Monitoring report form for CDM project activity (Version 08.0)

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

MONITORING REPORT			
Title of the project activity	Brazil NovaGerar Landfill Gas to Energy Project		
UNFCCC reference number of the project activity	0008		
Version number of the PDD applicable to this monitoring report	8		
Version number of this monitoring report	1		
Completion date of this monitoring report	05/05/2021		
Monitoring period number	13th Monitoring Period[1]		
Duration of this monitoring period	03/03/2020 – 31/12/2020		
Monitoring report number for this monitoring period	1		
Project participants	Haztec Tecnologia e Planejamento Ambiental S.A. (Brazil) ALLCOT AG (Switzerland)		
Host Party	Brazil		
Applied methodologies and standardized baselines	ACM0001: Flaring or use of landfill gas, version 19.0		
Sectoral scopes	Sectoral Scope: 1 -Energy industries (renewable – / non-renewable sources) Sectoral Scope: 13 (waste handling and disposal)		
Amount of GHG emission reductions or net anthropogenic GHG removals achieved by the project activity in this monitoring period	Amount achieved before 1 January 2013	Amount achieved from 1 January 2013 until 31 December 2020	Amount achieved from 1 January 2021
	0 tCO_2e	492,769 tCO_2e	0 tCO_2e
Amount of GHG emission reductions or net anthropogenic GHG removals estimated ex ante for this monitoring period in the PDD	277,579[2] tCO_2e		

[1] Corresponding to 2nd Monitoring Period from the 3rd Crediting Period.

[2] Calculated proportionally by multiplying the total estimative for 2020 (334,191 tCO_2e) by the quotient between the number of days in this monitoring period for that year (304 days) and the total number of days (366 days).

SECTION A. Description of project activity

A.1. General description of project activity

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The initial purpose of the Brazil NovaGerar Landfill Gas to Energy Project was to capture the landfill gas (LFG) generated at the NovaGerar sites (Marambaia and Adrianópolis) and to use it for power generation and/or flaring. The Project site is located in Nova Iguacu, State of Rio de Janeiro, Brazil.

The project activity generates emission reductions by avoiding methane emissions through the destruction of the methane generated by the landfill.

The Marambaia dump site opened in 1986 and closed in February 2003; about 700,000 tons of waste was disposed at the site. The Adrianópolis landfill started operations in February 2003, and is currently disposing about 3,000 tons of municipal solid waste per day. The Adrianópolis and Marambaia sites are adjacent to each other located beside a densely populated section of the municipality of Nova Iguaçu, Rio de Janeiro, with more than 800,000 inhabitants. The project consists of two phases:

- Phase I: Collection and flaring of LFG, reducing uncontrolled release of methane;
- Phase II: Generation of electricity from LFG, reducing CO2 emissions associated to the use of grid electricity.

Currently the project has implemented Phase I and II. The LFG collection and flaring system in Adrianópolis have been in operation since 15/03/2007. Marambaia system started operations in 17/05/2007 and has been closed since 2010. Electricity generation component (Phase II) started on 07/05/2019.

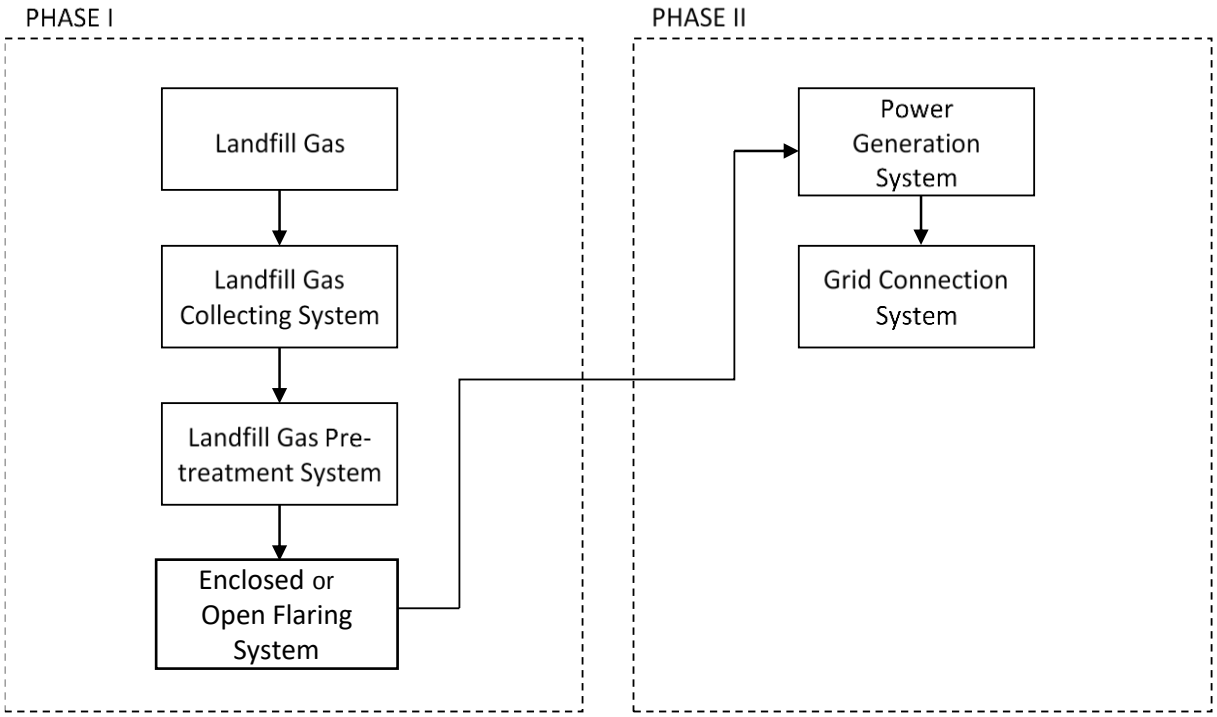
The low flow and gas quality (methane percentage) in Marambaia site indicated that operation is not economically viable. Therefore, as described in the registered PDD, the project activity no longer extracts LFG from this site.

The project consists of a LFG collecting system, LFG pre-treatment system, open flaring system, electricity generation system and grid connection system. First, the landfill gas is collected, and then through a network composed of transportation pipes, the landfill gas reaches the pre-treatment system in which the moisture is removed.

After the gas is treat it is sent to the electricity generation plant. Electricity generated by the project is exported to the Brazilian National Interconnected System (NIS). Flare system is kept operational to ensure the combustion of LFG (e.g., maintenance, breakdown or when the volume of gas exceeds the capacity of the power generation system).

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

Figure 1: Location of the Project Activity



The total emission reductions achieved in this monitoring period is 492,769 tCO_2e.

A.2. Location of project activity

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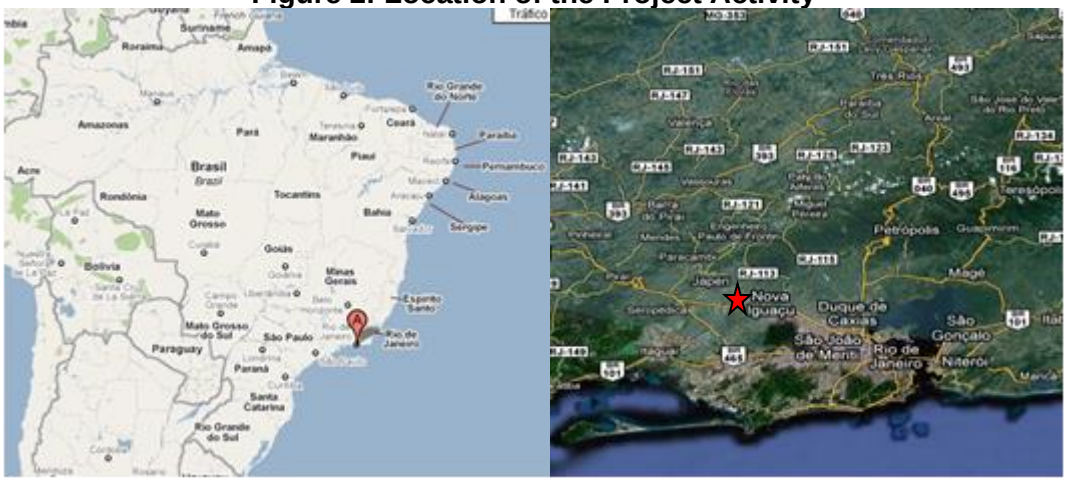
The project site is located at approximately 10 Km from the Nova Iguaçu downtown, province of Rio de Janeiro, Brazil. Latitude 22.666667 S; Longitude: 43.466667 W.

Figure 2: Location of the Project Activity



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)	Haztec Tecnologia e Planejamento Ambiental S.A.	No
Switzerland	ALLCOT AG	Yes

A.4. References to applied methodologies and standardized baselines

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The project renewed its crediting period applying the latest version of the approved baseline methodology ACM0001 - "Flaring or use of landfill gas" (Version 19.0)[3].

Tools to which the methodology refers are:

- Large-scale Consolidated Methodology ACM0001: "Flaring or use of landfill gas" (Version 19.0)[4];
- TOOL02 Methodological tool: "Combined tool to identify the baseline scenario and demonstrate additionality" (Version 07.0)[5];
- TOOL03 Methodological tool: "Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion" (Version 03.0)[6].
- TOOL04 Methodological tool: "Emissions from solid waste disposal sites" (Version 08.0)[7];
- TOOL05 Methodological tool: "Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation" (Version 03.0)[8];
- TOOL06 Methodological tool: "Project emissions from flaring" (Version 03.0)[9];
- TOOL08 Methodological tool: "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" (Version 03.0)[10];
- TOOL09 Methodological tool: "Determining the baseline efficiency of thermal or electric energy generation systems" (Version 02.0)[11];
- TOOL10 Methodological Tool: "Tool to determine the remaining lifetime of equipment" (Version 01)[12];
- TOOL12 Methodological tool: "Project and leakage emissions from transportation of freight" (Version 01.1.0)[13];
- TOOL07 Methodological tool: "Tool to calculate the emission factor for an electricity system" (Version 07.0)[14];
- TOOL11 Methodological Tool: "Assessment of the validity of the original/current baseline and update of the baseline at the renewal of the crediting period" (Version 03.0.1)[15];
- TOOL32 Methodological tool: "Positive lists of technologies" (Version 01.0)[16]

A.5. Crediting period type and duration

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The project activity has a crediting period that can be renewed two times. The current third crediting period of the project activity, to which this monitored period applies, began on 01/07/2018 and runs for 7 years until 30/06/2025.

SECTION B. Implementation of project activity

B.1. Description of implemented project activity

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[3] https://cdm.unfccc.int/methodologies/DB/JPYB4DYQUXQPZLBDVPHA87479EMY9M
[4] https://cdm.unfccc.int/methodologies/DB/JPYB4DYQUXQPZLBDVPHA87479EMY9M
[5] https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-02-v7.0.pdf
[6] https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-03-v3.pdf
[7] https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-04-v8.0.pdf
[8] https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-05-v3.0.pdf
[9] https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-06-v3.0.pdf
[10] https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-08-v3.0.pdf
[11] https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-09-v2.0.pdf
[12] https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-10-v1.pdf
[13] https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-12-v1.1.0.pdf
[14] https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-07-v7.0.pdf
[15] https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-11-v3.0.1.pdf
[16] https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-32-v1.pdf

The sanitary landfill is divided into 4 cells for waste disposal, named Sub-Landfill 1, 2, 3 and 4 (Figure 3).

Figure 3: Disposition of the 4 cells in the landfill

Initially, the waste was only disposed in 2 cells (Sub-Landfill 1 and Sub-Landfill 3) and the gas extraction system was operating only in the Sub-Landfill 1. In November 2008, the Sub-Landfill 4 started to receive waste and the gas extraction system was extended to Sub-Landfill 3. Later on, in June 2010, the gas extraction system was extended to Sub-Landfill 4.

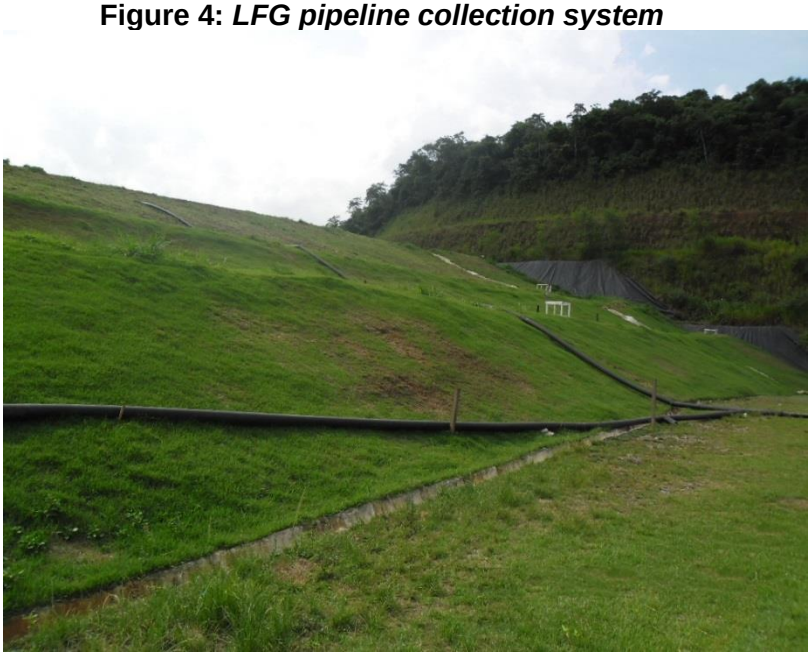
The LFG collection and flaring system has a capacity for 7,500 Nm^3/h. The process in which the LFG is collected and flared has 3 main stages:

1. LFG is collected in the biogas wells and transported in the landfill pipeline system with the use of two blowers;
2. LFG enters in the pre-treatment system which removes excess moisture and impurities;
3. LFG is send to the flare system for its combustion.

Landfill gas collection System:

- Vertical wells used to extract gas and leachate;
- Horizontal wells used to extract gas;
- Wellheads designed as a looping system in order to allow partial or total loss of header function in one direction without losing gas system functionality;
- Condensate extraction and storage systems installed at strategic low points throughout the gas system; and
- Pipeline structures connected with the flare system.

Figure 4: *LFG pipeline collection system*



Landfill gas flaring system:

- One open flare with burning controlled system (since17/02/2017);
- Blowers system used to create negative pressure in the pipeline structures in order to send the landfill gas to the flaring system;
- Equipment to continuously monitor the landfill gas methane composition, gas flow, and flare temperature;
- Security restart system in case the flaring system is turned off.

The flaring system is controlled by a Programmable Logic Controller (PLC) which receives and transmits signals associated to the operating conditions of the flare. The open flare used (Figure 5) is designed to operate continuously to safely destroy the biogas generated by solid waste and will achieve destruction efficiency of 50%[17]

Data and monitoring readings are routinely uploaded (every minute) to the external data center of the management program, manufactured and managed by an independent third party. The project participants can access all readings in any place and time through the software provider program website which analyses and calculates all the information related to the facility management, operation and carbon Credit Emission Reduction (CER) control.

The condensed biogas generated inside the pipeline is continuously collected and sent to the de-humidification unit and then to the leachate treatment station of the project site.

[17] Open flare manufacturer technical data

Figure 5: Example of flare system – Adrianópolis Landfill/Brazil.

The system has installed backup diesel generators, to supply electricity for the project in case of power shortage. The specification of these equipment is presented in the table below:

Diesel generators					
Manufacturer	PRAMAC	PRAMAC	CATERPILLAR	CATERPILLAR	CATERPILLAR
Model	220	220	GES350	GES350	GBW200
Serial Number / Patrimonial Number	0213416	00213584	0730949	0730912	0731171
Capacity	220 KVA	220 KVA	350 KVA	350 KVA	220 KVA
Year	2006	2006	2008	2008	2013

The project operator registered every event occurred during the monitored period. The relevant downtimes (duration of more than one hour) are presented in the table below. The complete set of records was made available to the DOE during the verification.

Start (dd/mm/yyyy hh:mm)	**End** (dd/mm/yyyy hh:mm)	**Duration** (hh:mm)	**Recorded reason for shutdown**
03/03/2020 07:40	03/03/2020 15:06	07:26	Annual Preventive Maintenance (Demisters)
04/03/2020 02:56	04/03/2020 07:05	04:09	Generator Failure
10/03/2020 09:12	10/03/2020 11:42	02:30	Power outage (shutdown in the substation of the ETE)
01/04/2020 09:00	01/04/2020 10:12	1:12	Maintenance in the electric grid - Light (Plant connected to the generator)
06/04/2020 09:12	06/04/2020 10:12	1:00	Input collector maintenance
02/05/2020 18:27	03/05/2020 00:08	5:41	Power outage
04/05/2020 08:38	04/05/2020 10:50	2:12	Input collector maintenance
18/05/2020 10:56	18/05/2020 11:59	1:03	Power Exchange Light/ Generator (generator at 90%)
22/05/2020 18:41	22/05/2020 20:50	2:09	Power Outage
05/06/2020 08:08	05/06/2020 09:40	1:32	Aggreko Connection to Delivery Point
10/06/2020 09:42	10/06/2020 11:03	1:21	PLC Card Exchange
22/06/2020 08:07	22/06/2020 10:02	1:55	Input Collector Maintenance (Plant Connected to Generator)
25/06/2020 17:05	25/06/2020 18:20	1:15	PLC Card Exchange

08/07/2020 11:03	08/07/2020 12:08	1:05	Power Outage
24/07/2020 09:22	24/07/2020 11:49	2:27	Communication Failure between PC and PLC
05/08/2020 07:56	05/08/2020 14:52	6:56	Assembly of the 7.500 Nm³/h blower
06/08/2020 08:14	06/08/2020 14:28	6:14	Supervisory update for inclusion of the new blower
14/08/2020 07:36	14/08/2020 09:12	1:36	Power Outage
18/08/2020 20:08	19/08/2020 06:04	9:56	PLC programming logic failure
22/08/2020 09:01	22/08/2020 11:35	2:34	Power Outage
31/08/2020 08:58	31/08/2020 10:06	1:08	Power Outage
04/09/2020 15:26	04/09/2020 17:06	1:40	563 KVA generator test
08/09/2020 10:21	08/09/2020 11:31	1:10	Power Outage
07/10/2020 00:49	07/10/2020 02:01	1:12	Low compressed air pressure
14/10/2020 09:02	14/10/2020 19:24	10:22	NIEGAR/AB shutdown request
31/10/2020 19:28	31/10/2020 20:37	1:09	Power Outage
16/11/2020 15:45	16/11/2020 16:49	1:04	Power Outage
17/11/2020 05:49	17/11/2020 06:55	1:06	Power Outage
20/11/2020 11:09	20/11/2020 12:17	1:08	Inlet manifold maintenance
19/12/2020 09:33	19/12/2020 10:36	1:03	Power Exchange Light/Generator
23/12/2020 09:41	23/12/2020 11:32	1:51	Input Collector Maintenance

B.2. Post-registration changes

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

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This deviation is applied for the period between 01/11/2020 until 31/12/2020.
Generation units #13 to #16 became operational on 01/11/2020. However, the gas flow meter was installed in 2021, *i.e.* after the current monitored period. For this reason, a temporary deviation from the monitoring plan is being requested for November and December 2020, specifically related to the gas used to generate electricity in generators #13 to #16.
It's worth mentioning that the plant operated normally and electricity generated by these nits were correctly registered by the supervisory system. Hence, emission reductions will be claimed according to a conservative estimative based on the electricity exported using landfill gas.

The estimative of methane volume into power plant will be based on the electricity exported to the grid instead of electricity generated by the power plant, which is greater as it includes the electricity for self-consumption by the plant equipment. The methane fed to the engines will be calculated as follows:

$$F_{CH4,EL} = \frac{EC_{BL} \times (Conversion\ rate\ MWh\ to\ TJ)}{(NCV_{CH4}) \times El.eff}$$

Where:

$F_{CH4,EL}$ = Amount of methane in the LFG which is used for electricity generation (tCH4)

EC_{BL}	=	Net amount of electricity generated using LFG and exported to the grid during the monitoring period applying deviation (MWh)[18]
Conversion rate MWh to TJ	=	Unit conversion rate from MWh to TJ (0.0036 TJ/MWh)[19]
NCV_{CH4}	=	Net calorific value of methane at reference conditions (0.0504 TJ/tCH4) according to ex-ante PDD.
El.eff	=	Efficiency of engine, assuming a 100% plant load factor as a conservative approach[20] (40.30%)

Then, the emission reductions will be calculated accordingly to the methodologies and tools defined in the registered PDD and in the Section E of this monitoring report.

B.2.2. Corrections

>>
Not applicable.

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

>>
Not applicable.

B.2.4. Inclusion of monitoring plan

>>
Not applicable.

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 will be proposed a post registration change in the registered monitoring plan of the registered PDD (ISSUANCE TRACK). A new PDD version 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) is being prepared.
The inclusion of other options provided by the tool that were not considered in the registered version of the PDD, mainly Option C, will 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;"*

B.2.6. Changes to project design

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Changes to project design of the registered PDD of the third crediting Period[21]:

[18] According to electricity reports provided by the local Electricity Trader Company and Electricity Chamber Company.
[19] According to MIT Units & Conversions Fact Sheet. Source: https://cngcenter.com/wp-content/uploads/2013/09/UnitsAndConversions.pdf, accessed on 07/10/2019.
[20] As a conservative approach, a 100% load factor and 40.30% efficiency of engine (%) according to group generator data sheet was used in order to lower the calculated volume of CH_4 fed into the group generators.
[21] Please refer to the registered PDD for a complete list of the changes, corrections and deviations approved by the Board since the Project was first registered, *i.e.* changes requested during the first and second crediting periods.

During the current crediting period, a request for post registration change was submitted for the prior approval of the Board. The request PRC-0008-005 was approved[22] on 15/04/2021 and consisted of the following changes:

1) Change to the project design regarding to electricity generation plant installed capacity increase, from 4.245 MW to 27.64 MW. Due to paragraph 241 from PS for PA´s, CERs may be claimed up to an amount calculated based on the increased installed capacity by 20 per cent of the capacity specified in the originally registered PDD (before PRC).

2) Change to project design regarding LFG collection efficiency amended from 40% to 50% (default value in accordance with ACM0001 version 19).

3) Change to project design regarding update electricity plant load factor from 91% to 92%.

4) Change to project design regarding flare type from enclosed flare to open flare, representing a decrease in the capacity of combustion efficiency and to generate CERs.

5) Change to the project design regarding inclusion of diesel generator when electricity from the grid is not available.

6) Permanent Changes in the cashflow considering amendments of key parameters:
    a. Exchange rate used for the investment analysis: 3.97 BRL/EUR;
    b. Total installed capacity: from 4.245 MW to 27.64 MW, being that:
        i. 2019: 12 units X 1.411 MW, total 16.93 MW
        ii. 2020: (12 units X 1.411 MW) + (4 units X 1.25 MW), total 21.93 MW
        iii. 2021: (12 units X 1.411 MW) + (4 units X 1.25 MW) + (2 units X 1.426 MW), total 24.78 MW
        iv. 2022-2025: (12 units X 1.411 MW) + (4 units X 1.25 MW) + (4 units X 1.426 MW), total 27.64 MW
    c. Energy price: from 48.00 R$/MWh to 170.00 R$/MWh
    d. Generation of electricity amended in:
        i. 2019: 102,811 MWh
        ii. 2020: 176,754 MWh
        iii. 2021: 199,739 MWh
        iv. 2022-2024: 222,724 MWh
        v. 2025 (1st semester, up to 30/06/2025): 111,362 MWh
    e. O&M LFG costs amended will be:
        i. In 2019: R$ 2,373,215.92
        ii. From 2020 to 2024: R$ 3,149,904.77 per year
        iii. In 2025: R$ 1,574,952.38
    f. O&M electricity costs amended will be:
        i. 300,000 R$/year (fixed) and 100 R$/MWh.
    g. Investment on Electricity generation plant will be in:
        i. Year 2019: R$ 29,219,200.00
        ii. Year 2020: R$ 9,739,733.33
        iii. Year 2021: R$ 4,869,866.67
        iv. Year 2022: R$ 4,869,866.67
    h. Amendment in cash flow:
        i. Sheet “Schedule Engines”
        ii. Sheet “Summary - Cash Flow”

[22] Available at: <https://cdm.unfccc.int/PRCContainer/DB/prcp653500754/view>.

iii. Period of cash flow was extended from 2004-2023 to 2004-2025 in order to cover the whole 3rd Crediting Period. Moreover, this approach is more conservative since includes more revenues without adding any Capex.

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

>>
Not applicable.

SECTION C. Description of monitoring system

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The monitoring plan is done according to the applicable version of methodology ACM0001 and relevant tools, as well as per the CDM project standard. A detailed description of the monitoring procedures is provided in Section B.7.3. of the registered PDD and includes, but is not limited to: objectives, training of the personnel, measurement procedures and quality assurance of the monitored parameters.

Monitoring equipment locations are presented in the illustrative diagram below:

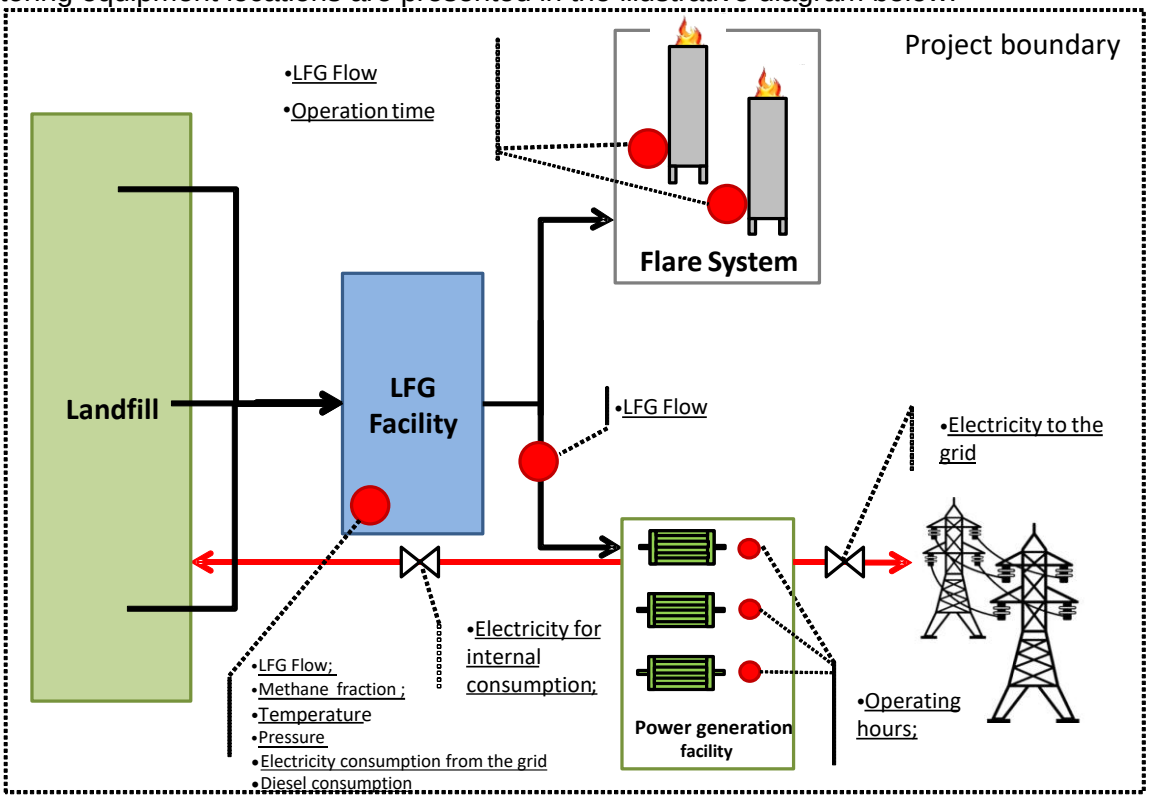

Figure 6 – Illustrative diagram of the monitoring equipment and parameters.

All data are electronically collected and continually stored in a server.

Monitoring instruments, described in the below table, were running properly and calibrated during this monitoring period. No errors or uncertainties were applied to the monitored data in the relevant monitoring period due to delayed calibration.

Parameter name	Range	Accuracy	Manufacturer	Model	Serial number	Starting Period	Finishing Period	Calibration frequency	Date of Calibration	Validity	Error used in data discount (%)	Calibration coverage status
Methane fraction in LFG	0 - 100% CH4	2%	SIEMENS	Ultramat 23	N1C7778	03/03/2020	17/03/2020		16/04/2019	15/04/2020		ok
	0 - 100% CH4	2%	SIEMENS	Ultramat 23	N1C7778	18/03/2020	20/08/2020		18/03/2020	17/03/2021		ok
	0 - 100% CH4	2%	SIEMENS	Ultramat 23	N1F6767	21/08/2020	31/12/2020		18/03/2020	17/03/2021		ok
LFG Pressure	0 - 250 mbar	0.06%	ABB	266HSH	3K646619004047	03/03/2020	31/12/2020	1 year	27/01/2020	24/01/2021		ok
LFG Temperature	0 to 100°C	0.10%	Elsi	PT100	E19TP0083	03/03/2020	31/12/2020	2 years	29/01/2020	28/01/2022		ok
LFG flow to GG1	0 - 160 mbar	0.06%	ABB	266DSH	3K646618004288	03/03/2020	31/12/2020	4 year	15/02/2018	14/02/2022		ok
LFG flow to GG2	0 - 160 mbar	0.06%	ABB	266DSH	3K646618004287	03/03/2020	31/12/2020	4 year	14/02/2018	13/02/2022		ok
LFG flow to GG3	0 - 160 mbar	0.06%	ABB	266DSH	3K646618004283	03/03/2020	31/12/2020	4 year	15/02/2018	14/02/2022		ok
LFG flow to GG4	0 - 160 mbar	0.06%	ABB	266DSH	3K646618008068	03/03/2020	31/12/2020	4 year	19/03/2018	18/03/2022		ok
LFG flow to GG5	0 - 160 mbar	0.06%	ABB	266DSH	3K646618005641	03/03/2020	31/12/2020	4 year	26/02/2018	25/02/2022		ok
LFG flow to GG6	0 - 160 mbar	0.06%	ABB	266DSH	3K646618004284	03/03/2020	31/12/2020	4 year	15/02/2018	14/02/2022		ok
LFG flow to GG7	0 - 160 mbar	0.06%	ABB	266DSH	3K646618004285	03/03/2020	31/12/2020	4 year	16/02/2018	15/02/2022		ok
LFG flow to GG8	0 - 160 mbar	0.06%	ABB	266DSH	3K646618004289	03/03/2020	31/12/2020	4 year	15/02/2018	14/02/2022		ok
LFG flow to GG9	0 - 160 mbar	0.06%	ABB	266DSH	3K646618004294	03/03/2020	31/12/2020	4 year	15/02/2018	14/02/2022		ok
LFG flow to GG10	0 - 160 mbar	0.06%	ABB	266DSH	3K646618004282	03/03/2020	31/12/2020	4 year	20/02/2018	19/02/2022		ok
LFG flow to GG11	0 - 160 mbar	0.06%	ABB	266DSH	3K646618004293	03/03/2020	31/12/2020	4 year	15/02/2018	14/02/2022		ok
LFG flow to GG12	0 - 160 mbar	0.06%	ABB	266DSH	3K646618004286	03/03/2020	31/12/2020	4 year	20/02/2018	13/02/2022		ok
LFG flow to GG13 to GG16	NOT USED - DEVIATION APPLIED											ok
LFG flow to open flare	0 - 160 mbar	0.06%	ABB	266DSH	3K646618029790	03/03/2020	31/12/2020	4 year	27/01/2020	26/01/2024		ok
Diesel Consumption Meter	0 to 100 Liters	0.10%	LUPUS	9644	17081046	03/03/2020	03/11/2020	1 year	08/11/2019	07/11/2020		ok
	0 to 100 Liters	0.10%	LUPUS	9644	17081046	04/11/2020	31/12/2020	1 year	04/11/2020	03/11/2021		ok
Eletricity exported and consumed from the grid (NIEGAR) - Primary	0 - 20A	0.20%	SCHNEIDER	ION 8650	MW-1802B061-02	03/03/2020	31/12/2020	5 years	05/02/2019	04/02/2024		ok
Eletricity exported and consumed from the grid (NIEGAR) - Secondary	0 - 20A	0.20%	SCHNEIDER	ION 8650	MW-1801A681-02	03/03/2020	31/12/2020	5 years	05/02/2019	04/02/2024		ok
Eletricity consumed from the grid (Haztec)	0 - 5A	1.00%	SCHNEIDER	PM1200	34152820065	03/03/2020	21/06/2020	5 years	07/07/2015	06/07/2020		ok
	0 - 5A	1.00%	SCHNEIDER	PM1200	34152820065	22/06/2020	31/12/2020	5 years	22/06/2020	21/06/2025		ok

Table 1 – Monitoring instruments calibration

SECTION D. Data and parameters

D.1. Data and parameters fixed ex ante

The following fixed parameters, listed in the registered PDD, were not used during the current monitored period: Waste composition, η_{PJ}, $\varphi_{default}$, OX, F, $DOC_{f,default}$, $MFC_{default}$, DOC_j and K_j.

Data/Parameter	**$EF_{grid,BM,y}$**
Unit	tCO_2/MWh
Description	Build margin emission factor of the Brazilian grid
Source of data	Brazilian DNA
Value(s) applied	0.1404
Choice of data or measurement methods and procedures	The build margin emission factor has been determined by the Brazilian DNA. For the third crediting period, value used during the second crediting period shall be applied.
Purpose of data/parameter	(b) Calculation of project emissions or actual net GHG removals by sinks;
Additional comments	All data and parameters to determine the grid electricity emission factor, as required by the "Tool to calculate the emission factor for an electricity system", were included in the monitoring plan. For more details, see Annex 3 of the registered PDD.

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	Calculation of baseline emission
Additional comments	Applicable to Step A

Data/Parameter	**GWP_{CH4}**
Unit	tCO_2/tCH_4
Description	Global Warming Potential of CH_4
Source of data	IPCC Guidelines
Value(s) applied	25
Choice of data or measurement methods and procedures	Updated for the 2nd commitment period according to COP/MOP decisions[23]
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	-

[23] IPCC Fourth Assessment Report: Climate Change 2007, item 2.10.2: Direct Global Warming Potentials, Table 2.14, available at: http://www.ipcc.ch/publications_and_data/ar4/wg1/en/ch2s2-10-2.html , accessed on 11/02/2015 and in accordance with EB69, Annex 3 and decision 4/CMP.7, available at: http://cdm.unfccc.int/Reference/Standards/meth/reg_stan02.pdf , accessed on 11/02/2015.

Data/Parameter	R_u
Unit	Pa.m^3/kmol.K
Description	Universal ideal gas constant
Source of data	Methodological tool “Project emissions from flaring”
Value(s) applied	8,314.4720 (according to TOOL06)
Choice of data or measurement methods and procedures	Default value used, according to Methodological tool “Project emissions from flaring”, table 1: Constants used in equations.
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	-

Data/Parameter	P_{ref}
Unit	Pa
Description	Atmospheric pressure at reference conditions
Source of data	Tool “Project emissions from flaring”
Value(s) applied	101,325
Choice of data or measurement methods and procedures	Default value extracted from Tool “Project emissions from flaring”
Purpose of data/parameter	Calculation of project emissions
Additional comments	-

Data/Parameter	T_{ref}
Unit	K
Description	Temperature at reference conditions
Source of data	Tool “Project emissions from flaring”
Value(s) applied	273.15
Choice of data or measurement methods and procedures	Default value extracted from Tool “Project emissions from flaring”
Purpose of data/parameter	Calculation of project emissions
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	Compound: Methane; Structure: CH_4; Molecular mass (kg/kmol): 16.04
Choice of data or measurement methods and procedures	According to “Tool to determine the mass flow of a greenhouse gas in a gaseous stream”
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	-

Data/Parameter	MM_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	Compound: Nitrogen; Structure: N_2; Molecular mass (kg/kmol): 28.01
Choice of data or measurement methods and procedures	According to "Tool to determine the mass flow of a greenhouse gas in a gaseous stream"
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	-

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

D.2. Data and parameters monitored

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

- $v_{i,t,db}$: Volumetric fraction of greenhouse gas i in a time interval t on a dry basis
- $Maintenance_y$: Maintenance events completed in year y

Data/Parameter	**$EF_{grid,CM,y}$**
Unit	tCO_2/MWh
Description	CO_2 emission factor of the Brazilian grid electricity during the year y
Measured/calculated/ default	Calculated
Source of data	Published data by the Brazilian DNA for values for OM_{grid} and registered PDD for the second crediting period
Value(s) of monitored parameter	0.2188
Monitoring equipment	-
Measuring/reading/recording frequency	Annual
Calculation method (if applicable)	As per the *"Tool to calculate the emission factor for an electricity system"*
QA/QC procedures	Apply procedures in the "Tool to calculate the emission factor for an electricity system"
Purpose of data/parameter	(b) Calculation of project emissions or actual net GHG removals by sinks;
Additional comments	All data and parameters to determine the grid electricity emission factor, as required by the "Tool to calculate the emission factor for an electricity system" were included in the monitoring plan. For more details, see Annex 3of the registered PDD.

Data/Parameter	**$EF_{grid,OM,y}$**

Unit	tCO_2/MWh
Description	Operating margin emission factor of the Brazilian grid
Measured/calculated/ default	Calculated
Source of data	Published data by the Brazilian DNA
Value(s) of monitored parameter	0.4539
Monitoring equipment	-
Measuring/reading/recording frequency	Annual
Calculation method (if applicable)	As per the *"Tool to calculate the emission factor for an electricity system"*
QA/QC procedures	Apply procedures in the "Tool to calculate the emission factor for an electricity system"
Purpose of data/parameter	(b) Calculation of project emissions or actual net GHG removals by sinks;
Additional comments	All data and parameters to determine the grid electricity emission factor, as required by the "Tool to calculate the emission factor for an electricity system" were included in the monitoring plan. For more details, see Annex 3 of the registered PDD.

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	-
Source of data	Brazilian Energy Balance 2020: base year 2019 (Most recent data).
Value(s) of monitored parameter	26.3%[24]
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)	For (a): *TDLj/k/l,y* should be estimated for the distribution and transmission networks of the electricity grid of the same voltage as the connection where the proposed CDM project activity is connected to. The technical distribution losses should not contain other types of grid losses (e.g. commercial losses/theft). The distribution losses can either be calculated by the project participants or be based on references from utilities, network operators or other official documentation
QA/QC procedures	-
Purpose of data/parameter	(b) Calculation of project emissions or actual net GHG removals by sinks;
Additional comments	-

Data/Parameter	**$EC_{PJ1,y} = EG_{EC1,y}$**
Unit	MWh/y
Description	Quantity of electricity consumed from the grid by the project activity during the year y;

[24] Available at: https://www.epe.gov.br/sites-pt/publicacoes-dados-abertos/publicacoes/PublicacoesArquivos/publicacao-479/topico-521/Relato%CC%81rio%20Si%CC%81ntese%20BEN%202020-ab%202019_Final.pdf

Measured/calculated/ default	Measured
Source of data	Measurement from the Project Participants
Value(s) of monitored parameter	Please refer to ER calculation spreadsheet for the monitored values.
Monitoring equipment	

Parameter name	Eletricity exported and consumed from the grid (NIEGAR) - Primary	Eletricity exported and consumed from the grid (NIEGAR) - Secondary	Eletricity consumed from the grid (Haztec)	
Range	0 - 20A	0 - 20A	0 - 5A	0 - 5A
Accuracy	0.20%	0.20%	1.00%	1.00%
Manufacturer	SCHNEIDER	SCHNEIDER	SCHNEIDER	SCHNEIDER
Model	ION 8650	ION 8650	PM1200	PM1200
Serial number	MW-1802B061-02	MW-1801A681-02	34152820065	34152820065
Starting Period	03/03/2020	03/03/2020	03/03/2020	22/06/2020
Finishing Period	31/12/2020	31/12/2020	21/06/2020	31/12/2020
Calibration frequency	5 years	5 years	5 years	5 years
Date of Calibration	05/02/2019	05/02/2019	07/07/2015	22/06/2020
Validity	04/02/2024	04/02/2024	06/07/2020	21/06/2025

Measuring/reading/recording frequency	Continuously measured by electricity meters for the grid electricity consumption as per the “Methodological tool: Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation” and methodology ACM0001.
Calculation method (if applicable)	N/A
QA/QC procedures	As per the “Methodological tool: Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation”
Purpose of data/parameter	(b) Calculation of project emissions or actual net GHG removals by sinks;
Additional comments	The data will be archived throughout the crediting period and two years thereafter.

Data/Parameter	$NCV_{fuel,y}$
Unit	GJ per mass (GJ/ton)
Description	Weighted average net calorific value of fossil fuel i in year y
Measured/calculated/ default	Default
Source of data	IPCC
Value(s) of monitored parameter	46.71
Monitoring equipment	-
Measuring/reading/recording frequency	Review appropriateness of the values annually.
Calculation method (if applicable)	-
QA/QC procedures	Verify if the values under a), b) and c) are within the uncertainty range of the IPCC default values as provided in Table 1.2, Vol. 2 of the 2006 IPCC Guidelines. If the values fall below this range collect additional information from the testing laboratory to justify the outcome or conduct additional measurements. 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	(b) Calculation of project emissions or actual net GHG removals by sinks;
Additional comments	The value was based on Brazilian Database. The data will be archived throughout the crediting period and two years thereafter

Data/Parameter	$EF_{CO2,Diesel,y}$
Unit	tCO2/GJ

Description	Weighted average CO_2 emission factor of fuel type j (Diesel Oil) year y
Measured/calculated/ default	Default
Source of data	IPCC 2006
Value(s) of monitored parameter	0.0843
Monitoring equipment	-
Measuring/reading/recording frequency	Review appropriateness of the values annually
Calculation method (if applicable)	-
QA/QC procedures	Verify if the values under a), b) and c) are within the uncertainty range of the IPCC default values as provided in Table 1.2, Vol. 2 of the 2006 IPCC Guidelines. If the values fall below this range collect additional information from the testing laboratory to justify the outcome or conduct additional measurements. 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	(b) Calculation of project emissions or actual net GHG removals by sinks;
Additional comments	-

Data/Parameter	**$FC_{i,j,y}$**
Unit	m^3/year
Description	Quantity of fossil fuels of type i (Diesel Oil) in process j (diesel generators) during the year y
Measured/calculated/ default	Measured
Source of data	Project developer
Value(s) of monitored parameter	Please refer to ER calculation spreadsheet for the monitored values
Monitoring equipment	<table><tr><td>Parameter name</td><td colspan="2">Diesel Consumption Meter</td></tr><tr><td>Range</td><td>0 to 100 Liters</td><td>0 to 100 Liters</td></tr><tr><td>Accuracy</td><td>0.10%</td><td>0.10%</td></tr><tr><td>Manufacturer</td><td>LUPUS</td><td>LUPUS</td></tr><tr><td>Model</td><td>9644</td><td>9644</td></tr><tr><td>Serial number</td><td>17081046</td><td>17081046</td></tr><tr><td>Starting Period</td><td>03/03/2020</td><td>04/11/2020</td></tr><tr><td>Finishing Period</td><td>03/11/2020</td><td>31/12/2020</td></tr><tr><td>Calibration frequency</td><td>1 year</td><td>1 year</td></tr><tr><td>Date of Calibration</td><td>08/11/2019</td><td>04/11/2020</td></tr><tr><td>Validity</td><td>07/11/2020</td><td>03/11/2021</td></tr></table>
Measuring/reading/recording frequency	Continuously
Calculation method (if applicable)	-
QA/QC procedures	The metered fuel consumption quantities should also be cross-checked with available purchase invoices from the financial records
Purpose of data/parameter	(b) Calculation of project emissions or actual net GHG removals by sinks;
Additional comments	The data will be archived throughout the crediting period and two years thereafter.

Data/Parameter	**Management of SWDS**
Unit	-
Description	Management of SWDS

Measured/calculated/ default	As per the adopted monitoring procedure for the project activity, the management of the landfill is yearly compared against the previously conceived original construction and operational design of the landfill in order to confirm that the overall management and operation of the landfill (including relevant aspects related to landfilling practice) were not modified with the unique aim to increase generation of methane on site. By performing the checking annually, it is monitored whether any practice aiming to increase methane generation in the landfill has occurred. As required by ACM0001, any change in the management of the landfill after the implementation of the project activity should be justified by referring to applicable technical or regulatory specifications.
Source of data	Project Participant The current configuration and operational conditions of the landfill were compared against the previously conceived design and operational conditions of the landfill prior to the implementation of the project activity. According to the declaration issued by the Project Participant on April 2021: - Inside landfill does not exist organic waste recycling;
Value(s) of monitored parameter	Not applicable
Monitoring equipment	-
Measuring/reading/recording frequency	Annually
Calculation method (if applicable)	Project participants should refer to the original design of the landfill to ensure that any practice to increase methane generation have been occurring prior to the implementation of the project activity. Any change in the management of the SWDS after the implementation of the project activity should be justified by referring to technical or regulatory specifications.
QA/QC procedures	-
Purpose of data/parameter	(a) Calculation of baseline emissions or baseline net GHG removals by sinks;
Additional comments	-

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

Parameter name	Eletricity exported and consumed from the grid (NIEGAR) - Primary	Eletricity exported and consumed from the grid (NIEGAR) - Secondary
Range	0 - 20A	0 - 20A
Accuracy	0.20%	0.20%
Manufacturer	SCHNEIDER	SCHNEIDER
Model	ION 8650	ION 8650
Serial number	MW-1802B061-02	MW-1801A681-02
Starting Period	03/03/2020	03/03/2020
Finishing Period	31/12/2020	31/12/2020
Calibration frequency	5 years	5 years
Date of Calibration	05/02/2019	05/02/2019
Validity	04/02/2024	04/02/2024

Measuring/reading/recording frequency	Continuous
Calculation method (if applicable)	N/A
QA/QC procedures	Electricity meter will be subject to regular (in accordance with stipulation of the meter supplier) maintenance and testing to ensure accuracy. The readings will be double checked by the electricity distribution company.
Purpose of data/parameter	(b) Calculation of project emissions or actual net GHG removals by sinks;
Additional comments	This parameter is required for calculating baseline emissions associated with electricity generation ($BE_{EC,y}$) using the "Methodological tool: Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation". Due to PRC-0008-005 (detailed above in section B.2.6), in accordance with paragraph 241 from PS for PAs, CERs may be claimed up to an amount calculated based on the increased capacity by 20 per cent of the capacity specified in the originally registered PDD (before PRC).

Data/Parameter	**$O_{pj,h}$**
Unit	-
Description	Operation of the equipment that consumes the LFG
Measured/calculated/ default	Measured
Source of data	Measurements by Project participant using a device integrated with the operational software at the landfill gas plant.
Value(s) of monitored parameter	N/A
Monitoring equipment	For each equipment unit j using the LFG monitor that the plant is operating in hour h by the monitoring any one or more of the following three parameters: (a) Temperature. Determine the location for temperature measurements and minimum operational temperature based on manufacturer's specifications of the burning equipment. Document and justify the location and minimum threshold in the PDD; (b) Flame. Flame detection system is used to ensure that the equipment is in operation; (c) Products generated. Monitor the generation of steam for the case of boilers and air-heaters and glass for the case of glass melting furnances. This option is not applicable to brick kilns. $O_{pj,h}$=0 when: (a) One of more temperature measurements are missing or below the minimum threshold in hour h (instantaneous measurements are made at least every minute); (b) Flame is not detected continuously in hour h (instantaneous measurements are made at least every minute); (c) No products are generated in the hour h. Otherwise, Opj,h=1
Measuring/reading/recording frequency	Once per minute
Calculation method (if applicable)	-
QA/QC procedures	The calibration of this equipment is not applicable since it is a device integrated with the operational software at the landfill gas plant.
Purpose of data/parameter	(a) Calculation of baseline emissions or baseline net GHG removals by sinks;

Additional comments	For open flares is only possible to detect the flame to ensure if the equipment is in operation or not.

Data/Parameter	$V_{t,db}$
Unit	m³ /h
Description	Volumetric flow of the gaseous stream in time interval t on a dry basis
Measured/calculated/ default	Measured
Source of data	Measurements by Project participants using a flow meter(s)
Value(s) of monitored parameter	Please refer to the ER calculation spreadsheet for monitored values.
Monitoring equipment	

Parameter name	LFG flow to GG1	LFG flow to GG2	LFG flow to GG3	LFG flow to GG4	LFG flow to GG5	LFG flow to GG6
Range	0 - 160 mbar	0 - 160 mbar	0 - 160 mbar	0 - 160 mbar	0 - 160 mbar	0 - 160 mbar
Accuracy	0.06%	0.06%	0.06%	0.06%	0.06%	0.06%
Manufacturer	ABB	ABB	ABB	ABB	ABB	ABB
Model	266DSH	266DSH	266DSH	266DSH	266DSH	266DSH
Serial number	3K646618004288	3K646618004287	3K646618004283	3K646618008068	3K646618005641	3K646618004284
Starting Period	03/03/2020	03/03/2020	03/03/2020	03/03/2020	03/03/2020	03/03/2020
Finishing Period	31/12/2020	31/12/2020	31/12/2020	31/12/2020	31/12/2020	31/12/2020
Calibration frequency	4 year	4 year	4 year	4 year	4 year	4 year
Date of Calibration	15/02/2018	14/02/2018	15/02/2018	19/03/2018	26/02/2018	15/02/2018
Validity	14/02/2022	13/02/2022	14/02/2022	18/03/2022	25/02/2022	14/02/2022

Parameter name	LFG flow to GG7	LFG flow to GG8	LFG flow to GG9	LFG flow to GG10	LFG flow to GG11	LFG flow to GG12
Range	0 - 160 mbar	0 - 160 mbar	0 - 160 mbar	0 - 160 mbar	0 - 160 mbar	0 - 160 mbar
Accuracy	0.06%	0.06%	0.06%	0.06%	0.06%	0.06%
Manufacturer	ABB	ABB	ABB	ABB	ABB	ABB
Model	266DSH	266DSH	266DSH	266DSH	266DSH	266DSH
Serial number	3K646618004285	3K646618004289	3K646618004294	3K646618004282	3K646618004293	3K646618004286
Starting Period	03/03/2020	03/03/2020	03/03/2020	03/03/2020	03/03/2020	03/03/2020
Finishing Period	31/12/2020	31/12/2020	31/12/2020	31/12/2020	31/12/2020	31/12/2020
Calibration frequency	4 year	4 year	4 year	4 year	4 year	4 year
Date of Calibration	16/02/2018	15/02/2018	15/02/2018	20/02/2018	15/02/2018	20/02/2018
Validity	15/02/2022	14/02/2022	14/02/2022	19/02/2022	14/02/2022	13/02/2022

Parameter name	LFG flow to GG13 to GG16	LFG flow to open flare
Range	NOT USED - DEVIATION APPLIED	0 - 160 mbar
Accuracy		0.06%
Manufacturer		ABB
Model		266DSH
Serial number		3K646618029790
Starting Period		03/03/2020
Finishing Period		31/12/2020
Calibration frequency		4 year
Date of Calibration		27/01/2020
Validity		26/01/2024

Measuring/reading/recording frequency	Continuous recorded and hourly aggregated
Calculation method (if applicable)	-
QA/QC procedures	Periodic calibration against a primary device provided by an independent accredited laboratory is mandatory. The calibration frequency of this monitoring equipment should be in accordance with manufacturer's specifications.
Purpose of data/parameter	(a) Calculation of baseline emissions or baseline net GHG removals by sinks;
Additional comments	This parameter will be monitored only in case Option A of the "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" is applied for the determination of $F_{CH4,flared,y}$, $F_{CH4,EL,y}$

Data/Parameter	$V_{t,wb}$
Unit	m³ /h
Description	Volumetric flow of the gaseous stream in time interval t on a wet basis
Measured/calculated/ default	Measured
Source of data	Measurements by Project participants using a flow meter(s)

Value(s) of monitored parameter	Please refer to the ER calculation spreadsheet for monitored values.
Monitoring equipment	

Parameter name	LFG flow to GG1	LFG flow to GG2	LFG flow to GG3	LFG flow to GG4	LFG flow to GG5	LFG flow to GG6
Range	0 - 160 mbar	0 - 160 mbar	0 - 160 mbar	0 - 160 mbar	0 - 160 mbar	0 - 160 mbar
Accuracy	0.06%	0.06%	0.06%	0.06%	0.06%	0.06%
Manufacturer	ABB	ABB	ABB	ABB	ABB	ABB
Model	266DSH	266DSH	266DSH	266DSH	266DSH	266DSH
Serial number	3K646618004288	3K646618004287	3K646618004283	3K646618008068	3K646618005641	3K646618004284
Starting Period	03/03/2020	03/03/2020	03/03/2020	03/03/2020	03/03/2020	03/03/2020
Finishing Period	31/12/2020	31/12/2020	31/12/2020	31/12/2020	31/12/2020	31/12/2020
Calibration frequency	4 year	4 year	4 year	4 year	4 year	4 year
Date of Calibration	15/02/2018	14/02/2018	15/02/2018	19/03/2018	26/02/2018	15/02/2018
Validity	14/02/2022	13/02/2022	14/02/2022	18/03/2022	25/02/2022	14/02/2022

Parameter name	LFG flow to GG7	LFG flow to GG8	LFG flow to GG9	LFG flow to GG10	LFG flow to GG11	LFG flow to GG12
Range	0 - 160 mbar	0 - 160 mbar	0 - 160 mbar	0 - 160 mbar	0 - 160 mbar	0 - 160 mbar
Accuracy	0.06%	0.06%	0.06%	0.06%	0.06%	0.06%
Manufacturer	ABB	ABB	ABB	ABB	ABB	ABB
Model	266DSH	266DSH	266DSH	266DSH	266DSH	266DSH
Serial number	3K646618004285	3K646618004289	3K646618004294	3K646618004282	3K646618004293	3K646618004286
Starting Period	03/03/2020	03/03/2020	03/03/2020	03/03/2020	03/03/2020	03/03/2020
Finishing Period	31/12/2020	31/12/2020	31/12/2020	31/12/2020	31/12/2020	31/12/2020
Calibration frequency	4 year	4 year	4 year	4 year	4 year	4 year
Date of Calibration	16/02/2018	15/02/2018	15/02/2018	20/02/2018	15/02/2018	20/02/2018
Validity	15/02/2022	14/02/2022	14/02/2022	19/02/2022	14/02/2022	13/02/2022

Parameter name	LFG flow to GG13 to GG16	LFG flow to open flare
Range	NOT USED - DEVIATION APPLIED	0 - 160 mbar
Accuracy		0.06%
Manufacturer		ABB
Model		266DSH
Serial number		3K646618029790
Starting Period		03/03/2020
Finishing Period		31/12/2020
Calibration frequency		4 year
Date of Calibration		27/01/2020
Validity		26/01/2024

Measuring/reading/recording frequency	Continuous recorded and hourly aggregated
Calculation method (if applicable)	-
QA/QC procedures	Periodic calibration against a primary device provided by an independent accredited laboratory is mandatory. The calibration frequency of this monitoring equipment should be in accordance with manufacturer's specifications.
Purpose of data/parameter	(a) Calculation of baseline emissions or baseline net GHG removals by sinks;
Additional comments	This parameter will be monitored only in case Options B or C of the "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" is applied for the determination of $F_{CH4,flared,y}$, $F_{CH4,EL,y}$

Data/Parameter	$v_{i,t,wb}$
Unit	m^3 gas i/m^3 dry gas
Description	Volumetric fraction of greenhouse gas i in a time interval t on a wet basis
Measured/calculated/ default	Measured
Source of data	Measurements by Project participants using gas analyzer
Value(s) of monitored parameter	Please refer to the ER calculation spreadsheet for the monitored values

Monitoring equipment	<table><tr><td>Parameter name</td><td colspan="3">Methane fraction in LFG</td></tr><tr><td>Range</td><td>0 - 100% CH4</td><td>0 - 100% CH4</td><td>0 - 100% CH4</td></tr><tr><td>Accuracy</td><td>2%</td><td>2%</td><td>2%</td></tr><tr><td>Manufacturer</td><td>SIEMENS</td><td>SIEMENS</td><td>SIEMENS</td></tr><tr><td>Model</td><td>Ultramat 23</td><td>Ultramat 23</td><td>Ultramat 23</td></tr><tr><td>Serial number</td><td>N1C7778</td><td>N1C7778</td><td>N1F6767</td></tr><tr><td>Starting Period</td><td>03/03/2020</td><td>18/03/2020</td><td>21/08/2020</td></tr><tr><td>Finishing Period</td><td>17/03/2020</td><td>20/08/2020</td><td>31/12/2020</td></tr><tr><td>Calibration frequency</td><td></td><td></td><td></td></tr><tr><td>Date of Calibration</td><td>16/04/2019</td><td>18/03/2020</td><td>18/03/2020</td></tr><tr><td>Validity</td><td>15/04/2020</td><td>17/03/2021</td><td>17/03/2021</td></tr></table>
Measuring/reading/recording frequency	Continuous recorded and hourly aggregated
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	(a) Calculation of baseline emissions or baseline net GHG removals by sinks;
Additional comments	This parameter may be monitored only in case Option B of the tool “Tool to determine the mass flow of a greenhouse gas in a gaseous stream” is applied for the determination of $F_{CH4,flared,y}$, $F_{CH4,EL,y}$. During the monitored period, Option C is used due to the deviation (please refer to section B.2.1.).

Data/Parameter	T_t
Unit	K
Description	Temperature of the gaseous stream in time interval t
Measured/calculated/ default	Measured
Source of data	Measurements by Project participant using a temperature meter
Value(s) of monitored parameter	Please refer to the ER calculation spreadsheet for the monitored values
Monitoring equipment	<table><tr><td>Parameter name</td><td>LFG Temperature</td></tr><tr><td>Range</td><td>0 to 100°C</td></tr><tr><td>Accuracy</td><td>0.10%</td></tr><tr><td>Manufacturer</td><td>Elsi</td></tr><tr><td>Model</td><td>PT100</td></tr><tr><td>Serial number</td><td>E19TP0083</td></tr><tr><td>Starting Period</td><td>03/03/2020</td></tr><tr><td>Finishing Period</td><td>31/12/2020</td></tr><tr><td>Calibration frequency</td><td>2 years</td></tr><tr><td>Date of Calibration</td><td>29/01/2020</td></tr><tr><td>Validity</td><td>28/01/2022</td></tr></table>
Measuring/reading/recording frequency	Continuous
Calculation method (if applicable)	-
QA/QC procedures	Periodic calibration against a primary device provided by an independent accredited laboratory is mandatory. The calibration frequency of this monitoring equipment should be according to the manufacturer’s specifications

Purpose of data/parameter	(a) Calculation of baseline emissions or baseline net GHG removals by sinks;
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.

Data/Parameter	P_t
Unit	Pa
Description	Pressure of the gaseous stream in time interval t
Measured/calculated/ default	Measured
Source of data	Measurements by Project participant using a pressure meter
Value(s) of monitored parameter	Please refer to the ER calculation spreadsheet for the monitored values.
Monitoring equipment	Parameter name: LFG Pressure Range: 0 - 250 mbar Accuracy: 0.06% Manufacturer: ABB Model: 266HSH Serial number: 3K646619004047 Starting Period: 03/03/2020 Finishing Period: 31/12/2020 Calibration frequency: 1 year Date of Calibration: 27/01/2020 Validity: 24/01/2021
Measuring/reading/recording frequency	Continuous
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 according manufacturer recommendation. In case the pressure meter is not a capacitive or resistive pressure transducer, the calibration frequency of this monitoring equipment should be according to the manufacturer's specifications.
Purpose of data/parameter	(a) Calculation of baseline emissions or baseline net GHG removals by sinks;
Additional comments	Provided all parameters are converted to normal conditions during the monitoring process, this parameter may not be needed except for moisture content determination and therefore it should be metered only when performing such measurements (with same frequency)

Data/Parameter	Status of biogas destruction device
Unit	-
Description	Operational status of biogas destruction devices
Measured/calculated/ default	-
Source of data	Provided by project participants
Value(s) of monitored parameter	-

Monitoring equipment	-
Measuring/reading/recording frequency	Continuous
Calculation method (if applicable)	Monitoring and documenting may be undertaken by recording the energy production from methane captured or the operation of the flare by means of a flame detector to demonstrate the actual destruction of methane, unless a different method is specified in the underlying methodology/tool. Emission reductions will not accrue for periods in which the destruction device is not operational.
QA/QC procedures	-
Purpose of data/parameter	(a) Calculation of baseline emissions or baseline net GHG removals by sinks;
Additional comments	For Flame detector devices refer to the methodological tool "Project emissions from flaring"

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

Data/Parameter	$Flame_m$
Unit	Flame on or Flame off
Description	Flame detection of flare in the minute m
Measured/calculated/ default	-
Source of data	Project Participants
Value(s) of monitored parameter	-
Monitoring equipment	Measurements by project participants using a continuous ultraviolet flame detector
Measuring/reading/recording frequency	Once per minute. Detection of flame recorded as a minute that the flame was on, otherwise recorded as a minute that the flame was off
Calculation method (if applicable)	-
QA/QC procedures	Equipment shall be maintained and calibrated in accordance with manufacturer's recommendations

Purpose of data/parameter	Calculation of baseline and project emissions when the flame is on[25].
Additional comments	-

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

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The below table presents the results for the calculation of baseline emissions achieved during the monitored period.

	DEVIATION applied	BE,y	BEEC,y	BECH4,y	FCH4PJ,y	FCH4BL,y	FCH4flared,y	FCH4EL,y	% CH4	FCH4 sentflare,y	ECBL	Total methane for Group generators	Total methane to Flare	FCH4RG,t	PEflare,y
	(yes/no)	tCO2	tCO2	tCO2	tCH4	tCH4	tCH4	tCH4	%	tCH4	MWh	Nm³CH4	Nm³CH4	kg	tCO2
From 03/03/2020	No	41,082	786	40,296	2,303	461	529	1,773	51.9%	1,058	2,845	2,474,064	1,476,613	1,058,436	13,230
04/2020	No	48,991	884	48,107	2,749	550	519	2,230	50.8%	1,038	3,199	3,110,657	1,448,776	1,038,482	12,981
05/2020	No	49,357	879	48,478	2,770	554	541	2,229	51.4%	1,082	3,181	3,109,747	1,509,824	1,082,242	13,528
06/2020	No	49,936	911	49,024	2,801	560	405	2,396	51.8%	810	3,299	3,343,235	1,129,893	809,907	10,124
07/2020	No	51,654	941	50,713	2,898	580	448	2,450	51.4%	896	3,404	3,417,516	1,250,606	896,434	11,205
08/2020	No	47,582	909	46,672	2,667	533	343	2,324	51.4%	686	3,291	3,241,869	957,647	686,441	8,581
09/2020	No	48,417	881	47,536	2,716	543	401	2,315	51.8%	802	3,187	3,229,889	1,119,329	802,335	10,029
10/2020	No	49,129	901	48,228	2,756	551	356	2,400	51.9%	712	3,262	3,347,745	993,885	712,417	8,905
11/2020	Yes	53,339	916	52,423	2,996	599	229	2,767	52.5%	457	3,316	3,859,992	638,251	457,499	5,719
12/2020	Yes	53,803	908	52,895	3,023	605	253	2,770	52.9%	505	3,287	3,864,192	705,114	505,426	6,318

The baseline emission was calculated according to the following formula:

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

Where:

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

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

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

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

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

Where:

$BE_{CH4,y}$ = Baseline emissions of LFG from the SWDS in year *y* (t CO_2e/yr)
OX_{top_layer} = Fraction of methane in the LFG that would be oxidized in the top layer of the

[25] When the flame is off, neither baseline nor project emissions occurs since the LFG is not combusted and instead released to the atmosphere.

SWDS in the baseline (dimensionless)

$F_{CH4,PJ,y}$ = Amount of methane in the LFG which is flared and/or used in the project activity in year *y* (t CH_4/yr)

$F_{CH4,BL,y}$ = Amount of methane in the LFG that would be flared in the baseline in year *y* (t CH_4/yr)

GWP_{CH4} = Global warming potential of CH_4 (t CO_2e/t CH_4)

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

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

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

Where:

$F_{CH4,PJ,y}$ = Amount of methane in the LFG which is flared and/or used in the project activity in year y (tCH_4/yr)

$F_{CH4,flared,y}$ = Amount of methane in the LFG which is destroyed by flaring in year y (t CH_4/yr)

$F_{CH4,EL,y}$ = Amount of methane in the LFG which is used for electricity generation in year y (t CH_4/yr)

$F_{CH4,HG,y}$ Amount of methane in the LFG which is used for heat generation in year y (t CH_4/yr)

$F_{CH4,NG,y}$ = Amount of methane in the LFG which is sent to the natural gas distribution network and/or dedicated pipeline and/or to the trucks in year y (t CH_4/yr)

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

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

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

The following requirements apply:

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

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

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

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

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

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

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

Where:

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

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

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

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

  And

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

Option A

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

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

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

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

With

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

Where:
$F_{i,t}$ = Mass flow of greenhouse gas *i* in the gaseous stream in time interval *t* (kg gas/h)
$V_{t,db}$ = Volumetric flow of the gaseous stream in time interval *t* on a dry basis (m^3 dry gas/h)

$v_{i,t,db}$ = Volumetric fraction of greenhouse gas *i* in the gaseous stream in a time interval *t* on a dry basis (m^3 gas *i*/m^3 dry gas)
$\rho_{i,t}$ = Density of greenhouse gas i in the gaseous stream in time interval *t* (kg gas *i*/m^3 gas *i*)
P_t = Absolute pressure of the gaseous stream in time interval *t* (Pa)
MM_i = Molecular mass of greenhouse gas *i* (kg/kmol)
R_u = Universal ideal gases constant (8,314 Pa.m^3/kmol.K)
T_t = Temperature of the gaseous stream in time interval *t* (K)

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

Option B

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

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

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

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

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

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

The absolute humidity of 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[26].

[26] 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).

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

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

Where:

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

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

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

Where:

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

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

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

To determine the project emissions from flaring gases was used the tool "Project emissions from flaring". The project emissions calculation procedure is given in the following steps:

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

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

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

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

The following requirements apply:

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

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

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

Step 2: Determination of flare efficiency

According to "Project emissions from flaring", the flare efficiency will be calculated as follows:

Open flare

In the case of open flares, the flare efficiency in the minute *m* ($\eta_{flare,m}$) is 50% when the flame is detected in the 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 for each minute *m* in year *y,* based on the methane mass flow in the residual gas ($F_{CH4,RG,m}$) and the flare efficiency ($\eta_{flare,m}$), as follows:

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

Where:

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

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

Parameter	Description	Value	Unit
P_{ref}	Atmospheric pressure at reference conditions	101,325	Pa
R_u	Universal ideal gas constant	8314.472	$Pa.m^3/kmol.K$
T_{ref}	Temperature at reference conditions	273.15	K
GWP_{CH4}	Global warming potential of methane valid for the commitment period	25[27]	tCO_2/tCH_4

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

$\rho_{CH4,n}$	Density of methane at reference conditions	0.716	kg/m^3

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

In the baseline there are no regulatory or contractual requirements, or to address safety and odour concerns to capture and destroy LFG. Thus, the case of the project activity for determining methane captured and destroyed in the baseline is **Case 3** because there is existing LFG capture system (passive system), however there is no requirement to destroy methane. In this case:

In this situation:

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

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

$F_{CH4,BL,sys,y} = 20\% \times F_{CH4,PJ,y}$; or

$F_{CH4,BL,y} = 20\% \times F_{CH4,PJ,y}$

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

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

Where:

$BE_{EC,y}$	=	Baseline emissions from electricity generation in year *y* (tCO2/yr)
$EC_{BL,k,y} = EG_{PJ,y}$	=	Net amount of electricity generated using LFG in year y (MWh/yr)
$EF_{EL,k,y}$[28]	=	Emission factor for electricity generation for source *k* in year *y* (tCO_2/MWh)
$TDL_{k,y}$	=	Average technical transmission and distribution losses for providing electricity to source *k* in year *y*.

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

Emission Factor calculation

The project emissions derived from fossil fuels used for electricity consumption from grid connected power plants are estimated and guided using the “Methodological tool: Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation”. The combined margin emission factor was calculated by the “Tool to calculate the emission factor for an electricity system”, as follows:

Step 1. Identify the relevant electric power system

For the purpose of determining the electricity emission factors, a project electricity system is defined by the spatial extent of the power plants that are physically connected through transmission and distribution lines to the project activity (e.g. the renewable power plant location or

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

the consumers where electricity is being saved) and that can be dispatched without signification transmission constraints.

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

The Brazilian DNA published an official delineation of the project electricity system in Brazil, considering a national interconnected system.[29]

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

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

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

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

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

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

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

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

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

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

The emission factor is calculated as follows:

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

Where:

$EF_{grid,OM-DD,y}$ = Dispatch data analysis operating margin CO_2 emission factor in year *y* (tCO_2/MWh)

$EG_{PJ,h}$ = Electricity displaced by the project activity in hour *h* m of year *y* (MWh)

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

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

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

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

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

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

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

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

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

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

Where:

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

Step 6. Calculate the combined margin emissions factor

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

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

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

The build margin CO_2 emission factors will be ex-ante.

The operating margin CO_2 emission factors will be ex-post.

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

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

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The below table presents the calculation results for project emissions occurring during the monitored period.

	DEVIATION applied	PE,y	PEEC1	PEFC, diesel, j, y	ECPJ1	FC_diesel,j,y
	(yes/no)	tCO2	tCO2	tCO2	MWh	L
From 03/03/2020	No	47.90	45.72	2.18	165.45	554.00
04/2020	No	51.78	50.21	1.58	181.70	400.00
05/2020	No	52.96	51.49	1.47	186.33	374.00
06/2020	No	42.06	41.71	0.35	150.95	90.00
07/2020	No	53.54	52.94	0.61	191.58	154.00
08/2020	No	49.73	48.98	0.75	177.27	190.00
09/2020	No	58.01	50.26	7.76	181.89	1970.00
10/2020	No	59.16	51.40	7.76	186.03	1970.00
11/2020	Yes	50.69	50.69	0.00	183.46	0.00
12/2020	Yes	53.42	51.01	2.41	184.59	612.00

Project emissions are calculated using the following formula:

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

Where:

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

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

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

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

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

The parameter $PE_{DT,y}$ is not used in the calculation of project emissions since there is no distribution of compressed/liquefied LFG using trucks in the project activity.

Since there is no supply of LFG to consumers through a dedicated pipeline, $PE_{SP,y}$ = 0

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

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

- $PE_{EC1,y}$ - Grid (Brazilian interconnected electric system);
- $PE_{EC2,y}$ - Diesel generator(s) (off-grid captive power plant)

Thus,

$$PE_{EC,y} = PE_{EC1,y} + PE_{EC2,y}$$

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

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

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

Thus, the project emission is calculated as following:

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

Where:

$EC_{PJ1,y}$	= quantity of electricity consumed from the grid by the project activity during the year y (MWh);
$EF_{grid,CM,y}$	= the emission factor for the grid in year y (tCO_2/MWh);
TDL_y	= average technical transmission and distribution losses in the grid in year y for the voltage level at which electricity is obtained from the grid at the project site.

$PE_{EC2,y}$ - Project emission from electricity consumption from an off-grid captive power plant (diesel generator(s))

As electricity will be consumed from diesel generators (off-grid captive power plant), an alternative approach for project and/or leakage emissions was adopted and the Option B3 was chosen because in the particular case of the project activity, project emissions from consumption of electricity will be determined by calculating the CO2 emissions from diesel fuel combustion in the captive power plant. As stated in TOOL05, these emissions should be calculated using the latest approved version of the "Tool to calculate project or leakage CO2 emissions from fossil fuel combustion". This option provides an accurate estimate since all the power generated by the captive power plant is consumed by the proposed CDM project activity.

Then,

$$PE_{EC2,y} = PE_{FC,j,y}$$

Calculation of $PE_{FC,y}$ – project emission from consumption of fossil fuel

Project emissions from fossil fuel combustion ($PE_{FC,j,y}$) are calculated following "*Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion*". For this project, Diesel Oil is used in

diesel generators when electricity from the grid is not available, thus these emissions are calculated below:

For fuel Diesel Oil for diesel generators:

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

Where:

$FC_{i,j,y}$ is the quantity of fossil fuel *i* (Diesel Oil) combusted in process *j* (diesel generators) during year *y* (m^3)

$COEF_{i,y}$ is the CO_2 emission coefficient of the Diesel Oil (tCO_2/ m^3 fuel)

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

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

Where:

$NCV_{i,y}$ Is the weighted average net calorific value of the fuel type *i* (Diesel Oil) in year *y* (GJ/ m^3)

$EF_{CO2i,y}$ Is the weighted average CO_2 emission factor of fuel type *i* (Diesel Oil) in year *y* (tCO_2/GJ)

E.3. Calculation of leakage emissions

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No leakage effects need to be accounted accordingly to the applicable methodology.

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 until 31/12/ 2020	From 01/01/ 2021	Total amount
Total	493,289	520	0	0	492,769	0	492,769

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)
492,769	277,579

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

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Calculated proportionally from what was *ex-ante* estimated in the registered PDD multiplying the total estimative for 2020 (334,191 tCO2e) by the quotient between the number of days in this monitoring period for that year (304 days) and the total number of days (366 days).

E.6. Remarks on increase in achieved emission reductions

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The difference between the CERs calculated value for this monitoring period and estimated value in registered PDD is 44%.
It is important to highlight that the difference between CERs amount estimated ex ante for this monitoring period and real amount of CERs achieved in the monitoring period is due to an increase in the efficiency of the landfill gas collecting system that enabled an increment of emission reductions production.

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

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Not applicable.

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Document information

Version	*Date*	*Description*
08.0	6 April 2021	Revision to: • Reflect the “Clarification: Regulatory requirements under temporary measures for post-2020 cases” (CDM-EB109-A01-CLAR).
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.

Version	*Date*	*Description*
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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