	Total methane for Consumer	Total methane to Flare	FCH4RG,t	PEflare,y
	(yes/no)	tCO2	tCO2	tCO2	tCH4	tCH4	tCH4	tCH4	%	tCH4	Nm³CH4	Nm³CH4	kg	tCO2
12/2017	Yes	4,153	3,705	447	212	42	59.5	152	60.1%	119.0	212,752	166,216	118,955	1,487
01/2018	Yes	7,644	6,882	763	393	79	133.7	260	59.9%	267.4	362,648	373,624	267,390	3,342
02/2018	Yes	4,368	3,859	508	221	44	47.6	173	59.6%	95.2	241,660	132,984	95,172	1,190
03/2018	Yes	13,761	12,354	1,407	706	141	227.3	479	59.4%	454.6	668,866	635,172	454,570	5,682
04/2018	Yes	12,122	10,617	1,505	607	121	94.5	512	59.8%	188.9	715,738	263,971	188,915	2,361
05/2018	Yes	18,890	16,537	2,353	945	189	144.1	801	60.1%	288.2	1,119,091	402,670	288,177	3,602
06/2018	Yes	30,349	26,146	4,203	1,494	299	63.7	1,430	59.5%	127.4	1,998,644	177,989	127,380	1,592
07/2018	Yes	38,965	33,413	5,552	1,909	382	19.9	1,889	59.5%	39.8	2,640,102	55,567	39,767	497
08/2018	Yes	39,105	33,543	5,563	1,917	383	23.6	1,893	59.5%	47.1	2,645,306	65,864	47,137	589
09/2018	Yes	35,830	30,703	5,127	1,754	351	9.5	1,745	59.0%	18.9	2,438,251	26,462	18,938	237
10/2018	Yes	34,907	29,945	4,962	1,711	342	22.3	1,689	58.3%	44.6	2,359,830	62,320	44,601	558
11/2018	Yes	34,119	29,239	4,880	1,671	334	10.1	1,661	58.3%	20.3	2,320,461	28,346	20,286	254
12/2018	Yes	32,769	28,084	4,685	1,605	321	10.5	1,594	58.3%	21.0	2,227,726	29,365	21,016	263
01/2019	Yes	36,947	31,663	5,284	1,809	362	11.0	1,798	58.0%	21.9	2,512,862	30,617	21,912	274
02/2019	Yes	33,210	28,463	4,747	1,626	325	10.9	1,616	58.3%	21.8	2,257,402	30,474	21,809	273
03/2019	Yes	35,610	30,807	4,803	1,760	352	126.0	1,634	58.3%	251.9	2,283,851	351,992	251,908	3,149
04/2019	Yes	39,991	34,324	5,667	1,961	392	32.6	1,929	58.0%	65.2	2,695,051	91,044	65,157	814
05/2019	Yes	41,461	35,566	5,895	2,032	406	26.2	2,006	58.3%	52.4	2,803,155	73,267	52,435	655
06/2019	Yes	38,226	32,740	5,485	1,871	374	4.0	1,867	58.3%	8.0	2,608,566	11,230	8,037	100
07/2019	Yes	36,937	31,726	5,211	1,813	363	39.3	1,774	58.0%	78.7	2,478,226	109,905	78,655	983
08/2019	Yes	32,877	28,180	4,697	1,610	322	11.8	1,598	58.3%	23.5	2,233,579	32,905	23,549	294
09/2019	Yes	37,879	32,506	5,372	1,858	372	29.2	1,828	58.0%	58.4	2,554,682	81,641	58,427	730
10/2019	Yes	36,551	31,455	5,096	1,797	359	63.3	1,734	58.3%	126.6	2,423,150	176,845	126,561	1,582
11/2019	Yes	37,195	31,860	5,335	1,821	364	5.0	1,816	58.3%	10.1	2,536,846	14,104	10,094	126
12/2019	Yes	38,499	32,989	5,510	1,885	377	10.0	1,875	58.0%	20.0	2,620,125	27,886	19,957	249
01/2020	Yes	40,913	35,106	5,807	2,006	401	29.7	1,976	58.3%	59.5	2,761,547	83,079	59,457	743
02/2020	Yes	39,618	34,004	5,615	1,943	389	32.3	1,911	58.0%	64.5	2,669,959	90,160	64,524	807
03/2020	Yes	43,992	37,700	6,292	2,154	431	12.9	2,141	58.3%	25.8	2,992,141	36,120	25,850	323
04/2020	Yes	41,173	35,282	5,891	2,016	403	11.2	2,005	58.0%	22.3	2,801,513	31,208	22,334	279
05/2020	Yes	43,592	37,343	6,249	2,134	427	7.2	2,127	58.3%	14.4	2,971,604	20,186	14,446	181
06/2020	Yes	40,166	34,419	5,747	1,967	393	11.0	1,956	58.3%	22.0	2,732,805	30,789	22,034	275
07/2020	Yes	41,704	35,729	5,975	2,042	408	8.2	2,033	58.3%	16.5	2,841,280	23,038	16,487	206
08/2020	Yes	36,489	31,264	5,225	1,787	357	8.3	1,778	57.8%	16.6	2,484,678	23,232	16,626	208
09/2020	Yes	15,495	13,289	2,206	759	152	8.5	751	58.3%	16.9	1,049,224	23,656	16,930	212

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_2e/yr)
$BE_{CH4,y}$ = Baseline emissions of methane from the SWDS in year y (t CO_2e/yr)
$BE_{EC,y}$ = Baseline emissions associated with electricity generation in year y (t CO_2/yr)
$BE_{HG4,y}$ = 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:
$BE_y = BE_{CH4,y} + BE_{NG,y}$
$BE_y = 6,882 + 763 = 7,644\ tCO_2e$

Baseline emissions of methane from the SWDS ($BE_{CH4,y}$) 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 account[20].

$$BE_{CH4,y} = \left(\left(1 - OX_{top\_layer}\right) \times F_{CH4,PJ,y} - F_{CH4,BL,y}\right) \quad GWP_{CH4} \qquad \textbf{Equation 2}$$

Where,

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

Sample calculations
$BE_{CH4,y} = ((1 – OX_{top\_layer}) * F_{CH4,PJy} - F_{CH4,BLy}) * GWP_{CH4}$
$BE_{CH4,y} = ((1 – 0.1) * 393 – 79) * 25 = 6{,}882\ tCO_2e$

During the crediting period, $F_{CH4,PJ,y}$ is determined as the sum of the quantities of methane flared and forwarded to the natural gas distribution network, considering the following equation:

$$F_{CH4,PJ,y} = F_{CH4,flared,y} + F_{CH4,EL,y} + F_{CH4,HG,y} + F_{CH4,NG,y} \qquad \textbf{Equation 3}$$

Where,

$F_{CH4,PJ,y}$ = Amount of methane in the LFG which is flared and/or used in the project activity in year *y* (tCH_4/yr)
$F_{CH4,flared,y}$ = Amount of methane in the LFG which is destroyed by flaring in year *y* (tCH_4/yr)
$F_{CH4,EL,y}$ = Amount of methane in the LFG which is used for electricity generation in year *y* (tCH_4/yr)
$F_{CH4,HG,y}$ = Amount of methane in the LFG which is used for heat generation in year *y* (tCH_4/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* (tCH_4/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
$F_{CH4,PJ,y} = F_{CH4,flared,y} + F_{CH4,EL,y} + F_{CH4,HG,y} + F_{CH4,NG,y}$
$F_{CH4,PJ,y} = 133.7 + 260 = 393\ tCO_2e$

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"*. Monitoring followed the requirements of the ACM0001 and "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" and considered the below options:

[20] $OX_{top\text{-}layer}$ 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 main a high methane concentration in the LFG. For this reason, this effect is neglected as a conservative assumption.

- **Option A** (Volume flow in dry basis and volumetric fraction in dry basis) when the temperature of the gaseous stream is less than 60ºC (333.15 K) at the flow measurement point, *AND*;
- **Option B** (Volume flow in wet basis and volumetric fraction in dry basis) *OR* **Option C** (Volume flow in wet basis and volumetric fraction in wet basis) when the temperature of the gaseous stream is higher than 60ºC (333.15 K) at the flow measurement point.

During the monitored period Options A and B were used to determine the mass flow of gases containing methane. Methodological steps applicable when this options are used are detailed below.

Option A of the Tool applies when biogas mass flow and volumetric fraction of methane measured in dry basis). While considering this option, it is necessary to demonstrate that the gaseous stream is dry by:

(a) Measuring the moisture content of the gaseous stream ($C_{H2O,t,db,n}$) and demonstrate that this is less or equal to 0.05 kg H_2O/m^3 dry gas; or

(b) 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.

Under this option, $F_{CH4,NG,y} = F_{i,t}$.

$$\mathrm{F_{i,t}} = V_{t,db} \times v_{i,t,db} \times \rho_{i,t}$$ **Equation 4**

And:

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

Where:

Fi,t = Mass flow of greenhouse gas *i* in the gaseous stream in time interval *t* (kg gas/h);
Vt,db = Volumetric flow of the gaseous stream in time interval *t* on a dry basis (m³ wet gas/h);
vi,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);
ρi,t = Density of greenhouse gas *i* in the gaseous stream in time interval t (kg gas *i*/m³ gas *i*);
Pt = Absolute pressure of the gaseous stream in time interval *t* (Pa);
MMi = Molecular mass of greenhouse gas *i* (kg/kmol);
Ru = Universal ideal gases constant (Pa.m³/kmol.K);
T_t = Temperature of the gaseous stream in time interval *t* (K).

All flow meters used in the project activity during the monitored period measures stream flows at normal condition automatically according to meters specification. However, the parameter Volumetric flow of greenhouse gas ($V_{t,db}$) presented in the *"Tool to determine the mass flow of a greenhouse gas in a gaseous stream -Version 02.0.0"* is not under normal conditions, neither the Density of greenhouse gas. So, considering the normalized flow meters installed ate the project plant, the calculation of the Density of greenhouse gas should be under normal conditions as well. Thus, Density of greenhouse gas was calculated as follows:

$$\rho_{i,n} = \frac{P_n * MM_i}{R_u * T_n}$$

Where:

ρi,n = Density of greenhouse gas *i* in the gaseous stream at normal conditions (kg gas *i*/m³ wet gas *i*);

Pn = Absolute pressure at normal conditions (Pa);
MMi = Molecular mass of greenhouse gas *i* (kg/kmol);
Ru = Universal ideal gases constant (Pa.m³/kmol.K);
Tn = Temperature at normal conditions (K).

Option B is applicable when the volume flow in wet basis and volumetric fraction in dry basis, following the demonstration criteria presented under Option A.

The mass flow of greenhouse gas *i* ($F_{i,t}$) is determined using Equation 4 and Equation 5 used in Option A. The volumetric flow of the gaseous stream in time interval *t* on a dry basis ($V_{t,db}$) is determined by converting the measured volumetric flow from wet basis to dry basis as follows:

$$V_{t,tb} = V_{t,wb}/(1 + v_{H2O,t,db})$$ **Equation 6**

Where:

$V_{t,db}$ = Volumetric flow of the gaseous stream in time interval *t* on a dry basis (m³ dry gas/h)
$V_{t,wb}$ = Volumetric flow of the gaseous stream in time interval *t* on a wet basis (m³ wet gas/h)
$v_{H2O,t,db}$ = Volumetric fraction of H_2O in the gaseous stream in time interval *t* on a dry basis (m³ H_2O/m³ dry gas)

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

$$v_{H2O,t,db} = \frac{m_{H2O,t,db} * MM_{t,db}}{MM_{H2O}}$$ **Equation 7**

Where:

$v_{H2O,t,db}$ = Volumetric fraction of H_2O in the gaseous stream in time interval *t* on a dry basis (m³ H_2O/m³ dry gas)
$m_{H2O,t,db}$ = Absolute humidity in the gaseous stream in time interval *t* on a dry basis(kg H_2O/kg dry gas)
$MM_{t,db}$ = Molecular mass of the gaseous stream in time interval *t* on a dry basis(kg dry gas/kmol dry gas)
MM_{H2O} = Molecular mass of H_2O (kg H_2O/kmol H_2O)

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

Option 2: Simplified calculation without measurement of the moisture content

This option provides a simple and conservative approach to determine the absolute humidity by assuming the gaseous stream is dry or saturated depending on which is the conservative situation[21].

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

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

$$m_{H2O,t,db,Sat} = \frac{p_{H2O,t,Sat} * MM_{H2O}}{(P_t - p_{H2O,t,Sat}) * MM_{t,db}}$$ **Equation 8**

Where:

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

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

$$MM_{t,db} = \sum_k (v_{k,t,db} * MM_k)$$ **Equation 9**

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

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

$F_{CH4,flared,y}$ 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:

$$F_{CH4,flared,y} = F_{CH4,sent\_flare,y} \quad \frac{PE_{flare,y}}{GWP_{CH4}}$$ **Equation 10**

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

$F_{CH4,sent\_flare,y}$ 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.

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, one of those options and its respective requirements are applied.

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* ($F_{CH4,m}$) 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;
- CH_4 is the greenhouse gas *i* for which the mass flow should be determined;
- The simplification offered for calculating the molecular mass of the gaseous stream is valid (equations 3 and 17 in the tool); and
- The time interval *t* for which mass flow should be calculated is every minute *m*.

$F_{CH4,m}$, which is measured as the mass flow during minute *m*, shall then be used to determine the mass of methane in kilograms fed to the flare in minute *m* ($F_{CH4,RG,m}$). This parameter corresponds to $F_{CH4,sent\_flare,y}$. 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 $F_{CH4,sent\_flare,y}$ 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 ($F_{CH4,RG,m}$) and the flare efficiency ($\eta_{flare,m}$), as follows:

$$PE_{flare,y} = GWP_{CH_4} \times \sum_{m=1}^{525600} F_{CH\,4,RG,m} \cdot \left(1 - \eta_{flare,m}\right) \times 10^{-3} \qquad \textbf{Equation 11}$$

Where,

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

Sample calculation
$PE_{flare,y} = GWP_{CH4} * \sum F_{CH4,RG,m} * (1 - \eta_{flare,m}).10^{-3}$
$PE_{flare,y} = 25 * 267{,}390 * (1 - 0.5).10^{-3} = 3{,}342\ tCO_2e$

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

$BE_{NG,y}$ is estimated as follows:

$$\mathrm{BE}_{\mathrm{NG,\,y}} = 0.0504 \times F_{CH4,NG,y} \times EF_{CO2,NG,y} \qquad \textbf{Equation 12}$$

Where,

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

$EF_{CO2,NG,y}$ = Average CO_2 emission factor of natural gas in the natural gas network or in trucks in year *y* (tCO_2/TJ)

$F_{CH4,NG,y}$ = Amount of methane in the LFG which is sent to the natural gas distribution network or in trucks in year *y* (tCH_4/yr)

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

Sample calculation

$BE_{NG,y} = 0.0504 * F_{CH4NG,y} * EF_{CO2,NG,y}$

$BE_{NG,y} = 0.0504 * 260 * 58.3 = 763\ tCO_2e$

Finally, the determination of the amount of methane in the LFG that would be flared in the baseline ($F_{CH4,BL,y}$) 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*, $F_{CH4,BL,y}$ = $F_{CH4,BL,sys,y}$ and the following equation applies:

$$F_{CH4,BL,sys,y} = 0.2 \times F_{CH4,PJ,y} \qquad \textbf{Equation 13}$$

Sample calculation

$F_{CH4,BL,sys,y} = F_{CH4,BL,y} = 0.2 * F_{CH4,PJ,y}$

$F_{CH4,BL,y} = 0.2 * 393 = 79\ tCO_2e$

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

>>

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	FCi,j
	(yes/no)	tCO2	tCO2	tCO2	MWh	Kg
12/2017	Yes	177.82	177.82	0.0000	483.00	0.00
01/2018	Yes	293.44	293.44	0.0001	793.58	45.00
02/2018	Yes	151.17	151.17	0.0000	408.82	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	503.81	503.81	0.0000	1344.00	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	469.92	469.92	0.0000	1253.60	0.00
09/2020	Yes	440.90	440.90	0.0000	1176.18	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 14**

Where,

$PE_{EC,y}$ = Emissions from consumption of electricity due to the project activity in year *y* (t CO_2/yr);
$PE_{FC,y}$ = Emissions from consumption of fossil fuels due to the project activity, for purpose other than electricity generation, in year *y* (t CO_2/yr);
$PE_{DT,y}$ = Emissions from the distribution of compressed/liquefied LFG using trucks, in year *y* (t CO_2/yr).

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
$PE_y = PE_{EC,y} + PE_{FC,y}$
$PE_y = 293.44 + 0.0001 = 293.44\ tCO_2e$

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:

$$PE_{EC,grid,y} = \sum_{j} EC_{PJ,j,y} \times EF_{EL,j,y} \times (1 + TDL_{j,y}) \qquad \textbf{Equation 15}$$

Where,

$PE_{EC,grid,y}$ = Project emissions from electricity consumption from the grid by the project activity during the year *y* (tCO_2/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 (tCO_2/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

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

$PE_{EC,grid,y} = 793.58 * 0.3231 * (1 + 14.4\%) = 293.4\ tCO_2e$

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:

$$PE_{FC,j,y} = SUM(FC_{i,j,y} * COEF_{i,y}) \qquad \textbf{Equation 16}$$

Where,

$PE_{FC,j,y}$ = Are the CO_2 emissions from fossil fuel combustion in process *j* during the year *y* (tCO_2/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 CO_2 emission coefficient of fuel type *i* in year *y* (tCO_2/mass or volume unit)

i = Are the fuel types combusted in process *j* during the year *y*

Sample calculation

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

$PE_{FC,j,y} = SUM(45 * ((0.0465*0.0656)/1000)) = 0.0001\ tCO_2e$

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 tCO_2e

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

	Baseline GHG emissions or baseline net GHG removals (t CO_2e)	Project GHG emissions or actual net GHG removals (t CO_2e)	Leakage GHG emissions (t CO_2e)	GHG emission reductions or net anthropogenic GHG removals (t CO_2e)		
				Before 01/01/2013	From 01/01/2013	Total amount
Total	1,095,505	14,374.0	0	0	1,081,131	1,081,131

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

Amount achieved during this monitoring period (t CO_2e)	Amount estimated ex ante for this monitoring period in the PDD (t CO_2e)
1,081,131	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 tCO_2e) 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 tCO_2e), 2019 (519,375 tCO_2e) and 2020 (531,649 tCO_2e) 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

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

Version	*Date*	*Description*
01.0	28 May 2010	EB 54, Annex 34. Initial adoption.