Monitoring report form for CDM project activity

(Version 06.0)

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

MONITORING REPORT

Title of the project activity	Manaus Landfill Gas Project	
UNFCCC reference number of the project activity	4211	
Version number of the PDD applicable to this monitoring report	03.1	
Version number of this monitoring report	1	
Completion date of this monitoring report	24/02/2019	
Monitoring period number	First monitoring period	
Duration of this monitoring period	From 08/07/2018 to 31/01/2019 (both days included)	
Monitoring report number for this monitoring report	1	
Project participants	Conestoga Rovers e Associados Engenharia Ltda. (Brazil) Nordic Environment Finance Corporation (Norway)	
Host Party	Brazil	
Sectoral scopes	1 - Energy industries (renewable - / non renewable sources) 13 - Waste handling and disposal	
Applied methodologies and standardized baselines	ACM0001: Flaring or use landfill gas (version 18.0)	
Amount of GHG emission reductions or net anthropogenic GHG removals achieved by the project activity in this monitoring period	Amount achieved before 1 2013	Amount achieved from 1 January 2013
	0	219,404 tCO_2e
Amount of GHG emission reductions or net anthropogenic GHG removals estimated ex ante for this monitoring period in the PDD	322,997 tCO_2e	

SECTION A. Description of project activity

A.1. General description of project activity

The Manaus Landfill Gas Project has been developed at the Manaus Landfill (Site), originally called the Aterro Municipal de Manaus. The Site has received non-hazardous solid municipal, industrial, commercial, institutional, and some agricultural wastes for approximately 20 years. Landfills normally emit carbon dioxide (CO_2) and methane (CH_4) into the atmosphere, with these compounds being generated by the anaerobic decomposition of the above-noted wastes placed at the project site. Prior to the implementation of the Project, the Manaus landfill was basically a landfill with has minimal control of surface water and leachate and no control of landfill gas (LFG).

Purpose of the Project Activity

The purpose of the project activity is to collect landfill gas (LFG) at the Manaus Landfill and combust the extracted LFG over a seven year-period, using a high efficiency enclosed flare, thereby reducing greenhouse gas emissions (GHG) and generating Certified Emission Reductions (CERs).

Installed Technology and Equipment

The project involved the construction of a LFG collection system consisting of horizontal trenches and vertical LFG extraction wells, centrifugal blower(s), and all other supporting mechanical and electrical subsystems and appurtenances necessary to collect the LFG.

The LFG collected from the Site is combusted in an enclosed LFG flare with full process controls and instrumentation installed and operating. The state-of-the-art flare is capable of providing sufficient temperature and retention time of the extracted LFG for complete destruction of hydrocarbons.

Relevant dates for the project activity

Conestoga-Rovers & Associates (CRA) started design activities in late 2005 and construction works started in October 2008. The project was ready for commissioning in July 2009.

Accordingly, to the completeness check, the official registration date was on July 8, 2011. First monitoring period report was from July 8, 2011 to October 31, 2011; the Second monitoring period was from November 01, 2011 to January 31, 2013; the Third monitoring period was from February 01, 2013 to December 31, 2013; the Fourth monitoring period was from January 01, 2014 to June 30, 2014; the Fifth monitoring period was from July 01, 2014 to December 31, 2014; the Sixth monitoring period was from January 01, 2015 to June 30, 2015; the Seventh monitoring period was

from July 01, 2015 to December 31, 2015; the Eighth monitoring period was from January 01, 2016 to June 30, 2016; the Ninth monitoring period was from July 01, 2016 to December 31, 2016; the Tenth monitoring period was from January 01, 2017 to June 30, 2017 and the Eleventh monitoring period was from July 01, 2017 to December 31, 2017.

The project activity was renewal on October 04, 2018. Thus, the second crediting period is from July 08, 2018 to July 07, 2025.

Total GHG emission reductions achieved in this monitoring report

The Certified Emission Reductions (CERs) volume claimed for the monitoring period extending from July 08, 2018 to January 31, 2019[1] is 219,404 tCO_2e.

A.2. Location of project activity

The project activity takes places in Manaus Landfill, located in the city of Manaus, capital of Amazonas state, at the geographical coordinates 2º57’29.92’’S and 60º00’54.74’’W. The project site is located at Km 19 of Highway AM-010. The Manaus Landfill covers 60 hectares (ha) area and the current waste filling area has 41 ha, with available space for continued filling.

A.3. Parties and project participants

Parties involved	Project participants	Indicate if the Party involved wishes to be considered as project participant (Yes/No)
Brazil (Host Party)	Conestoga Rovers e Associados Engenharia Ltda. (Private Entity)	No
Norway	Nordic Environment Finance Corporation (Private Entity)	No

A.4. Reference to applied methodologies and standardized baselines

The approved baseline and monitoring methodology applied to this project is the approved ACM0001 version 18 – Flaring or use of landfill gas[2].

This methodology also refers to the following tools:

- Combined tool to identify the baseline scenario and demonstrate additionality (version 07.0)[3];
- Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion (version

[1] Both days included.

[2] Available at: <https://cdm.unfccc.int/methodologies/DB/Y88077XT5O83TZ2PYEZ36LFIAMAODR>.

[3] Available at: <https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-02-v7.0.pdf>.

03)[4].

- Emissions from solid waste disposal sites (version 08.0)[5];
- Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation (version 03.0)[6];
- Project emissions from flaring (version 02.0.0)[7];
- Tool to determine the mass flow of a greenhouse gas in a gaseous stream (version 03.0)[8];
- Determine the baseline efficiency of thermal or electricity energy generation systems (version 02.0)[9];
- Tool to determine the remaining lifetime of equipment (version 01)[10];
- 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)[11];
- Project and leakage emissions from transportation of freight (version 01.1.0)[12].

While applying the methodological tool “Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation”, the “Tool to calculate the emission factor for an electricity system” (Version 06.0)[13] was also considered to the project activity.

Since this PDD refers to the second crediting period of Manaus project, the “Tool for the demonstration and assessment of additionality” and the “Combined tool to identify the baseline scenario and demonstrate additionality” are not applicable.

The tool “Project and leakage emissions from transportation of freight” is also not applied to Manaus project, since there are no GHG emissions from transportation of freight in the project boundary.

A.5. Crediting period type and duration

The second crediting period for this project is from July 8, 2018 to July 7, 2025 (7 years renewable). This is the 01st monitoring period corresponding to 08/07/2018 to 31/01/ 2019[1].

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[4] Available at: <https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-03-v3.pdf>.

[5] Available at: <https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-04-v8.0.pdf>.

[6] Available at: <https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-05-v3.0.pdf>.

[7] Available at: <https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-06-v2.0.pdf>.

[8] Available at: <https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-08-v3.0.pdf>.

[9] Available at: <https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-09-v2.0.pdf>.

[10] Available at: <https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-10-v1.pdf>.

[11] Available at: <https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-11-v3.0.1.pdf>.

[12] Available at: <https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-12-v1.1.0.pdf>.

[13] Available at: <https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-07-v6.pdf>.

SECTION B. Implementation of project activity

B.1. Description of implemented project activity

The Project consists of two phases: (1) the construction of a LFG collection and flaring system and (2) the construction of a LFG-fired power.

The technology used to gather the LFG is a grid of horizontal gas extraction wells within the landfill, connected to a centralized blower system used to induce vacuum. Upon collection of the LFG, the methane component of the LFG is combusted in a state-of-the-art high-efficiency enclosed flare. The Global Warming Potential (GWP) of the LFG is reduced by the destruction of the methane portion of the LFG.

The LFG management system is comprised of the following three major components:

1. LFG management facility - houses mechanical and electrical components required for the extraction and delivery of LFG for disposal by flaring
2. LFG collection field - removes LFG from the wastes within the limit of waste and includes trenches and collection piping to convey LFG from the field to the LFG management facility
3. Condensate management system - removes liquid condensate from the LFG collection system and directs the condensate to the leachate collection system.

There are two blowers working in the system, they are responsible to give negative pressure to the landfill. Each blower has maximum capacity to 4,800 SCFM.

The destruction of methane content in the LFG is made via enclosed flare, in order to assure a higher methane destruction. The flare used is manufactured by John Zink (imported from USA). The capacity is 4,800 SCFM.

The power generation facility will be comprised of LFG engine generator sets of high performance standards. The engine-generator sets will be the primary equipment to combust the collected LFG once they are installed. A fraction of the collected LFG will be diverted to flares, which will be used to combust any gas in excess of the fuel demand for the engines, as well as a contingency backup.

The design for the overall landfill gas (LFG) management system for the Site was completed by Conestoga-Rovers & Associates (CRA) from late 2005 to mid-2006. Construction of the LFG management system commenced in early 2008, and the facility was commissioned in 2009.

Accordingly, to the completeness check, the official registration date was on July 8, 2011. Since the project registration date, efforts have been made to establish a formal power purchase agreement suitable for long term electrical utilization of the LFG. However, the Brazilian energy scenario has changed in recent years, with the final price of energy sales dropping a lot. Consequently, the interested investors declined. But, CRA continues to seek interested parties to concretize Phase 2 of the project.

To date there has been ten issuances of CERs, as follows:

Verification N	Monitoring Period	CERs	Date of Issuance
First	July 8, 2011 to October 31, 2011	53,283 tCO_2e	Oct 30, 2012
Second	November 1, 2011 to January 31, 2013	398,522 tCO_2e	Aug 12, 2013
Third	February 1,2013 to December 31, 2013	374,294 tCO_2e	June 20, 2014
Fourth	January 1,2014 to June 30, 2014	208,853 tCO_2e	November 13, 2014
Fifth	July 1,2014 to December 31, 2014	274,491 tCO_2e	May 29, 2015
Sixth	January 1,2015 to June 30, 2015	270,484 tCO_2e	December 11, 2015
Seventh	July 1, 2015 to December 31, 2015	233,240 tCO_2e	June 01, 2016
Eighth	January 1,2016 to June 30, 2016	231,011 tCO2e	November 04, 2016
Ninth	July 1, 2016 to December 31, 2016	232,698 tCO2e	July 05, 2017
Tenth	January 1, 2017 to June 30, 2017	257,866 tCO2e	December 12, 2017
Eleventh	July 1, 2017 to December 31, 2017	275,145 tCO2e	June 07, 2018
TOTAL CERs ISSUED		**2,810,484 tCO_2e**	

During the current monitoring period July 8, 2018 to January 31, 2019[1], there have been the following major maintenance activities:

Description	Date of maintenance activity/ interruption	Period	Description
Flare maintenance	July 125, 2018	1:00 pm to 2:00 pm	LFG Plant was not operating
Gas valve maintenance	December 12, 2018	7:00 am to 8:00 am	LFG Plant was not operating

During the current monitored period the system went down a few times. Reports describing actions taken by the project operator to solve the issues are available with Project Participants and were provided to the DOE. It is also worth mentioning that no CERs are being claimed for emissions reductions occurring under the circumstances like high electrical discharge in the system.

There were no events or situations occurred during the monitoring period that may impact the applicability of the applied methodology.

B.2. Post-registration changes

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

A temporary deviation from the registered monitoring plan, and well the applied methodology, will be applied in this monitoring period (from July 08, 2018 to January 31, 2019).

The deviation is necessary since the Field Analytical Unit (FAU), responsible for all collecting data, is not operational yet due financials difficult. The equipment has already been purchased and the installation was confirmed by the middle of March 2019.

B.2.2. Corrections

A correction in the registered PDD was approved in August 12th, 2013 (PRC reference- 4211-001). This correction consists of the revise in the formula presented under section B.6.1 to determine the stoichiometric quantity of moles of O_2 required for a complete oxidation of one kg of residual gas in hour h adds the last element by mistake.

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

There are no changes to the start date of the crediting period that have been approved during this period or submitted with this monitoring report.

B.2.4. Inclusion of monitoring plan

There is no inclusion of a monitoring plan to the registered PDD that was not included at registration.

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

There are no changes from registered monitoring plan, applied methodology or applied standardized baseline that have been approved during this monitoring period or submitted with this monitoring report.

B.2.6. Changes to project design

There are no changes to the project design of the project activity that have been approved during this monitoring period or submitted with this monitoring report.

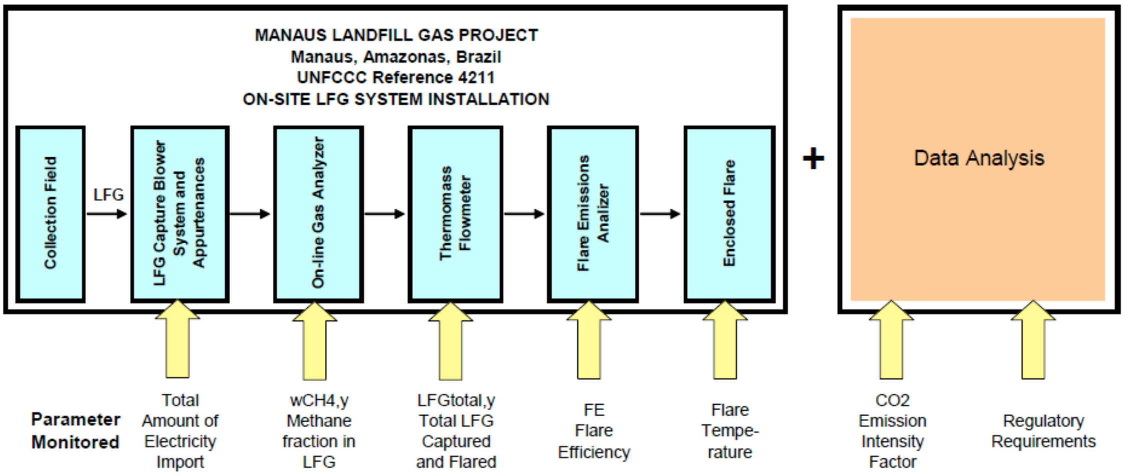
SECTION C. Description of monitoring system

The approved monitoring methodology applied to this project activity is the ACM0001 version 18 – Flaring or use of landfill gas, the applicable tools, as well as per the CDM Project Standard for Project Activity.

All continuously measured parameters (LFG flow, CH4 concentration, flare temperature, flare operating hours, engine operating hours, and engine electrical output) are recorded electronically via a datalogger, located within the site boundary which have the capability to aggregate and print the collected data at the frequencies as specified above. It is the responsibility of the Site Operator to provide all requested data logs which is stored over the duration of the reporting period at the Site office. The data logs are summarized into emission reduction calculation summaries prior to each verification. This task is completed by CRA and reported directly to the DOE. These logs are available as required by the DOE in order to prove the operational integrity of the Project.

The LFG monitoring program is designed to collect system operating data required to safely and effectively operate the system as required for the verification of CERs. This data is collected in real time, and provides a continuous record that is easy to monitor, review, and verify.

The monitoring methodology is based on the direct measurement of the quantity of LFG captured and destroyed by the LFG management system. The actual tonnage of methane emissions reduced by the project is calculated based on the flow rate of the LFG, methane concentration, and destruction efficiency of the combustion equipment. The monitoring plan provides for the continuous measurement of LFG quantity and quality using a continuous flow meter, an online LFG and a flare emissions analyser.



Flow measurement

Following ACM0001, one flow meter was installed during Phase 1 (flaring) on the piping, straight before the flares. The flow of LFG collected by the system and subsequently utilized or flared are measured via individual flow measuring devices suitable for measuring the velocity and volumetric flow of a gas. One common example is an annubar. The flow measurements are taken within the piping itself, and the flow sensors are connected to transmitters that are capable of collecting and sending continuous data to a recording device such as a datalogger.

The flow sensors are calibrated according to a specified temperature and composition of the gas, thus the flow actually measured must be corrected to according to actual temperature, pressure, and composition, thus density, of the gas measured. The equipment selected allows dynamic compensation for these parameters, normalized to a standard temperature, pressure, and gas composition. For reporting purposes, the flows are generally required to be normalized to 0°C and 1.01325 bar at standard gas composition of 50% methane and carbon dioxide each by volume. The accuracy of a flow meter is dependent on the design of the equipment, and the specific type of sensor used, however equipment is available that will provide a minimum accuracy of +/- 2% by volume. The equipment selected for the site utilizes a continuous monitoring system as defined in ACM0001, which measures once every minute and aggregates flow data approximately once every hour.

All data that is collected is recorded for the permanent record. Both electronic and hard copies of the data are maintained for auditing purposes and for use in the calculation of CERs.

Gas quality

The two parameters that are most pertinent to the validation of CERs, as well as the safe and efficient operation of the system are the concentration of methane and oxygen in the gas stream delivered for utilization or diverted to flaring. These two parameters are measured via a common sample line that is run to the main collection system piping, and measured in real time by two

separate sensors, one each for methane and oxygen, installed as per ACM0001. Regular calibration of the equipment is especially important, as the accuracy of the methane and oxygen sensors is greatest within the expected range of the gas stream to be measured. Equipment is readily available that will provide an accuracy of at least +/- 1% by volume. The equipment selected for the site aggregates gas compositions approximately once every 1 minute as per the definition of a continuous monitoring system in ACM0001.

Emission reduction calculations

Guidelines and directives in order to standardize the data acquisition and handling processes are in place for calculating the generation of Certified Emission Reductions (CERs) for the project. The Site uses a Landtec™ data acquisition device [Field Analytical Unit – (FAU)], which measures parameters such as methane (CH_4) concentration, flare temperature, and landfill gas flow on a continuous-basis of the residual gas. A Flare Emission Analyzer (FEA) monitors the CH_4 and O_2 content in the Flare gas exhausted. The data is collected and stored on-site using a Field Server Unit (FSU), which also sends the data to a Landtec server in California (USA) for off-site storage and back-up. Through the EnviroComp Report Service (ECRS), the data is viewed and downloaded to a spreadsheet file for further analysis.

A series of procedures are in place to retrieve and store the data, and set up tables and reports for the verification events. Based on operational data and the applicable monitoring methodology, the emission reductions are calculated on a monthly basis and compiled in a monitoring report during a verification exercise.

Data collection and record keeping

The monitoring methodology requires the continuous measurement of the quantity and quality of the LFG being flared and the quality of exhaust gas from the flare. Data collected from each of the parameter sensors is transmitted directly to an electronic database from which the CER volume calculations may be carried out. A hard copy backup or reports of the data may be printed as required or recorded in Portable Document Format (PDF). Backup of the electronic data is conducted on a 2-3 minute intervals.

A summary of all data collection and reporting requirements, as listed in the UNFCCC ACM0001 (version 18) monitoring methodology, and a summary of on-site monitoring responsibilities and frequencies are provided below.

SUMMARY OF SITE MONITORING RESPONSIBILITIES
Landfill Gas Development Project
Manaus Landfill
Manaus, Amazonas, Brazil

Project Activity	*Equipment*	*Personnel*	*Responsibilities*	*Frequency*
Quantity of LFG Captured	Flow Meter	Site Operator	* Verify the flow meter and FSU are operating correctly and collecting gas flow rate data continuously	Daily
Methane Fraction in LFG	Gas Analyser	Site Operator	* Verify the FAU and FSU are operating correctly and collecting gas composition data continuously	Daily
Flare Efficiency	Emissions Gas Analyser	Site Operator	* Verify the FEA and FSU are operating correctly and collecting exhausted gas composition data continuously	Daily
Flare Operation Time	Flare Stack	Site Operator	* Verify the FSU is recording the flare temperature on a continual basis	Daily
			* Follow operation and maintenance requirements as outlined in the Operation and Maintenance Report	Daily
Amount of Electricity Used	n/a	Site Operator	* Collect all Electricity bills and file on-Site and to office.	Monthly

Emergency procedures

As a precautionary measure, the Landtec system is plugged to a battery-based uninterruptible power supply (UPS) to avoid data loss due to power failures. As a backup is produced and stored off-site from the main recording system, no more than 2 to 3 minutes of data at a time would ever be lost due to a system malfunction.

All data is collected through a Landtec Field Analytical Unit (FAU) and will be transmitted to a Landtec Field Server Unit (FSU), which records the data on-site and automatically sends it via an “always-on” Internet connection to an off-site server for storage and off-site back-up. All collected data is available for viewing, report generation, and retrieval through a Web interface, the EnviroComp™ Reporting System (ECRS), which can be accessed from anywhere an Internet connection is available. The plant Manager checks daily the records. In addition, was developed an Emergency Plan including others types of emergencies such as fire and work accidents.

In addition to the previous monitoring practices, the Project Participant keeps records of sustainable development parameters to monitor benefits the project activity is having in the area. Amongst these monitored parameters are:

- record keeping of job creation: includes number of employees hired and definition of responsibilities of employees working at the LFG collection system plant;
- tracking of odour complaints (dealt with by landfill operator): for this monitoring period there were no complaints during January to July 07, 2018.;
- subsurface migration of LFG is monitored on a monthly basis through monitoring rounds of the applied vacuum on the collection field. Negative pressure readings indicate the gas is being collected by the combustion system avoiding LFG migrating to the surroundings;
- training records of personnel: meetings are performed on site for training and communication purposes, attendees include field, administrative and technical personnel from CRA;
- Income generation: as part of the agreement with the landfill operator (City of Manaus agency), a portion of CERs generated each verification period is transferred to them as royalties.

SECTION D. Data and parameters

D.1. Data and parameters fixed ex ante

ACM0001: Flaring or use of landfill gas

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	Default value used, according to ACM0001
Purpose of data/parameter	Baseline emission calculations
Additional comments	-

Data/Parameter	**η_{PJ}**
Unit	Dimensionless
Description	Efficiency of the LFG capture system that is be installed in the project activity
Source of data	Flare manufacturer and company which has been responsible for assembly and testing of the equipment at the landfill site
Value(s) applied	80%
Choice of data or measurement methods and procedures	Based on the active LFG capture system installed in the project activity.
Purpose of data/parameter	Calculation of baseline emission
Additional comments	-

Project emissions from flaring

Data/Parameter	GWP_{CH4}
Unit	tCO_2e/tCH_4
Description	Global warming Potential of CH_4
Source of data	IPCC
Value(s) applied	25. Updated for the 2nd commitment period according to COP/MOP decisions
Choice of data or measurement methods and procedures	Default value used, according to IPCC Fourth Assessment Report: Climate Change 2007, item 2.10.2: Direct Global Warming Potentials, Table 2.14
Purpose of data/parameter	Calculation of baseline emission
Additional comments	-

<table>
<tr><th>Data/Parameter</th><th>$SPEC_{flare}$</th></tr>
<tr><td>Unit</td><td>Temperature - ºC
Flow rate – Nm^3/h
Maintenance schedule – number of days</td></tr>
<tr><td>Description</td><td>Manufacturer’s flare specifications for temperature, flow rate and maintenance schedule</td></tr>
<tr><td>Source of data</td><td>Flare manufacturer</td></tr>
<tr><td>Value(s) applied</td><td>-</td></tr>
<tr><td>Choice of data or measurement methods and procedures</td><td><table>
<tr><td>Flare model</td><td>ZTOF® Enclosed – John Zink</td></tr>
<tr><td>Minimum flare temperature</td><td>760 ºC</td></tr>
<tr><td>Maximum flare temperature</td><td>982 ºC</td></tr>
<tr><td>Minimum and maximum inlet flow rate</td><td>Minimum flow: 858 Nm^3/h
Maximum flow: 5,150 Nm^3/h</td></tr>
<tr><td>Maximum duration in days between maintenance events</td><td>N/A</td></tr>
</table></td></tr>
<tr><td>Purpose of data/parameter</td><td>Calculation of project emission</td></tr>
<tr><td>Additional comments</td><td>-</td></tr>
</table>

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

Data/Parameter	R_u
Unit	$Pa.m^3/kmol.K$
Description	Universal ideal gas constant
Source of data	Methodological “Tool to determine the mass flow of a greenhouse gas in a gaseous stream” version 03.0
Value(s) applied	8,314
Choice of data or measurement methods and procedures	Default value used, according to methodological tool “Project emissions from flaring” version 02.0.0, table 1: Constants used in equations
Purpose of data/parameter	Baseline emission calculations
Additional comments	-

Data/Parameter	MM_i
Unit	kg/kmol
Description	Molecular mass of greenhouse gas i
Source of data	“Tool to determine the mass flow of a greenhouse gas in a gaseous stream”

Value(s) applied	<table><tr><td>Compound</td><td>Structure</td><td>Molecular mass (kg/kmol)</td></tr><tr><td>Methane</td><td>CH_4</td><td>16.04</td></tr></table>
Choice of data or measurement methods and procedures	According to “Tool to determine the mass flow of a greenhouse gas in a gaseous stream”
Purpose of data/parameter	Baseline emission calculations
Additional comments	-

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

Data/Parameter	**MM_{H20}**
Unit	kg/kmol
Description	Molecular mass of water
Source of data	“Tool to determine the mass flow of a greenhouse gas in a gaseous stream”
Value(s) applied	18.0152
Choice of data or measurement methods and procedures	According to “Tool to determine the mass flow of a greenhouse gas in a gaseous stream”
Purpose of data/parameter	Baseline emission calculations
Additional comments	-

Data/Parameter	**P_{ref}**
Unit	Pa
Description	Atmospheric pressure at reference conditions
Source of data	“Tool to determine the mass flow of a greenhouse gas in a gaseous stream”
Value(s) applied	101,325
Choice of data or measurement methods and procedures	Default value extracted from “Tool to determine the mass flow of a greenhouse gas in a gaseous stream”
Purpose of data/parameter	Project emission calculations
Additional comments	-

Data/Parameter	**T_{ref}**
Unit	K
Description	Temperature at reference conditions

Source of data	"Tool to determine the mass flow of a greenhouse gas in a gaseous stream"
Value(s) applied	273.15
Choice of data or measurement methods and procedures	Default value extracted from "Tool to determine the mass flow of a greenhouse gas in a gaseous stream"
Purpose of data/parameter	Project emission calculations
Additional comments	-

Emissions from solid waste disposal sites

Data/Parameter	$\varphi_{default}$
Unit	-
Description	Default value for the model correction factor to account for model uncertainties
Source of data	Tool "Emissions from solid waste disposal sites"
Value(s) applied	0.75
Choice of data or measurement methods and procedures	According to "Emissions from solid waste disposal sites", the Application A was used because the landfill is an existing solid waste disposal site and in the project activity the methane emissions are being mitigated by capturing and flaring the methane (ACM0001).
Purpose of data/parameter	Baselie emission calculations
Additional comments	-

Data/Parameter	**OX**
Unit	-
Description	Oxidation factor (reflecting the amount of methane from SWDS that is oxidized in the soil or other material covering the waste)
Source of data	Based on an extensive review of published literature on this subject, including the IPCC 2006 Guidelines for National Greenhouse Gas Inventories
Value(s) applied	0.1
Choice of data or measurement methods and procedures	Default value used according to Tool "Emissions from solid waste disposal sites"
Purpose of data/parameter	Baseline emission calculations
Additional comments	When methane passes through the top-layer, part of it is oxidized by methanotrophic bacteria to produce CO2. The oxidation factor represents the proportion of methane that is oxidized to CO2.This should be distinguished from the methane correction factor (MCF) which is to account for the situation that ambient air might intrude into the SWDS and prevent methane from being formed in the upper layer of SWDS.

Data/Parameter	**F**
Unit	-
Description	Fraction of methane in the SWDS gas (volume fraction)
Source of data	2006 IPCC Guidelines for National Greenhouse Gas Inventories
Value(s) applied	0.5
Choice of data or measurement methods and procedures	Default value used according to Tool "Emissions from solid waste disposal sites"

Purpose of data/parameter	Baseline emission calculations
Additional comments	Upon biodegradation, organic material is converted to a mixture of methane and carbon dioxide

Data/Parameter	**$DOC_{f, default}$**
Unit	Weight fraction
Description	Default value for the fraction of degradable organic carbon (DOC) in MSW that decomposes in the SWDS
Source of data	IPCC 2006 Guidelines for National Greenhouse Gas Inventories
Value(s) applied	0.5
Choice of data or measurement methods and procedures	The default value was used for type Application A). according to Tool "Emissions from solid waste disposal sites"
Purpose of data/parameter	Baseline emission calculations
Additional comments	This factor reflects the fact that some degradable organic carbon does not degrade, or degrades very slowly, in the SWDS. This default value can be used for Application A.

Data/Parameter	**$MCF_{default}$**
Unit	-
Description	Methane correction factor
Source of data	IPCC 2006 Guidelines for National Greenhouse Gas Inventories
Value(s) applied	1.0
Choice of data or measurement methods and procedures	The project activity is an anaerobic managed solid waste disposal site with controlled placement of waste (i.e. waste directed to specific deposition areas, a degree of control of scavenging and a degree of control of fires) and is include: (i) cover material; (ii) mechanical compacting and (iii) levelling of the waste.
Purpose of data/parameter	Baseline emission calculations
Additional comments	-

Data/Parameter	**DOC_j**
Unit	-
Description	Fraction of degradable organic carbon in the waste type j (weight fraction)
Source of data	IPCC 2006 Guidelines for National Greenhouse Gas Inventories (adapted from Volume 5, Tables 2.4 and 2.5)
Value(s) applied	see table below

Waste type j	**DOCj (% wet waste)**
Wood and wood products	43%
Pulp, paper and carboard (other than sludge)	40%
Food, food waste, beverages and tobacco (other than sludge)	15%
Textiles	24%
Garden, yard and park waste	20%
Glass, plastic, metal, other inert waste	0%

Choice of data or measurement methods and procedures	IPCC default value for municipal solid waste (MSW) disposal site is applied.
Purpose of data/parameter	Baseline emission calculations
Additional comments	-

Data/Parameter	**k_j**
Unit	1/yr
Description	Decay rate for waste type j
Source of data	2006 IPCC Guidelines for National Greenhouse Gas Inventories
Value(s) applied	Pulp, paper and cardboard (other than sludge), textiles = 0.07 Wood, wood products and straw = 0.035 Other (non-food) organic putrescible garden and park waste = 0.17 Food, food waste, sewage sludge, beverages and tobacco = 0.40
Choice of data or measurement methods and procedures	IPCC default value for anaerobic managed solid waste disposal site is applied.
Purpose of data/parameter	Baseline emission calculations
Additional comments	Used for projection of methane avoidance. The Brazil's climate database was provided by EMBRAPA, and historical data from 1961 to 1990 for the municipality of Manaus was used.

Data/Parameter	**Waste composition**
Unit	%
Description	Waste composition
Source of data	Landfill internal data
Value(s) applied	Wood and wood products = 6.31% Pulp, paper and cardboard (other than sludge) = 23.47% Food, food waste, beverages and tobacco (other than sludge) = 35.84% Textiles = 0.00% Garden, yard and park waste = 0.00% Glass, plastic, metal and other inert waste = 34.39%
Choice of data or measurement methods and procedures	Internal report
Purpose of data/parameter	Baseline emission calculations
Additional comments	Used for projection of methane avoidance.

Tool to calculate the emission factor for an electricity system

Data/Parameter	**$EF_{grid,CM,y}$**
Unit	tCO_2/MWh
Description	Combined margin CO_2 emission factor for the electricity system
Source of data	Isolated System Spreadsheet
Value(s) applied	0.7160
Choice of data or measurement methods and procedures	The emission factor is defined ex-ante as per the "Tool to calculate the emission factor for an electricity system" – Version 2.

Purpose of data/parameter	Project emission calculations
Additional comments	The emission factor is defined ex-ante.

Data/Parameter	**$EF_{grid,BM,2016}$**
Unit	tCO_2/MWh
Description	Build margin emission factor for the grid in year y
Source of data	Brazilian DNA.
Value(s) applied	0.1581 (*ex ante* estimate for year 2016)
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	Project emission calculations
Additional comments	For methodological choices details, please refer to Appendix 4 of the registered PDD.

Data/Parameter	**$EF_{grid,OM-adj,y}$**
Unit	tCO_2/MWh
Description	Simple adjusted operating margin CO_2 emission factor in year y
Source of data	Brazilian DNA.
Value(s) applied	0.4979
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	Project emission calculations
Additional comments	For methodological choices details, please refer to Appendix 4 of the registered PDD.

D.2. Data and parameters monitored

Data/Parameter	**$LFG_{total,y}$**
Unit	Nm^3
Description	Total amount of landfill gas captured at normal temperature and pressure
Measured/calculated/ default	Measured and calculated
Source of data	On-Line LFG flow meter (thermo mass)
Value(s) of monitored parameter	Multiple, continuously measured and calculated hourly. Values submitted in excel tables with this report.
Monitoring equipment	Thermal Instrument Co Model 62-9/9500 thermal flowmeter serial # 2012382 Flowrate Readout Accuracy: ± 1 % Full Scale Calibration frequency: 18 months Date of last calibration: February 01, 2018 Validity: July 31, 2019
Measuring/reading/recording frequency	Continuously every two minutes
Calculation method (if applicable)	In first phase, $LFG_{total,y} = LFG_{flare,y}$
QA/QC procedures	The flowmeter is recalibrated as per manufacturer's recommendation.
Purpose of data/parameter	Baseline emission calculations

Additional comments	-

Data/Parameter	$LFG_{flare, y}$
Unit	Nm^3
Description	Amount of landfill gas flared at normal temperature and pressure
Measured/calculated/ default	Measured and calculated
Source of data	On-Line LFG flow meter (thermo mass)
Value(s) of monitored parameter	Multiple, continuously measured and calculated hourly. Values submitted in excel tables with this report.
Monitoring equipment	Thermal Instrument Co Model 62-9/9500 thermal flowmeter serial # 2012382 Flowrate Readout Accuracy: ± 1 % Full Scale Calibration frequency: 18 months Date of last calibration: February 01, 2018 Validity: July 31, 2019
Measuring/reading/recording frequency	Continuously every two minutes
Calculation method (if applicable)	-
QA/QC procedures	The flowmeter is recalibrated as per manufacturer's recommendation
Purpose of data/parameter	Project Emissions from flaring of the residual gas stream in year y
Additional comments	-

Data/Parameter	$LFG_{electricity,y}$
Unit	Nm^3
Description	Amount of LFG combusted in power plant at normal temperature and pressure
Measured/calculated/ default	Measured
Source of data	Parameter to be monitored in phase 2
Value(s) of monitored parameter	Parameter to be monitored in phase 2
Monitoring equipment	The data will be collected continuously every 2-3 minutes using a flow meter. The data will be aggregated monthly and yearly for the power plant. The data will be archived throughout the crediting period and two years thereafter
Measuring/reading/recording frequency	Continuously every two minutes
Calculation method (if applicable)	Not applicable
QA/QC procedures	Calibration of equipment as per manufacturer specifications to ensure validity of data measured. Periodical calibration.
Purpose of data/parameter	Baseline emission calculations
Additional comments	-

Data/Parameter	$w_{CH_4,y}$
Unit	m^3 CH_4/m^3 LFG
Description	Methane fraction in the landfill gas
Measured/calculated/ default	Measured
Source of data	Measured by continuous gas quality analyzer

Value(s) of monitored parameter	Multiple, continuously measured. Values submitted in excel tables with this report.
Monitoring equipment	Landtec Field Analytical Unit (FAU), calibration automatically checked each three hours. Type: FAU Serial Number: 14046 Calibration Frequency: 12 months Accuracy: +/-1% Date of last calibration: February 02,2018 Validity: February 01, 2019
Measuring/reading/recording frequency	Continuously every two minutes
Calculation method (if applicable)	Not applicable
QA/QC procedures	Landtec Field Analytical Unit (FAU), calibration automatically checked each three hour, using standard gas from cylinder. Type: Gas Cylinder Serial Number: 40324 Composition: CH4 50%; CO2 35% Date of last calibration: March 01, 2017 Validity: February 28, 2022 Type: Gas Cylinder Serial Number: 4147430 Composition: O2- 4% Date of last calibration:June16, 2016 Validity: June 15, 2021
Purpose of data/parameter	Baseline emission calculations
Additional comments	The monitoring period of $w_{CH_4,y}$is on dry basis according “Tool to determine project emissions from flaring gases containing methane” the gas temperature is not greater than 60C. The gas temperature is monitoring by Landtec System.

Data/Parameter	**$PE_{flare,y}$**
Unit	tCO_2e
Description	Project Emissions from flaring of the residual gas stream in year y
Measured/calculated/ default	Calculated
Source of data	Not applicable
Value(s) of monitored parameter	Calculated on the daily table spreadsheet
Monitoring equipment	Not applicable
Measuring/reading/recording frequency	Annual data will be recorded as per the most current version of the “Tool to determine project emissions from flaring gases containing methane”. The data will archived throughout the crediting period and two years thereafter.
Calculation method (if applicable)	Tool to determine project emissions from flaring gases containing methane.
QA/QC procedures	The parameters used for determining the project emissions from flaring of the residual gas stream in year y will use the QA/QC procedures as per the “Tool to determine project emissions from flaring gases containing methane”.

Purpose of data/parameter	Project Emissions from flaring of the residual gas stream in year y
Additional comments	-

Data/Parameter	**EL_{LFG}**
Unit	MWh
Description	Net amount of electricity generated using LFG
Measured/calculated/ default	Measured
Source of data	Electricity meter
Value(s) of monitored parameter	Parameter to be monitored in phase 2
Monitoring equipment	Electricity meter
Measuring/reading/recording frequency	The data will be collected continuously using an electricity meter. The net amount of electricity will be directly measured.
Calculation method (if applicable)	Not applicable
QA/QC procedures	Calibration of equipment as per manufacturer specifications to ensure validity of data measured. Periodical calibration.
Purpose of data/parameter	Baseline emission calculations
Additional comments	-

Data/Parameter	**Operational of the energy plant**
Unit	Hours
Description	Operation of the energy plant
Measured/calculated/ default	Default
Source of data	Project Participants
Value(s) of monitored parameter	Parameter to be monitored in phase 2
Monitoring equipment	Reliable sources will be used
Measuring/reading/recording frequency	Information will be monitored and reviewed on an annual basis.
Calculation method (if applicable)	Not applicable
QA/QC procedures	Parameter to be monitored in phase 2
Purpose of data/parameter	Baseline emission calculations
Additional comments	-

Data/Parameter	**$NCV_{diesel,y}$**
Unit	GJ per mass (GJ/ton)
Description	Weighted average net calorific value of diesel in year y
Measured/calculated/ default	Default
Source of data	Brazilian Energy Balance (BEN) 2017 - base year 2016 https://ben.epe.gov.br/downloads/Relatorio_Final_BEN_2017.pdf page 226
Value(s) of monitored parameter	42.3
Monitoring equipment	-
Measuring/reading/recording frequency	Not applicable

Calculation method (if applicable)	Not applicable
QA/QC procedures	-
Purpose of data/parameter	Project emission calculations
Additional comments	-

Data/Parameter	**$EF_{CO_2,i,y}$**
Unit	tCO_2/GJ
Description	Weighted average CO_2 emission factor of diesel in year y
Measured/calculated/ default	Default
Source of data	Regional or national defaults values
Value(s) of monitored parameter	0.0748 (IPCC Guideline, 2006) Table 2.4
Monitoring equipment	Not applicable
Measuring/reading/recording frequency	-
Calculation method (if applicable)	Not applicable
QA/QC procedures	The CO_2 emission factor was obtained of the IPCC Guidelines.
Purpose of data/parameter	Project emission calculations
Additional comments	For a): If the fuel supplier does provide the NCV value and the CO_2 emission factor on the invoice and these two values are based on measurements for this specific fuel, this CO_2 factor should be used. If another source for the CO_2 emission factor is used or no CO_2 emission factor is provided, Options b), c) or d) should be used. According to the registered PDD, Option d) was chosen and, for this reason, the values of IPCC guidelines were applied.

Data/Parameter	**$PE_{FC,j,y}$**
Unit	tCO_2e
Description	Project Emissions from diesel combustion in process j during the year y
Measured/calculated/ default	Calculated
Source of data	Quantities of diesel used for the standby generator will be recorded via receipts and additional information will be delivered from the fuel company. In the event they cannot produce this information IPCC guidelines will be used.

Value(s) of monitored parameter

Period	**Quantity of diesel combusted (liters)**	***Weighted average net calorific value of diesel* (GJ/tone)**	***Weighted Average emission factor of diesel* (tCO_2e/GJ)**	***Emissions from fossil fuel combustion in process (tCO_2e)***
	∑FCi,j,y	*NCVi,y	EF CO_2, i, y	*PEFC*
July/2018	0	42.3	0.0748	0.00
August/ 2018	594	42.3	0.0748	1.579
September/ 2018	0	42.3	0.0748	0.00
October/ 2018	0	42.3	0.0748	0.00
November/ 2018	205	42.3	0.0748	0.545
December/ 2018	0	42.3	0.0748	0.00
January/ 2019	331	42.3	0.0748	0.880
Total	1,130	42.3	0.0748	3.004

* *Source: Balanço Energético Nacional 2018-Base Year 2017.*

PEFC,j,y=∑FCi,j,y * COEFi,y

COEFi,y = NCVi,y * EF CO_2, i, y
COEFi,y = 42.3 GJ/ton * 0.0748 t CO_2/GJ = 3.16404 tCO_2/ton

1,130 l * 0.84 kg/l * 0.00316404 tCO_2/kg = 949.2kg * 0.00316404 tCO_2/kg = $tCO_{2\,=}$ 3.004 tCO_2

Monitoring equipment	Not applicable
Measuring/reading/recording frequency	Recorded via purchase receipts from the product distributor in accordance with the “Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion” version 2
Calculation method (if applicable)	“Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion” version 2
QA/QC procedures	As per the “Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion” version 2.
Purpose of data/parameter	Project emission calculations
Additional comments	-

Data/Parameter	**f**
Unit	**-**
Description	Fraction of methane captured at SWDS and flared, combusted or used in another manner

Measured/calculated/ default	-
Source of data	Not applicable
Value(s) of monitored parameter	Not applicable
Monitoring equipment	-
Measuring/reading/recording frequency	-
Calculation method (if applicable)	-
QA/QC procedures	Consistency with mandatory laws and regulations
Purpose of data/parameter	Project emission calculations
Additional comments	-

Data/Parameter	**TDL_y**
Unit	-
Description	Average technical transmission and distribution losses in the grid in year *y* for the voltage level at which electricity is obtained from the grid at the project site.
Measured/calculated/ default	Calculated
Source of data	Brazilian Energy Balance 2018 - Síntese do Relatório Final (base year 2017) http://www.epe.gov.br/sites-pt/publicacoes-dados-abertos/publicacoes/PublicacoesArquivos/publicacao-303/topico-397/Relat%C3%B3rio%20S%C3%ADntese%202018-ab%202017vff.pdf
Value(s) of monitored parameter	15.7%
Monitoring equipment	Not applicable
Measuring/reading/recording frequency	-
Calculation method (if applicable)	The value was based on Brazilian Energy Balance 2016 (base year 2015).
QA/QC procedures	Project emission calculations
Purpose of data/parameter	-
Additional comments	The value was based on Brazilian Energy Balance 2017 - Síntese do Relatório Final (base year 2016), page 30

Data/Parameter	**$FC_{i,j,y}$**
Unit	Mass or volume unit per year
Description	Quantity of fuel type i combusted in process j during year y
Measured/calculated/ default	on site measurements
Source of data	Onsite measurements and invoices of diesel suppliers

<table>
<tr><td>Value(s) of monitored parameter</td><td>
<table>
<tr><td rowspan="2">Period</td><td>Quantity of diesel combusted (liters)</td></tr>
<tr><td>$\sum FC_{i,j,y}$</td></tr>
<tr><td>July/2018</td><td>0</td></tr>
<tr><td>August/2018</td><td>594</td></tr>
<tr><td>September/2018</td><td>0</td></tr>
<tr><td>October/2018</td><td>0</td></tr>
<tr><td>November/2018</td><td>205</td></tr>
<tr><td>December/2018</td><td>0</td></tr>
<tr><td>January/2019</td><td>331</td></tr>
<tr><td>From july 08, 2018 to january 31, 2019</td><td>1,130</td></tr>
</table>
</td></tr>
<tr><td>Monitoring equipment</td><td>N/A</td></tr>
<tr><td>Measuring/reading/recording frequency</td><td>The consumption of diesel is done every time the generator is used. There is a spreadsheet for internal control.</td></tr>
<tr><td>Calculation method (if applicable)</td><td>-</td></tr>
<tr><td>QA/QC procedures</td><td>The consistency of metered fuel consumption quantities should be cross-checked by an annual energy balance that is based in 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.</td></tr>
<tr><td>Purpose of data/parameter</td><td>Project emission calculations</td></tr>
<tr><td>Additional comments</td><td>-</td></tr>
</table>

Data/Parameter	**Mass $_{LPG}$**
Unit	Kg
Description	Consumption of LPG by the project activity
Measured/calculated/ default	Measured
Source of data	Invoices of LPG suppliers
Value(s) of monitored parameter	LPG cylinders of 13kg have been changed on: December 07, 2018 Mass LPG:13kg (invoice issued by LPG supplier)
Monitoring equipment	N/A
Measuring/reading/recording frequency	The mass of LPG purchased will be stated in the invoices issued by LPG suppliers

Calculation method (if applicable)	The mass of LPG used by the project activity is used to calculate the corresponding emissions: ETy * CEFthermal,y, where ETy = MassLPG * LHVLPG (MassLPG = consumption of LPG in kilograms; LHVLPG = lower heating value of LPG) and CEFthermal,y. MassLPG : 39kg (invoices issued by LPG supplier) LHVLPG: 46.46TJ/Gg (11,100 Kcal/Kg as per Balanço Energético Brasileiro 2018- base year 2017) CEF: 65,600 Kg CO2 / TJ (IPCC 2006) MassLPG * LHV *CEF = 0.000013Gg * 46.46TJ/Gg * 65600 KgCO2 / TJ = 39.62 kgCO2 = 0.039 tCO2 = 0.04 tCO2
QA/QC procedures	Scope of the LPG supplier
Purpose of data/parameter	Project emission calculations
Additional comments	-

Data/Parameter	**$PE_{EC,y}$**
Unit	tCO_2
Description	Project emissions from electricity consumption by the project activity during the year
Measured/calculated/ default	Calculated
Source of data	Electric meter
Value(s) of monitored parameter	(see table below)

Period	***Quantity of Electricity Imported MWh***	***Combined margin CO_2 emission factor tCO_2/MWh***	***Average Technical Transmission***	***Emissions from consumption of electricity tCO_2e/ month***
	EC	***EFgrid,CM***	***(1+TDL)***	***PEEC***
July/ 2018	19.51	0.716	1.157	16.16
August/ 2018	24.92	0.716	1.157	20.64
September/ 2018	28.98	0.716	1.157	24.01
October/ 2018	25.62	0.716	1.157	21.22
November/ 2018	22.54	0.716	1.157	18.67
December/ 2018	24.64	0.716	1.157	20.41
January/ 2018	23.94	0.716	1.157	20.71
July 08, 2018 to January 31, 2019	170.15	0.716	1.157	141.82

Monitoring equipment	Energy measurement meters. These meters are installed by the local electric provider Amazonas Energia S.A., are sealed and tamper proof. Calibration of the electricity meters is responsibility of Amazonas Energia as well as their frequency, according to INMETRO (National Institute of Metrology, Quality and Technology) and the Grid Procedures established by the Electric System National Operator (from the Portuguese Operador Nacional do Sistema Elétrico – ONS)[14]. The report of conformity was issued by the meter manufacturer (Landis+Gyr), and in accordance with INMETRO directives.
Measuring/reading/recording frequency	Measuring frequency: monthly meter reading by the electricity distribution company (Amazonas Energia) representative and billing to the company
Calculation method (if applicable)	Calculated as per the "Tool to calculate baseline, project and/or leakage emissions from electricity consumption" ver. 1
QA/QC procedures	The energy meters are installed at the site by Amazonas Energia. The meters are sealed and tempering with the meter is a criminal offence.
Purpose of data/parameter	Project emission calculations
Additional comments	-

Data/Parameter	**Wx**
Unit	Tons
Description	Total amount of organic waste prevented from disposal in year x
Measured/calculated/ default	Measured
Source of data	Weight scale on site
Value(s) of monitored parameter	(see table below) Estimated value based in July 2018

Months	Waste disposal (t/yr)
July/2018	56,785.64
*August/2018**	73,348.12
*September/2018**	73,348.12
*October/2018**	73,348.12
*November/2018**	73,348.12
*December/2018**	73,348.12
*January/2019**	73,348.12
July 08, 2018 to January 31,2019	496,874.36

Estimated value based in July 2018

[14] Sub-módulo 12.3. Metering System Maintenance for Invoicing, in a free translation from the Portuguese *Manutenção do Sistema de Medição para Faturamento*. Available at: <http://extranet.ons.org.br/operacao/prdocme.nsf/videntificadorlogico/5DA0C134065FB70F83257945005B1BDF/$file/Submodulo%2012.3_Rev_2.0.pdf?openelement>.

Monitoring equipment	Weigh scale logs are stored at site and summarized on a yearly basis Toledo do Brasil Industria de Balanças Ltda. Model 820 Serial Number: 10096527 Accuracy: +/- 10kg Calibration Frequency: 12 months Date of previous calibration: March 10, 2017 Date of last calibration: March 09, 2018
Measuring/reading/recording frequency	Continuously
Calculation method (if applicable)	N/A
QA/QC procedures	Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site
Purpose of data/parameter	N/A
Additional comments	-

Data/Parameter	$t_{O2,h}$
Unit	%
Description	Volumetric fraction of O_2 in the exhaust gas of the flares in the hour h
Measured/calculated/ default	Measured
Source of data	Measured by a Flare Emissions Analyzer (1)
Value(s) of monitored parameter	Multiple, continuously measured. Values submitted in excel tables with this report.
Monitoring equipment	Landtec Flare Emission Analyzer – FEA Accuracy: +/- 0.1% O2 Serial number: 4722 Calibration frequency: 12 months Date of previous calibration: February 1, 2017 Date of last calibration: January 30, 2018 Validity: January 29, 2019 Landtec Flare Emission Analyzer – FEA Accuracy: +/- 0.1% O2 Serial number: 4722 Calibration frequency: 12 months Date of previous calibration: February 1, 2017 Date of last calibration: January 29, 2019 Validity: January 28, 2020
Measuring/reading/recording frequency	Measuring frequency: continuously. Reporting every 2-3 minutes
Calculation method (if applicable)	Not applicable

QA/QC procedures	Zero check and spam check performance once a day using standard gas. Calibration of equipment as per manufacturer specifications to ensure validity of data measured Type: Gas Cylinder Serial Number: 288855 Composition: CH_4 50Micromol/mol; O2 15% Date of last calibration: June 16, 2016 Validity: June 15, 2021
Purpose of data/parameter	Project Emissions from flaring of the residual gas stream in year y
Additional comments	-

Data/Parameter	**$fv_{CH4,FG,h}$**
Unit	mg/m³
Description	Concentration of methane in the exhaust gas of the flare in dry basis at normal conditions in the hour h
Measured/calculated/ default	Measured
Source of data	Measured by a Flare Emissions Analyser
Value(s) of monitored parameter	Multiple, continuously measured. Values submitted in excel tables with this report.
Monitoring equipment	Landtec Flare Emission Analyzer – FEA Accuracy: +/- 0.1% O2 Serial number: 4722 Calibration frequency: 12 months Date of previous calibration: February 1, 2017 Date of last calibration: January 30, 2018 Validity: January 29, 2019 Landtec Flare Emission Analyzer – FEA Accuracy: +/- 0.1% O2 Serial number: 4722 Calibration frequency: 12 months Date of previous calibration: February 1, 2017 Date of last calibration: January 29, 2019 Validity: January 28, 2020
Measuring/reading/recording frequency	Measuring frequency: continuously. Reporting every 2-3 minutes
Calculation method (if applicable)	Not applicable
QA/QC procedures	Zero check and spam check performance once a day using standard gas. Calibration of equipment as per manufacturer specifications to ensure validity of data measured Type: Gas Cylinder Serial Number: 288855 Composition: CH_4 50Micromol/mol; O2 15% Date of last calibration: June 16, 2016 Validity: June 15, 2021
Purpose of data/parameter	Project emission calculations
Additional comments	-

Data/Parameter	**T_{flare}**
Unit	°C
Description	Temperature on the exhaust gas the flare
Measured/calculated/ default	Measured
Source of data	Measurements by a thermocouple
Value(s) of monitored parameter	The minimum flare temperature was used in the macro that determinates the flare operation uptime was 500°C. Values submitted in excel tables with this report.

Monitoring equipment	Thermocouples Type N. Pakari Industria e Serviços: Serial Number: 5210 Accuracy:+/- 2.2°C Date of last calibration: November 01, 2017 Frequency calibration: 1 year Validity: October 31, 2018 Serial Number: 5211 Accuracy:+/- 2.2°C Date of last calibration: November 01, 2017 Frequency calibration: 1 year Validity: October 31, 2018 Serial Number: 5212 Accuracy:+/- 2.2°C Date of last calibration: November 01, 2017 Frequency calibration: 1 year Validity: October 31, 2018 Serial Number: 5213 Accuracy:+/- 2.2°C Date of last calibration: November 01, 2017 Frequency calibration: 1 year Validity: October 31, 2018 Serial Number: 3881 Accuracy:+/- 2.2°C Date of last calibration: September 26, 2018 Frequency calibration: 1 year Validity: September 25, 2019 Serial Number: 3882 Accuracy:+/- 2.2°C Date of last calibration: September 26, 2018 Frequency calibration: 1 year Validity: September 25, 2019 Serial Number: 3883 Accuracy:+/- 2.2°C Date of last calibration: September 26, 2018 Frequency calibration: 1 year Validity: September 25, 2019 Serial Number: 3884 Accuracy:+/- 2.2°C Date of last calibration: September 26, 2018 Frequency calibration: 1 year Validity: September 25, 2019 The thermocouples # 5210, 5211, 5212, 5213 was replaced by thermocouples # 3881,3882, 3883, 3884 on October 04, 2018
Measuring/reading/recording frequency	Measuring frequency: continuously
Calculation method (if applicable)	Not applicable
QA/QC procedures	Thermocouples are calibrated every year
Purpose of data/parameter	Project emission calculation
Additional comments	-

Data/Parameter	**$FV_{RG,h}$**
Unit	m^3/h
Description	Volumetric flow rate of the residual gas in dry basis at normal conditions in the hour h.
Measured/calculated/ default	Measured
Source of data	Measurements using a flow meter
Value(s) of monitored parameter	Multiple, continuously measured. Values submitted in excel tables with this report.
Monitoring equipment	Thermal Instrument Co Model 62-9/9500 thermal flowmeter serial # 2012382 Flowrate Readout Accuracy: ± 1 % Full Scale Calibration frequency: 18 months Date of last calibration: February 01, 2018 Validity: July 31, 2020
Measuring/reading/recording frequency	Reporting Frequency: every two minutes
Calculation method (if applicable)	Not applicable
QA/QC procedures	The flowmeter is recalibrated as per manufacturer's recommendation
Purpose of data/parameter	Project Emissions from flaring of the residual gas stream in year y
Additional comments	The monitoring period of $FV_{RG,h}$ is on dry basis according "Tool to determine project emissions from flaring gases containing methane" the gas temperature is not greater than 60C. The gas temperature is monitoring by Landtec System.

Data/Parameter	**$fv_{i,h}$**
Unit	**%**
Description	Volumetric fraction component i of the residual gas in dry basis at normal conditions in the hour h, where I = CH_4 and N_2
Measured/calculated/ default	Measured
Source of data	Measured by continuous gas quality analyser
Value(s) of monitored parameter	Multiple, continuously measured. Values submitted in excel tables with this report.
Monitoring equipment	Landtec Field Analytical Unit (FAU), calibration automatically checked each three hours. Type: FAU Serial Number: 14046 Calibration Frequency: 12 months Accuracy: +/-1% Date of last calibration: February 02,2018 Validity: February 01, 2019
Measuring/reading/recording frequency	Measured continuously and Reporting every 2-3 minutes
Calculation method (if applicable)	Not applicable

QA/QC procedures	Landtec Field Analytical Unit, calibration automatically checked each three hour, using standard gas from cylinder. Type: Gas Cylinder Serial Number: 40324 Composition: CH4 50%; CO2 35% Date of last calibration: March 01, 2017 Validity: February 28, 2022 Type: Gas Cylinder Serial Number: 4147430 Composition: O2- 4% Date of last calibration: June 16, 2016 Validity: June 15, 2021
Purpose of data/parameter	Project Emissions from flaring of the residual gas stream in year y
Additional comments	The monitoring period of **$fv_{i,h}$** is on dry basis according "Tool to determine project emissions from flaring gases containing methane" the gas temperature is not greater than 60C. The gas temperature is monitoring from landtec System.

D.3. Implementation of sampling plan

Not applicable.

SECTION E. Calculation of emission reductions or net anthropogenic removals

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

The Methodology ACM0001 – Version 18 states that the greenhouse gas emissions reductions achieved by the project activity during a given period is the difference between the amount of methane actually destroyed/combusted and the amount of methane that would have been destroyed/combusted in the absence of the project activity, times the GWP of methane.

The baseline emissions were calculated according to the following formula:

$$BE_y = (MD_{project,y} - MD_{BL,y}) \times GWP_{CH4} + EL_{LFG,y} \times CEF_{elec,BL,y} + ET_{LFG,y} \times CEF_{ther,BL,y}$$

BE_y	$MD_{project}$[15]	MD_{BL}	GWP_{CH4}
-	-	0	25

Where:

BE_y = Baseline emissions in year *y* (tCO_2e);

$MD_{project,y}$ = The amount of methane that would have been destroyed/combusted during the year, in tonnes of methane (tCH_4) in project scenario;

[15] In the phase 1 $MD_{project} = MD_{flared}$

$MD_{BL,y}$ = The amount of methane that would have been destroyed/combusted during the year in the absence of the project due to regulatory and/or contractual requirement, in tonnes of methane (tCH_4);

GWP_{CH4} = Global Warming Potential value for methane for the second commitment period is 25 tCO_2e/tCH_4;

EL_{LFG} = Net quantity of electricity produced using LFG which in the absence of the project activity would have been produced by power plants connected to the grid or by an on-site/off-site fossil fuel based captive power generation, during year *y*, in megawatt hours (MWh);

$CEF_{elec,BL,y}$ = CO_2 emissions intensity of the baseline source of electricity displaced, in tCO_2e/MWh;

$ET_{LFG,y}$ = The quantity of thermal energy produced utilizing the landfill gas, which in the absence of the project activity would have been produced from onsite/offsite fossil fuel fired boiler, during the year y in TJ;

$CEF_{ther,BL,y}$ = CO_2 emissions intensity of the fuel used by boiler to generate thermal energy which is displaced by LFG based thermal energy generation, in tCO_2/TJ.

According to the methodology ACM0001 version 18, the methane destroyed by the project activity ($MD_{project,y}$) during a year is determined by monitoring the quantity of methane actually flared and gas used to generate electricity and/or produce thermal energy and/or supply to end users via natural gas distribution pipeline. The Manaus Landfill Gas Project aims to capture and flare LFG and in a second phase to generate electricity with LFG.

The sum of the quantities fed to the flare(s) and to the power plant(s):

$$MD_{project,y} = MD_{flared,y} + MD_{electricity,y};$$

Where:

$MD_{flared,y}$ = Quantity of methane destroyed by flaring (tCH_4);

$MD_{electricity,y}$ = Quantity of methane destroyed by generation of electricity (tCH_4).

$MD_{flared,y}$ is calculated as following:

$$MD_{flared,y} = (LFG_{flared,y} \times w_{CH4} \times D_{CH4}) - \frac{PE_{flare,y}}{GWP_{CH4}}$$

So $BE_y = (MD_{flared,y} – MD_{BL}) \times GWP_{CH4}$

$BE_y = (MD_{flared,y} – 0) \times GWP_{CH4}$

$BE_y = ((LFG_{flared,y} \times w_{CH4} \times D_{CH4}) – (PE_{flare,y}/GWP_{CH4})) \times GWP_{CH4}$

Where:

$LFG_{flare,y}$ = Quantity of landfill gas fed to the flare(s) during the year measured in (m^3);

w_{CH4} = Average methane fraction of the landfill gas as measured during the given time period t in time intervals of not greater than one hour (typically every 2-3 minutes) and expressed as a fraction of CH_4 volume per LFG volume (in m^3CH_4/m^3LFG);

D_{CH4} = Methane density, expressed in tonnes of methane per cubic meter of methane (tCH_4/m^3CH_4), and measured at STP[16] (0 degree Celsius and 1.01325 bar), which is 0.0007168 tCH_4/m^3CH_4 (as per consolidated methodology ACM0001 ver.11);

$PE_{flare,y}$ = Project emissions from flaring of the residual gas stream in year y (tCO_2e)

Period	$MD_{flared,y}$	$LFG_{flared,y}$	W_{CH4}	D_{CH4}	$PE_{flare,y}$	GWP_{CH4}
July 2018	924	3,562,857	0.584	0.0007168	14.085	25
August 2018	1,513	4,243,878	0.559	0.0007168	4.358	25
September 2018	1,412	3,820,930	0.531	0.0007168	929	25
October 2018	1,025	3,228,641	0.478	0.0007168	1,928	25
November 2018	1,286	3,514,033	0.516	0.0007168	263	25
December 2018	1,414	3,559,230	0.559	0.0007168	231	25
January 2019	1,208	3,131,512	0.552	0.0007168	937	25

$$BE_y = MD_{flared,y} \times GWP_{CH4}$$

The value of baseline emissions during the monitoring period is presented below:

Monitoring Period	***Baseline emissions (tCO_2e)***

[16] STP: Standard condition for temperature and pressure

	BE
July 2018	23,104
August 2018	37,835
September 2018	35,292
October 2018	25,623
November 2018	32,138
December 2018	35,360
January 2019	30,200
July 08, 2018 to January 31, 2019[1]	**219,551**

And $MD_{electricity,y}$ is calculated as follows:

$$MD_{electricity,y} = LFG_{electricity,y} \times w_{CH4} \times D_{CH4}$$

Where:

$LFG_{electricity,y}$ = Quantity of landfill gas fed into electricity generator (m^3).

Emission reductions are calculated as follows:

$$ER_y = BE_y – PE_y,$$

Where:

ER_y = Emission reductions in year y (tCO_2e/yr);

BE_y = Baseline emissions in year y (tCO_2e/yr);

PE_y = Project emissions in year y (tCO_2e/yr).

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

Project emissions:

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

Where:

$PE_{EC,y}$ = Emissions from consumption of electricity in the project case (tCO_2);

$PE_{FC,j,y}$ = Emission from fossil fuel combustion in process (tCO_2).

PE_{LPG} = Emission from consumption of LPG in the project case (tCO_2).

Project emissions due to the consumption of electricity by the project activity

As electricity is consumed from the grid, it follows in scenario A: *Electricity consumption from the grid* of the "Tool to calculate baseline, project and/or leakage emissions from electricity consumption", version 1. In this scenario, option A1 was chosen. Thus, the emission is calculated as following:

$$PE_{EC,y} = EC_{PJ,y} \text{ x } EF_{grid,CM,y} \text{ x } (1 + TDL_y)$$

Where:

$EC_{PJ,y}$ = Quantity of electricity consumed by the project activity during the year y (MWh);

$EF_{grid,CM,y}$ = Emission factor for the grid in year y (tCO_2/MWh);

TDL_y = Average technical transmission and distribution losses in the grid in year y for the voltage level at which electricity is obtained from the grid at the project site.

Methodology ACM0001 ver. 18 clearly states that the CO_2 emission intensity of the electricity consumed by the project activity must be taken into account. In the project activity, electrical consumption is associated with the blower system used to draw landfill gas to the enclosed drum flare.

Period	***Quantity of Electricity Imported (MWh)***	***Combined margin CO_2 emission factor (tCO_2/MWh)***	***Average Technical Transmission Lost***	***Emissions from consumption of electricity (tCO_2e/ month)***
	EC	***EF grid,CM***	***(1+TDL)****	***PEEC***
July 2018	19.51	0.716	1.157	16.16
August 2018	24.92	0.716	1.157	20.64
September 2018	28.98	0.716	1.157	24.01
October 2018	25.62	0.716	1.157	21.22
November 2018	22.54	0.716	1.157	18.67
December 2018	24.64	0.716	1.157	20.41
January 2019	23.94	0.716	1.157	19.83
July 08, 2018 to January 31, 2019	**170.15**	**0.716**	1.157	**121.12**

* TDL = 15.7% (National Energy Balance 2018 - Base year 2017)

Project emissions due to the consumption of fossil fuel (diesel) by the project activity:

$$PE_{FC,j,y} = \sum_{i} FC_{i,j,y} \times COEF_{i,y}$$

Where:

$PE_{FC,j,y}$ = CO_2 emissions from fossil fuel combustion in process j during the year y (tCO_2/yr);

$FC_{i,j,y}$ = Quantity of fuel type I combusted in process j during year y (mass or volume unit/yr);

$COEF_{i,y}$ = CO_2 emission coefficient of fuel type i in year y (tCO_2/mass or volume unit).

The value for $COEF_{i,y}$ will be calculated according to Option B of the "*Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion*" version 2, will be used as follows:

$$COEF_{i,y} = NCV_{i,y} \times EF_{CO2,i,y}$$

Where:

- $NCV_{i,y}$ is the weighted average net caloric value of fuel type i in year y (GJ/mass or volume unit); and
- $EF_{CO2,i,y}$ is the weighted average emission factor of fuel type i in year y (tCO_2/GJ).

All values associated with Option B of the "Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion" version 2 will be assessed on a yearly basis as per the IPCC Guidelines.

For the purposes of estimation in this document, Option B will be used.

$PE_{FC,j,y}=\sum FC_{i,j,y}$ X $COEF_{i,y}$

$COEF_{i,y}$ = $NCV_{i,y}$ X $EF_{CO_2,\ i,\ y}$

$COEF_{i,y}$ = 42.3 GJ/ton X 0.0748 t CO_2/GJ = 3.16404 tCO_2/ton

$PE_{FC,j,y}$= 1,130l X 0.84 kg/l X 0.00316404 tCO_2/kg =

$PE_{FC,j,y}$= 949.2 kg X 0.00316404 tCO_2/kg = 3.003tCO_2

Project emissions due to the consumption of LPG by the project activity:

The mass of LPG used by the project activity is used to calculate the corresponding emissions: ET_y * $CEF_{thermal,y,}$ where ET_y = $Mass_{LPG}$ * LHV_{LPG} ($Mass_{LPG}$ = consumption of LPG in kilograms; LHV_{LPG} = lower heating value of LPG) and $CEF_{thermal,y}$.

$Mass_{LPG}$: 13kg (invoices issued by LPG supplier)

LHV_{LPG}: 46.46TJ/Gg (11,100 Kcal/Kg as per Balanço Energético Brasileiro 2017- base year 2016)

CEF: 65,600 Kg CO2 / TJ (IPCC 2006)

MassLPG * LHV *CEF

= 0.000013Gg * 46.46TJ/Gg * 65,600 KgCO2 / TJ

= 39.621KgCO2 = 0.039 tCO2 = 0.04 tCO2

In addition, project emissions from flaring gases containing methane shall also be accounted for. The calculation of this source of emission is based on the steps provided by the “Tool to determine project emissions from flaring gases containing methane”, and determined using the STEPS below presented.

STEP 1. Determination of the mass flow rate of the residual gas that is flared

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

Example:

Where:

$FM_{RG,h}$	= Mass flow rate of the residual gas in hour *h* (kg/h);
$\rho_{RG,n,h}$	= Density of the residual gas at normal conditions in hour *h* (kg/m³);
$FV_{RG,h}$	= Volumetric flow rate of the residual gas in dry basis at normal conditions in the hour *h* (m³/h).

$$\rho_{RG,n,h} = \frac{P_n}{\frac{R_u}{MM_{RG,h}} \times T_n}$$

Where:

$\rho_{RG,n,h}$	= Density of the residual gas at normal conditions in hour *h* (kg/m³);
P_n	= Atmospheric pressure at normal conditions (101,325) (Pa);
R_u	= Universal ideal gas constant (8,314) (Pa.m³/kmol.K);
$MM_{RG,h}$	= Molecular mass of the residual gas in hour *h* (kg/kmol);
T_n	= Temperature at normal conditions (273.15) (K).

$$MM_{RG,h} = \sum_{i} fv_{i,h} \times MM_{i}$$

Example September 12:00 AM

$MM_{RG,h=}$ ((wch4,h/100*16.04)+(fvO2,h/100*32)+(((100- wch4,h - fvO2,h)/100)*28.02))

$MM_{RG,h=}$ 22.597 kg/kmol

Where:

$MM_{RG,h}$ = Molecular mass of the residual gas in hour *h* (kg/kmol);

$fv_{i,h}$ = Volumetric fraction of component *i* in the residual gas in the hour *h* (-);

MM_{j} = Molecular mass of residual gas component *i* (kg/kmol);

i = Gas components.

As a simplified approach, project participants will only measure the volumetric fraction of methane and consider the difference to 100% as being nitrogen (N_2).

STEP 2. Determination of the mass fraction of carbon, hydrogen, oxygen and nitrogen in the residual gas

$$fm_{j,h} = \frac{\sum_{i} fv_{i,h} \cdot AM_{j} \cdot NA_{j,i}}{MM_{RG,h}}$$

Where:

$fm_{j,h}$ = Mass fraction of element *j* in the residual gas in hour *h;*

$fv_{i,h}$ = Volumetric fraction of component *i* in the residual gas in the hour *h;*

AM_{j} = Atomic mass of element *j* (kg/kmol);

$NA_{j,i}$ = Number of atoms of element *j* in component *I;*

$MM_{RG,\ h}$ = Molecular mass of the residual gas in hour *h;*

j = The elements carbon, hydrogen, oxygen and nitrogen;

i = The components CH_4 and N_2 (according to the simplification used).

STEP 3. Determination of the volumetric flow rate of the exhaust gas on a dry basis

Determine the average volumetric flow rate of the exhaust gas in each hour h based on a stoichiometric calculation of the combustion process, which depends on the chemical composition

of the residual gas, the amount of air supplied to combust it and the composition of the exhaust gas, as follows:

$$TV_{n,FG,h} = V_{n.FG.h} \times FM_{RG,h}$$

Where:

$TV_{n,FG,h}$ = Volumetric flow rate of the exhaust gas in dry basis at normal conditions in hour *h* (m^3/h);

$V_{n,FG,h}$ = Volume of the exhaust gas of the flare in dry basis at normal conditions per kg of residual gas in hour *h* (m^3/kg residual gas);

$FM_{RG,h}$ = Mass flow rate of the residual gas in the hour *h* (kg residual gas/h).

$$V_{n,FG,h} = V_{n,CO2,h} + V_{n,O2,h} + V_{n,N2,h}$$

Where:

$V_{n,FG,h}$ = Volume of the exhaust gas of the flare in dry basis at normal conditions per kg of residual gas in the hour *h* (m^3/kg residual gas);

$V_{n,CO2,h}$ = Quantity of CO_2 volume free in the exhaust gas of the flare at normal conditions per kg of residual gas in the hour *h* (m^3/kg residual gas);

$V_{n,N2,h}$ = Quantity of N_2 volume free in the exhaust gas of the flare at normal conditions per kg of residual gas in the hour *h* (m^3/kg residual gas);

$V_{n,O2,h}$ = Quantity of O_2 volume free in the exhaust gas of the flare at normal conditions per kg of residual gas in the hour *h* (m^3/kg residual gas).

$$V_{n,CO_2,h} = \frac{fm_{C,h}}{AM_C} * MV_n$$

Where:

$V_{n,CO2,h}$ = Quantity of CO_2 volume free in the exhaust gas of the flare at normal conditions per kg of residual gas in the hour *h* (m^3/kg residual gas);

$fm_{C,h}$ = Mass fraction of carbon in the residual gas in the hour *h* (m^3/kg residual gas);

AM_C = Atomic mass of carbon (kg/kmol);

MV_n = Volume of one mole of any ideal gas at normal temperature and pressure (22.4 m^3/Kmol) (m^3/kmol).

$$V_{n.O2,h} = n_{O2,h} \times MV_n$$

Where:

$V_{n,O2,h}$ = Quantity of O_2 volume free in the exhaust gas of the flare at normal conditions per kg of residual gas in the hour h (m^3/kg residual gas);

$n_{O2,h}$ = Quantity of moles O_2 in the exhaust gas of the flare per kg residual gas flared in hour *h* (kmol/kg residual gas);

MV_n = Volume of one mole of any ideal gas at normal temperature and pressure (22.4 L/mol) (m^3/kmol).

$$V_{n,N_2,h} = MV_n * \left\{ \frac{fm_{N,h}}{200AM_N} + \left(\frac{1-MF_{O_2}}{MF_{O_2}} \right) * \left[F_h + n_{O_2,h} \right] \right\}$$

Where:

$V_{n,N2,h}$ = Quantity of N_2 volume free in the exhaust gas of the flare at normal conditions per kg of residual gas in the hour *h* (m^3/kg residual gas);

MV_n = Volume of one mole of any ideal gas at normal temperature and pressure (22.4 m^3/Kmol) (m^3/kmol);

$fm_{N,h}$ = Mass fraction of nitrogen in the residual gas in the hour *h* (-);

AM_N = Atomic mass of nitrogen (kg/kmol);

MF_{O2} = O_2 volumetric fraction of air (-);

F_h = Stoichiometric quantity of moles of O_2 required for a complete oxidation of one kg residual gas in hour *h* (kmol/kg residual gas);

$n_{O2,h}$ = Quantity of moles O_2 in the exhaust gas of the flare per kg residual gas flared in hour *h* (kmol/kg residual gas).

$$n_{O_2,h} = \frac{t_{O_2,h}}{\left(1-(t_{O_2,h}/MF_{O_2})\right)} \times \left[\frac{fm_{C,h}}{AM_C} + \frac{fm_{N,h}}{2AM_N} + \left(\frac{1-MF_{O_2}}{MF_{O_2}} \right) \times F_h \right]$$

Where:

$n_{O2,h}$ = Quantity of moles O_2 in the exhaust gas of the flare per kg residual gas flared in hour *h* (kmol/kg residual gas);

$t_{O2,h}$ = Volumetric fraction of O_2 in the exhaust gas in the hour *h*;

MF_{O2} = Volumetric fraction of O_2 in the air (0.21);

F_h = Stochiometric quantity of moles of O_2 required for a complete oxidation of one kg residual gas in hour *h* (kmol/kg residual gas);

$fm_{j,h}$ = Mass fraction of element j in the residual gas in hour *h*;

AM_j = Atomic mass of element *j* (kg/kmol);

j = The elements carbon, hydrogen, oxygen and nitrogen.

$$F_h = \frac{fm_{C,h}}{AM_C} + \frac{fm_{H,h}}{4AM_H} - \frac{fm_{O,h}}{2AM_O}$$

Where:

F_h = Stoichiometric quantity of moles of O_2 required for a complete oxidation of one kg residual gas in hour *h* (kmol O_2/kg residual gas);

$fm_{j,h}$ = Mass fraction of element j in the residual gas in hour *h*;

AM_j = Atomic mass of element *j;*

j = The elements carbon, hydrogen and oxygen (kg/kmol).

STEP 4. Determination of methane mass flow rate in the exhaust gas on a dry basis

The mass flow of methane in the exhaust gas is based on the volumetric flow of the exhaust gas and the measured concentration of methane in the exhaust gas, as follows:

$$TM_{FG,h} = \frac{TV_{n,FG,h} * fv_{CH4,FG,h}}{1000000}$$

Where:

$TM_{FG,h}$ = Mass flow rate of methane in the exhaust gas of the flare in dry basis at normal conditions in the hour *h* (kg/h);

$TV_{n,FG,h}$ = Volumetric flow rate of the exhaust gas in dry basis at normal conditions in hour h (m^3/h exhaust gas);

$fv_{CH4,FG,h}$ = Concentration of methane in the exhaust gas of the flare in dry basis at normal conditions in hour h (mg/m^3).

STEP 5. Determination of methane mass flow rate in the residual gas on a dry basis

$$TM_{RG,h} = FV_{RG,h} \times fv_{CH4,RG,h} \times \rho_{CH4,n}$$

Where:

$TM_{RG,h}$	= Mass flow rate of methane in the residual gas in the hour *h* (kg/h);
$FV_{RG,h}$	= Volumetric flow rate of the residual gas in dry basis at normal conditions in hour *h* (m^3/h);
$fv_{RG4,RG,h}$	= Concentration of methane in the residual gas of the flare on dry basis at normal conditions in hour *h*;
$\rho_{CH4,n}$	= Density of methane at normal conditions (0.716 kg/m^3).

STEP 6. Determination of the hourly flare efficiency

In case of enclosed flares and continuous monitoring of the flare efficiency, as the case of the project activity, the flare efficiency in the hour *h* ($\eta_{flare,h}$) is:

- 0% if the temperature of the exhaust gas of the flare (T_{flare}) is below 500 °C during more than 20 minutes during the hour *h*;
- determined as follows in cases where the temperature of the exhaust gas of the flare (T_{flare}) is above 500 °C for more than 40 minutes during the hour *h*:

$$\eta_{flare,h} = 1 - \frac{TM_{FG,h}}{TM_{RG,h}}$$

Where:

$\eta_{flare,h}$	= Flare efficiency in the hour *h*;
$TM_{FG,h}$	= Methane mass flow rate in exhaust gas averaged in a period of time *t* (kg/h);
$TM_{RG,h}$	= Mass flow rate of methane in the residual gas in the hour *h* (kg/h).

STEP 7. Calculation of annual project emissions from flaring

$$PE_{flare,y} = \sum_{h=1}^{8760} TM_{RG,h} \times \left(1 - \eta_{flare,y}\right) \times \frac{GWP_{CH4}}{1000}$$

Where,

$PE_{flare,y}$ = Project emissions from flaring of the residual gas stream in year *y* (tCO_2e);

$TM_{RG,h}$ = Mass flow rate of methane in the residual gas in the hour *h* (kg/h);

$\eta_{flare,h}$ = Flare efficiency in hour *h;*

GWP_{CH4} = Global Warming Potential of methane valid for the commitment period (tCO_2e/tCH_4).

The values of project emissions during the monitoring period are presented below:

Monitoring Period	***Emissions from consumption of electricity (tCO_2e/ month)***	***Emissions from fossil fuel combustion in process (tCO_2e/ month)***	***Emission from Consumption of LPG by the project activity (tCO_2e/ month)***
	PE_{EC}	***PE_{FC}***	***PE_{LPG}***
July 2018	16.16	0,000	0.00
August 2018	20.64	1.579	0.00
September 2018	24.01	0.000	0.00
October 2018	21.22	0.000	0,00
November 2018	18.67	0.545	0.00
December 2018	20.41	0.000	0.04
January 2019	19.83	0.880	0.00
July 08, 2018 to January 31, 2019[1]	**140.95**	**3.003**	**0.04**

E.3. Calculation of leakage emissions

No leakage effects need to be accounted under methodology ACM0001 ver. 18 (LE = 0).

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	219,551	143,997	0	0	219,404	219,404

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

Amount achieved during this monitoring period ($t\ CO_2e$)	Amount estimated ex ante ($t\ CO_2e$)
219,404	322,997[17]

E.6. Remarks on increase in achieved emission reductions

A total difference of 32% is noted when comparing the total emission reductions claimed during the monitored period (219,404 tCO_2e) against the total emission reductions estimated in the registered PDD (322,997 tCO_2e). As per information presented above, there is no increase in the actual emission reductions achieved during the current monitoring period when the comparison is done considering an equivalent period (from 08/07/2018 to 31/01/2019).

It's important to mention that the amount of waste disposal considered for this monitoring period was not available until the MR submission to the DOE. Thus, this information will be updated later.

[17] The amount estimated of this period is inserted in the Appendix 3 of PDD process: https://cdm.unfccc.int/Projects/DB/SGS-UKL1291802325.34/history. It is calculated on a pro-rata basis of 207 days of monitoring in the period (between 08/Jul/2018 to 31/Jan/2019)

Document information

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

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