Monitoring report form for CDM project activity
(Version 07.0)

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

MONITORING REPORT		
Title of the project activity	Project 3958: CTR Candeias Landfill Gas Project	
UNFCCC reference number of the project activity	3958	
Version number of the PDD applicable to this monitoring report	23	
Version number of this monitoring report	1	
Completion date of this monitoring report	03/02/2021	
Monitoring period number	6th monitoring period	
Duration of this monitoring period	From 29/09/2018 to 02/03/2020	
Monitoring report number for this monitoring period	Not applicable	
Project participants	Haztec Tecnologia e Planejamento Ambiental SA ALLCOT AG	
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) 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
	-	163,204
Amount of GHG emission reductions or net anthropogenic GHG removals estimated ex ante for this monitoring period in the PDD	616,856[1]	

[1]Calculated using the PDD estimation for 2018 (101,253), plus PDD estimation for 2019 (438,408), plus PDD estimation for 2020 (455,697) times the number of days in this monitoring period for this year (62 days) divided by the number of days in the year (366 days).

SECTION A. Description of project activity

A.1. General description of project activity

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CTR Candeias Landfill Gas Project is a landfill gas collection, use and flare project in Brazil. The project's core idea is to avoid methane emissions from the landfill CTR Candeias owned by Haztec Tecnologia e Planejamento Ambiental SA (HAZTEC) and located in the municipality of Jaboatão dos Guararapes, in the Recife Metropolitan Area, Brazil, in order to avoid emissions of methane gas to the atmosphere. The project activity comprises the installation of a new active LFG extraction, flaring and electricity generation systems. The main equipment currently installed in this project activity are:

- 2 blower;
- 1 flare;
- 10 Electricity Group Generators
- Several collection wells, manifolds and transmission pipelines;

See section B.1. for further details on the technology employed.

Haztec Tecnologia e Planejamento Ambiental SA (HAZTEC) is the company responsible for the implementation and operation of the landfill and Asja Paraíba Servicos Ambientais Spe Ltda. Is responsible for electricity generation and commercialization (disposing around 4,000 tons of solid waste per day) The project consists of two phases:

- **Phase I:** LFG capture and flaring, reducing uncontrolled release to atmosphere;
- **Phase II:** Generation of electricity from LFG. Part of the electricity will be used for self-consumption and the other part will be exported to the grid.

Currently the project has implemented Phase I and Phase 2.

The commissioning date considering Group generators are below:

- Group generator 1: 30/07/2019
- Group generator 2: 30/07/2019
- Group generator 3: 30/07/2019
- Group generator 4: 08/08/2019
- Group generator 5: 08/08/2019
- Group generator 6: 08/08/2019
- Group generator 7: 08/08/2019
- Group generator 8: 22/08/2019
- Group generator 9: 07/11/2019
- Group generator 10: 12/11/2019
- Group generator 11: 08/10/2020
- Group generator 12: To be commissioned.

The commercial operation start-up date considering Group generators are below:

- Group Generators 1 to 8: 26/07/2019
- Group Generators 9 and 10: 12/11/2019
- Group Generator 11: 06/10/2020
- Group Generator 12: Commercial operation to be authorized by Brazilian Electricity Energy Agency

The amount of CERs generated due to the electricity generation is requested only from 26/07/2019, date that corresponds to the beginning of generator´s commercial operation, as per dispatch authorized by ANEEL (Brazilian Electricity Energy Agency).

From the group generators mentioned above, Group Generator 11 and 12 were not operational during this monitoring period.

The landfill gas was collected only through a passive system, with no systematic and monitored flare. Therefore, an extra-incentive was needed to make additional investments and enhance its landfill gas collection rate and install appropriate facilities to properly flare the methane produced at the site and generate electricity.

The total emission reductions achieved in this period is **163,204 tCO2e.**

A.2. Location of project activity

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CTR Candeias Landfill is located in the city of Jaboatão dos Guararapes, in Recife Metropolitan Area, state of Pernambuco, Brazil.

The landfill is located at the following Geographic coordinates

Latitude: 8.164258
Longitude: : -34.985286

The picture below presents the detailed location of the landfill

Figure 1 - Location of the CTR Candeias Landfill Gas Project (Source: IBGE)

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 SA	No
Switzerland	ALLCOT AG	No

This monitoring report was developed and reviewed by:

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A.4. References to applied methodologies and standardized baselines

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The applied methodology is ACM0001 - Flaring or use of landfill gas, version 19.0.
Tools to which the methodology refers are the following:

- Large-scale Consolidated Methodology ACM0001: “Flaring or use of landfill gas” (Version 19.0)[2];
- TOOL02 Methodological tool: “Combined tool to identify the baseline scenario and demonstrate additionality” (Version 07.0)[3];
- TOOL03 Methodological tool: “Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion” (Version 03.0)[4].
- TOOL04 Methodological tool: “Emissions from solid waste disposal sites” (Version 08.0)[5];
- TOOL05 Methodological tool: “Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation” (Version 03.0)[6];
- TOOL06 Methodological tool: “Project emissions from flaring” (Version 03.0)[7];
- TOOL07 Methodological tool: “Tool to calculate the emission factor for an electricity system” (Version 07.0)[8];
- TOOL08 Methodological tool: “Tool to determine the mass flow of a greenhouse gas in a gaseous stream” (Version 03.0)[9];
- TOOL09 Methodological tool: “Determining the baseline efficiency of thermal or electric energy generation systems” (Version 02.0)[10];
- TOOL10 Methodological Tool: “Tool to determine the remaining lifetime of equipment” (Version 01)[11];
- TOOL12 Methodological tool: “Project and leakage emissions from transportation of freight” (Version 01.1.0)[12];
- TOOL32 Methodological tool: “Positive lists of technologies” (Version 01.1.0)[13].

[2] https://cdm.unfccc.int/methodologies/DB/JPYB4DYQUXQPZLBDVPHA87479EMY9M

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

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

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

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

[7] https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-06-v3.0.pdf

[8] https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-07-v7.0.pdf

[9] https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-08-v3.0.pdf

[10] https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-09-v2.0.pdf

[11] https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-10-v1.pdf

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

[13] https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-32-v1.pdf

A.5. Crediting period type and duration

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The renewable crediting period is from 29/09/2018 to 28/09/2025 (2nd Crediting Period).

SECTION B. Implementation of project activity

B.1. Description of implemented project activity

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From 29/09/2018 to 25/07/2019, the plant was decommissioned and thus not operational. The recommissioning of the project plant occurred on 26/07/2019.

During this monitoring period, the project has operated with one flare, two blowers and ten group generators destroying the LFG collected in only one landfill site.

Flare	Manufacturer	Biotecnogás (BTG)
	Type	Enclosed
	Model	2500 HT
	Serial number	BTG2500HT -163/13
	Year of manufacturing	07/2014
	Nominal gas flow	2,500 Nm³/h
	Minimum retention time	0.7 seconds
	Minimum methane content	30%
	Minimum efficiency	98%
	Lowest operation temperature	500ºC
Blower 1	Year	2016
	Manufacturer	2016
	Model	400A.04
	Serial number	09400001
	Maximum capacity	10,000 Nm³/h
Blower 2	Year	2019
	Manufacturer	2019
	Model	251A.05
	Serial number	192510003
	Maximum capacity	10,000 Nm³/h

Table 1 –Technical details of equipment installed at Project Activity

The system has installed group generators, to supply electricity for the project internal consumption and electricity export to the grid. The specification of these equipment is presented in the table below:

Group Generator	Engine					
	Group Generator 1 Manufacturer:	Group Generator 1 Model:	Serial Number Group Generator	Engine Type	Group Generator installed capacity:	Year
GMG 01	GE Jenbacher	JGC 420 GS-L.L.	1358712	JGC 420 GS-L,L	1.426 Kw	2018
GMG 02	GE Jenbacher	JGC 420 GS-L.L.	1358520	JGC 420 GS-L,L	1.426 Kw	2018
GMG 03	GE Jenbacher	JGC 420 GS-L.L.	1358569	JGC 420 GS-L,L	1.426 Kw	2018
GMG 04	GE Jenbacher	JGC 420 GS-L.L.	1358609	JGC 420 GS-L,L	1.426 Kw	2018
GMG 05	GE Jenbacher	JGC 420 GS-L.L.	1358588	JGC 420 GS-L,L	1.426 Kw	2018

GMG 06	GE Jenbacher	JGC 420 GS-L.L.	1358674	JGC 420 GS-L,L	1.426 Kw	2018
GMG 07	GE Jenbacher	JGC 420 GS-L.L.	1358473	JGC 420 GS-L,L	1.426 Kw	2018
GMG 08	GE Jenbacher	JGC 420 GS-L.L.	1358694	JGC 420 GS-L,L	1.426 Kw	2018
GMG 09	GE Jenbacher	JGC 420 GS-L.L.	1358552	JGC 420 GS-L,L	1.426 Kw	2018
GMG 10	GE Jenbacher	JGC 420 GS-L.L.	1422642	JGC 420 GS-L,L	1.426 Kw	2019
GMG 11	GE Jenbacher	JGC 420 GS-L.L.	1462629	JGC 420 GS-L,L	1.426 Kw	2020
GMG 12	GE Jenbacher	JGC 420 GS-L.L.	1462619	JGC 420 GS-L,L	1.426 Kw	2020

Table 2 – Group Generators specifications

From the group generators mentioned above, Group Generator 11 and 12 were not operational during this monitoring period.

The main incidents that occurred during the period of this monitoring report are listed in a separate table provided by the PP.

B.2. Post-registration changes

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

>>
Not applicable

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

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Permanent changes from registered monitoring plan have been approved prior to this verification. Please refer to: PRC-3958-001 (Effective approval date 7 February 2014).

B.2.6. Changes to project design

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Changes to Project Design, PDD version 23, that have been approved on 21/01/2021, post-registration changes reference number PRC-3958-003.

1) Typo mistake correction in the first and last days of crediting period from 29/10/2018 to 29/09/2018 and from 28/10/2025 to 28/09/2025 in tables presented Sections B.6.3., B.6.4 and also in table presented for the parameter "$EC_{PJ1,y} = EG_{EC1,y}$" and "$EC_{PJ2,y} = EG_{EC2,y}$" in Section B.7.1. The mistake was made during the renewal of the crediting period process and should be amended in order to be in line with 2nd crediting period dates presented in the project activity on UNFCCC's website.

2) Change to the project design regarding to electricity generation plant installed capacity increase, from 4.245 MW to 28.52 MW. The investments into the electricity generators were not under the PP's control.

3) Change to project design regarding LFG collection efficiency amended from 40% to 85%. The investments into the collection system were not under the PP's control.

4) Change to project design regarding update electricity plant load factor from 91% to 95%, not under PP´s control.

5) Permanent Changes in the cashflow considering amendments of key parameters, not under PP´s control and due to availability of waste disposed in the landfill.
    a. Exchange rate used for the investment analysis: from 1.80 R$/US$ and 2.2 R$/Euro to 3.97 BRL/EUR;
    b. Generation capacity: from 8.49 to 28.520 MW
        i. Energy price: From 148.39 R$/MWh to 170.00 R$/MWh
    c. Generation of electricity amended in:
        i. 2012 to 2018 as 0 MWh/year
        ii. 2019: 10 units X 1.426 MW, total 14.260 MW
        iii. 2020: 12 units X 1.426 MW, total 17.112 MW
        iv. 2021: 16 units X 1.426 MW, total 22.816 MW
        v. 2022: 18 units X 1.426 MW, total 25.668 MW
        vi. 2023-2030: 9 units X 1.426 MW, total 28.520 MW
    d. O&M electricity costs amended: 300,000 R$/year (fixed) and 100 R$/MWh.
    e. Extraordinary maintenance cost for gas engines:
        i. From 1,785,097 R$/year(2019) to 0 R$/year(2019)
        ii. In 2026, for 10 engines is estimated at: R$ 9,832,771
        iii. In 2027, for 10 engines is estimated at: R$ 2,055,049
        iv. In 2028, for 10 engines is estimated at: R$ 4,110,098
        v. In 2029, for 10 engines is estimated at: R$ 2,055,049
        vi. In 2030, for 10 engines is estimated at: R$ 2,055,049
    f. O&M LFG system costs: sum from 2010 to 2030 of 11,613,098 R$ to sum from 2010 to 2030 to 74,452,575 R$
    g. Investment on Electricity generation plant: from 14,299,218 R$ (2011) and 17,819,427 R$ (2016) to 25,879,796 (2019), 4,869,867 (2020), 9,739,733 (2021), 4,869,867 (2022) and 4,869,867 (2023).
    h. "Electricity Schedule" sheet included

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

>>
Not applicable.

SECTION C. Description of monitoring system

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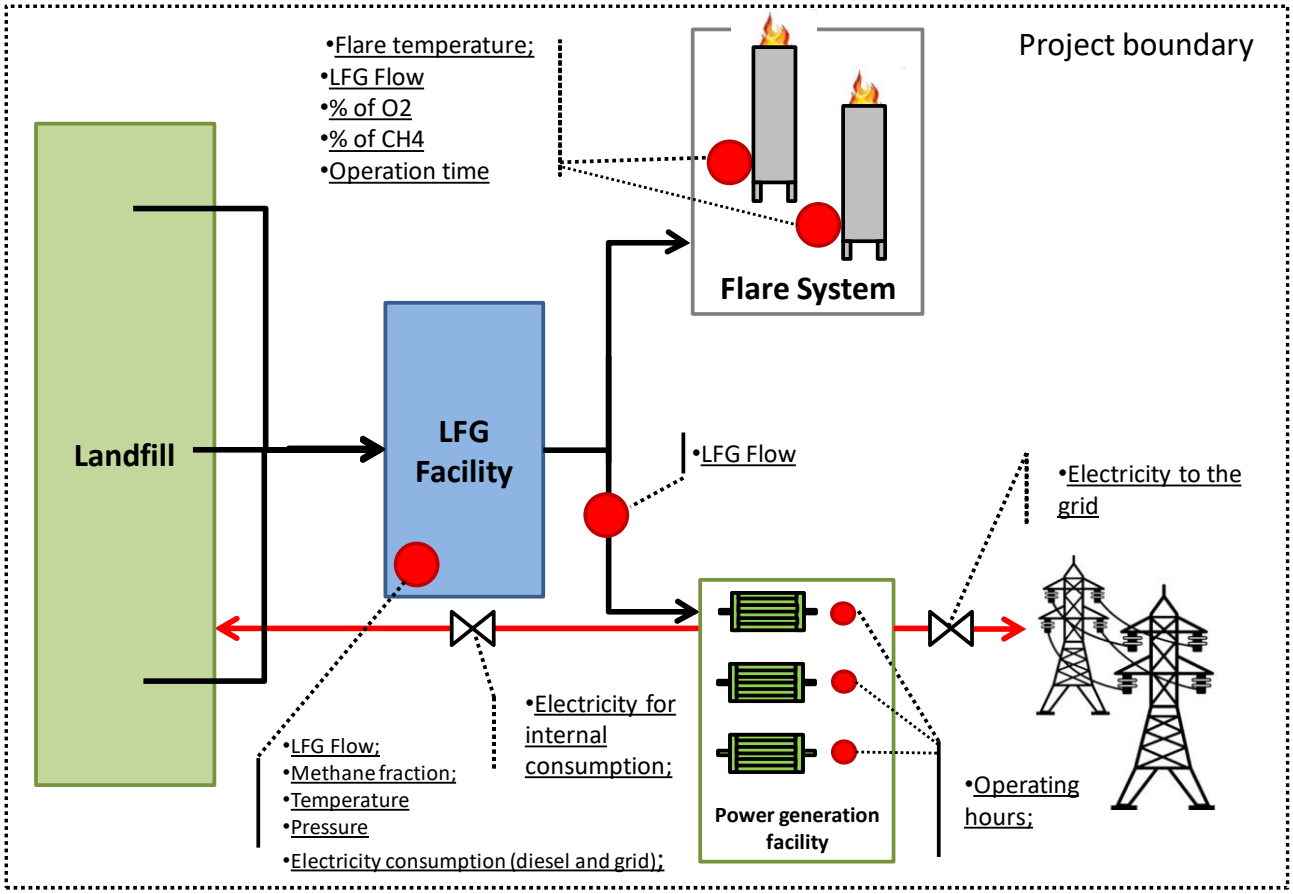
The monitoring equipment and their location are presented in below.



Considering the monitoring parameters presented in the registered PDD, it is important to highlight the current monitoring system situation for the present monitoring period:

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

All monitoring instruments were running properly and calibrated (some period were identified with delayed calibration and the procedures defined paragraph 369 of the CDM validation and verification standard for project activities have been adopted) during this monitoring period.

Type	Manufacturer	Model	Location	Range
Flow Meter Flare[14]	ABB	TRIO WIRL ST42	Flare pipeline	0 - 3600 Nm³/h
Flow Meter Main line[15]	FCI	ST51	Main pipeline	0.3 to 400 sfps
Temperature meter Flare (Thermocouple)	ELSI	M1 - Type S	Flare Unit	0 to 1600°C
	ECIL	Tipo K		0 to 1260 °C
Methane content analyzer in the residual gas	Siemens	ULTRAMAT 23	Main pipeline	0 to 100% CH4
LFG temperature meter	FCI	ST51	Main pipeline	0.3 to 400 sfps
LFG Pressure meter	Honeywell	STG 73S	Main pipeline	-1 to 3.5 bar

[14] Flow meter automatically converts the flow to Nm3.

[15] Flow meter automatically converts the flow to Nm3.

Volumetric fraction of O2 in the exhaust gas of the flare / Concentration of methane in the exhaust gas of the flare	Siemens	ULTRAMAT 23	Flare Unit	0 - 2500 ppm CH4 0 - 25% O2
Eletricity exported and consumed from the grid	SCHNEIDER	ION 8650	Electricity Cabin	0 - 20A

Table 3 – Monitoring instruments

All data are electronically collected and continually stored in a server.
The errors and uncertainties applied in the relevant monitoring period are presented below:

Parameter name	Range	Accuracy	Manufacturer	Model	Serial number	Starting Period	Finishing Period	Calibration frequency	Date of Calibration	Validity	Error used in data discount (%)
Methane fraction in the landfill gas	0 - 100% CH4	2%	SIEMENS	Ultramat 23	N1H8060	26/07/2019	17/01/2020	1 year	18/01/2019	17/01/2020	-
						18/01/2020	06/02/2020		Delayed		2.00%
						07/02/2020	02/03/2020		07/02/2020	06/02/2021	-
Values of the Volumetric fraction of O2 in the exhaust gas of the flare / Concentration of methane in the exhaust gas of the flare	0 - 2500 ppm CH4 0 - 25% O2	2% CH4 0.05% O2	SIEMENS	Ultramat 23	N1C7779	26/07/2019	21/01/2020	1 year	22/01/2019	21/01/2020	-
						22/01/2020	06/02/2020		Delayed		2% CH4 0.05% O2
						07/02/2020	02/03/2020		07/02/2020	06/02/2021	-
Eletricity exported and consumed from the grid	0 - 20A	0.10%	SCHNEIDER	ION 8650	MW-1807A325-02	26/07/2019	02/03/2020	5 years	22/11/2018	21/11/2023	-
Amount of landfill gas to generators - FT03 (**Main line**)	0.3 to 400 sfps	2%	FCI	ST51	662114	26/07/2019	31/01/2020	3 years	19/11/2018	18/11/2021	-
					678921	01/02/2020	02/03/2020		18/11/2019	17/11/2022	-
Amount of landfill gas flared - FT04 (**Flare 1**)	0 - 3600 Nm³/h	0.50%	ABB	TRIO WIRL ST42	242540862/X001	26/07/2019	02/03/2020	3 years	25/08/2017	24/08/2020	-
LFG Pressure (PT05)	-1 to 3.5 bar	0.02%	Honeywell	STG 73S	C4000005594899	26/07/2019	02/03/2020	2 years	19/06/2018	18/06/2020	-
LFG Temperature (TT06)	0.3 to 400 sfps	2%	FCI	ST51	662114	26/07/2019	30/01/2020	18 months	19/11/2018	18/05/2020	-
			FCI	ST51	678921	31/01/2020	02/03/2020		18/11/2019	17/05/2021	-
Exhaust gas temperature (TT09)	0 to 1600°C	2.704 °C	ELSI	M1 - Type S	08-14/67559	26/07/2019	14/08/2019	1 year	Delayed		2.704 °C
	0 to 1260 °C	0.40%	ECIL	Tipo K	N1922.933353	15/08/2019	02/03/2020	1 year	23/07/2019	22/07/2020	-

Note: From 29/09/2018 to 25/07/2019, the plant was decommissioned and thus not operational. The recommissioning of the project plant occurred on 26/07/2019, date when electricity commercial operation begins.

SECTION D. Data and parameters

D.1. Data and parameters fixed ex ante

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

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

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	Calculation of baseline emission
Additional comment	Applicable to Step A

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	0.0028 (2017)
Choice of data or Measurement methods and procedures	Brazilian DNA

Purpose of data	Calculation of baseline emission
Additional comment	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.

Data/Parameter	GWP_{CH4}
Unit	t CO_2e/t CH_4
Description	Global warming potential of CH_4
Source of data	IPCC
Value(s) applied	25. Updated for the 2nd commitment period according to COP/MOP decisions[16]
Choice of data or measurement methods and procedures	Default value used, according to IPCC Fourth Assessment Report: Climate Change 2007, item 2.10.2: Direct Global Warming Potentials, Table 2.14
Purpose of data/parameter	Calculation of baseline emission
Additional comments	-

Data/Parameter	$SPEC_{flare}$
Unit	Temperature - °C Flow rate - Nm³/h Maintenance schedule - number of days
Description	Manufacturer's flare specifications for temperature, flow rate and maintenance schedule
Source of data	Flare Manufacturer
Value(s) applied	Flare model: 2500 HT Minimum flare temperature: 850 ºC Maximum flare temperature: 1200 ºC Minimum and maximum inlet flow rate: Minimum flow: 500 Nm³/h * --- Maximum flow: 2,500 Nm³/h Maximum duration in days between maintenance events: 7 days[17]

[16] 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 11/01/2018 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 11/01/2018.

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

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

Data/Parameter	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	Calculation of baseline emissions
Additional comment	-

Data / Parameter	MM_k
Unit	kg/kmol

Description	Molecular mass of gas *k*
Source of data	Tool to determine the mass flow of a greenhouse gas in a gaseous stream
Value(s) applied	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	Calculation of baseline emissions
Additional comment	-

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	Calculation of baseline emissions
Additional comment	-

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:

- $P_{H20,t,Sat}$: Saturation pressure of H_2O at temperature Tt in time interval t
- $F_{CH4,EG,t}$: Mass flow of methane in the exhaust gas of the flare on a dry basis at reference conditions in the time period t
- $EC_{PJ2,y} = EG_{EC2,y}$: Quantity of electricity consumed from diesel generator by the project activity during the year y
- $V_{t,w,b}$: Volumetric flow of the gaseous stream in time interval t on a wet basis
- $V_{i,t,wb}$: Volumetric fraction of greenhouse gas i in a time interval t on a wet basis
- $EC_{PJ2,y} = EG_{EC2,y}$: Quantity of electricity consumed from the grid by the project activity during the year y.
- $V_{t,wb}$: Volumetric flow of the gaseous stream in time interval t on a wet basis
- $v_{i,t,wb}$: Volumetric fraction of greenhouse gas I in a time interval t on a wet basis
- $P_{H2O,t,Sat}$: Saturation pressure of H_2O at temperature Tt in time interval t

Baseline, project and/or leakage emission from electricity consumption and monitoring of electricity generation

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 as the weighted average of the dispatch data analysis OM (Operating Margin) and the BM (Build margin).
Source of data	Brazilian DNA
Value(s) of monitored parameter	0.1316 (2019) 0.1316 (2020)
Monitoring equipment	Not applicable
Measuring/reading/recording frequency:	Annual
Calculation method (if applicable):	Value applicable is calculated by considering the applicable guidance of 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	Calculation of baseline/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.

Data/parameter:	$EF_{grid,OM,y}$
Unit	tCO_2/MWh

Description	Operating margin emission factor of the Brazilian grid
Measured/calculated/default	Calculated (based on official monthly values as calculated and published by the DNA of Brazil).
Source of data	Brazilian DNA
Value(s) of monitored parameter	0.5181 (2019) 0.5181 (2020)
Monitoring equipment	Not applicable
Measuring/reading/recording frequency:	Annual
Calculation method (if applicable):	Value applicable is calculated by considering the applicable guidance of 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	Calculation of baseline/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. In the absence of data for 2020 so far, it was adopted the data from 2019.

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	Default value
Source of data	Default value as per the "Tool to calculate baseline, project and/or leakage emissions from electricity consumption"
Value(s) of monitored parameter	23.6%
Monitoring equipment	Not applicable
Measuring/reading/recording frequency:	Annually. In the absence of data from the relevant year, most recent figures should be used, but not older than 5 years
Calculation method (if applicable):	Not applicable
QA/QC procedures	-
Purpose of data/parameter	Calculation of baseline/project emissions or actual net GHG removals by sinks;
Additional comments	The data was based National Energy Balance 2020[18]

[18] National Energy Balance (26.3% for 2019 is the most recent data) Source: https://www.epe.gov.br/sitespt/publicacoes-dados-abertos/publicacoes/PublicacoesArquivos/publicacao-479/topico521/Relato%CC%81rio%20Si%CC%81ntese%20BEN%202020-ab%202019_Final.pdf

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;
Measured/calculated/default	Continuously measured by electricity meter.
Source of data	Measurement from Project participants.
Value(s) of monitored parameter	The CERs calculation spreadsheet includes all records of measurement data of this parameter during the considered monitoring period.
Monitoring equipment	<table><tr><td>Parameter name</td><td>Eletricity exported and consumed from the grid</td></tr><tr><td>Range</td><td>0 - 20A</td></tr><tr><td>Accuracy</td><td>0.10%</td></tr><tr><td>Manufacturer</td><td>SCHNEIDER</td></tr><tr><td>Model</td><td>ION 8650</td></tr><tr><td>Serial number</td><td>MW-1807A325-02</td></tr><tr><td>Starting Period</td><td>26/07/2019</td></tr><tr><td>Finishing Period</td><td>02/03/2020</td></tr><tr><td>Calibration frequency</td><td>5 years</td></tr><tr><td>Date of Calibration</td><td>22/11/2018</td></tr><tr><td>Validity</td><td>21/11/2023</td></tr><tr><td>Error used in data discount (%)</td><td>-</td></tr></table>
Measuring/reading/recording frequency:	Continuously
Calculation method (if applicable):	Not applicable
QA/QC procedures	As per the “Methodological tool: Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation” According to electricity reports provided by the local Electricity Trader Company (main data) and Electricity Chamber Company (cross check data).
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.

ACM0001: Flaring or use of landfill gas

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 May 2020: • 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):	Not applicable
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 by Project Participant
Source of data	Electricity meter
Value(s) of monitored parameter	The CERs calculation spreadsheet includes all records of measurement data of this parameter during the considered monitoring period.

Monitoring equipment	<table><tr><td>Parameter name</td><td>Eletricity exported and consumed from the grid</td></tr><tr><td>Range</td><td>0 - 20A</td></tr><tr><td>Accuracy</td><td>0.10%</td></tr><tr><td>Manufacturer</td><td>SCHNEIDER</td></tr><tr><td>Model</td><td>ION 8650</td></tr><tr><td>Serial number</td><td>MW-1807A325-02</td></tr><tr><td>Starting Period</td><td>26/07/2019</td></tr><tr><td>Finishing Period</td><td>02/03/2020</td></tr><tr><td>Calibration frequency</td><td>5 years</td></tr><tr><td>Date of Calibration</td><td>22/11/2018</td></tr><tr><td>Validity</td><td>21/11/2023</td></tr><tr><td>Error used in data discount (%)</td><td>-</td></tr></table>
Measuring/reading/recording frequency:	Continuous
Calculation method (if applicable):	Not applicable
QA/QC procedures	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" According to electricity reports provided by the local Electricity Trader Company (main data) and Electricity Chamber Company (cross check data).
Purpose of data/parameter	(b) Calculation of project emissions or actual net GHG removals by sinks;
Additional comments	It is important to clarify that first three Group Generators included in this project activity operated on test basis until 29/07/2019, being their commissioning on 30/07/2019. Nevertheless, the amount of CERs generated due to the electricity generation is requested only from 26/07/2019, date that corresponds to the beginning of the commercial dispatch authorized by ANEEL (Brazilian Electricity Energy Agency).

Data/parameter:	$O_{pj,h}$
Unit	-
Description	Operation of the equipment that consumes the LFG

Measured/calculated/default	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, $O_{pj,h}$=1
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	The CERs calculation spreadsheet includes all records of measurement data of this parameter during the considered monitoring period.
Monitoring equipment	Flame detection system / Flares temperature meters
Measuring/reading/recording frequency:	Once per minute
Calculation method (if applicable):	Not 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	-

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

Data/parameter:	$V_{t,db} = V_{RG,m}$
Unit	m³ /hyyy
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
Value(s) of monitored parameter	The CERs calculation spreadsheet includes all records of measurement data of this parameter during the considered monitoring period.

<table>
<tr><td>Monitoring equipment</td><td>
<table>
<tr><td>Parameter name</td><td colspan="2">Amount of landfill gas to generators - FT03 (Main line)</td><td>Amount of landfill gas flared - FT04 (Flare 1)</td></tr>
<tr><td>Range</td><td colspan="2">0.3 to 400 sfps</td><td>0 - 3600 Nm³/h</td></tr>
<tr><td>Accuracy</td><td colspan="2">2%</td><td>0.50%</td></tr>
<tr><td>Manufacturer</td><td colspan="2">FCI</td><td>ABB</td></tr>
<tr><td>Model</td><td colspan="2">ST51</td><td>TRIO WIRL ST42</td></tr>
<tr><td>Serial number</td><td>662114</td><td>678921</td><td>242540862/X001</td></tr>
<tr><td>Starting Period</td><td>26/07/2019</td><td>01/02/2020</td><td>26/07/2019</td></tr>
<tr><td>Finishing Period</td><td>31/01/2020</td><td>02/03/2020</td><td>02/03/2020</td></tr>
<tr><td>Calibration frequency</td><td colspan="2">3 years</td><td>3 years</td></tr>
<tr><td>Date of Calibration</td><td>19/11/2018</td><td>18/11/2019</td><td>25/08/2017</td></tr>
<tr><td>Validity</td><td>18/11/2021</td><td>17/11/2022</td><td>24/08/2020</td></tr>
<tr><td>Error used in data discount (%)</td><td>-</td><td>-</td><td>-</td></tr>
</table>
</td></tr>
<tr><td>Measuring/reading/recording frequency:</td><td>Continuous recorded and hourly aggregated</td></tr>
<tr><td>Calculation method (if applicable):</td><td>Not applicable</td></tr>
<tr><td>QA/QC procedures</td><td>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.</td></tr>
<tr><td>Purpose of data/parameter</td><td>(a) Calculation of baseline emissions or baseline net GHG removals by sinks;</td></tr>
<tr><td>Additional comments</td><td>The design of the installed LFG flow meter for measuring the LFG flow to the flare ensures that measurement data is automatically converted and recorded in normal cubic meters per hour (Nm3 /h). Due to that, as further explained in Section D.1, measurements of LFG pressure and LFG temperature are not required for determining $V_{t,db}$
Monitored in case of Option A from tool</td></tr>
</table>

Data/parameter:	$v_{i,t,db} = v_{i,RG,m}$
Unit	m^3 gas i/m^3 dry gas
Description	Volumetric fraction of greenhouse gas i in a time interval t on a dry basis
Measured/calculated/default	Continuously measured by continuous CH_4 content gas analyzer.
Source of data	Measured as part of the operation of the project activity by applying appropriate monitoring instruments (CH_4 content gas analyzer)
Value(s) of monitored parameter	The CERs calculation spreadsheet includes all records of measurement data of this parameter during the considered monitoring period.

Monitoring equipment	<table><tr><td>Parameter name</td><td colspan="3">Methane fraction in the landfill gas</td></tr><tr><td>Range</td><td colspan="3">0 - 100% CH4</td></tr><tr><td>Accuracy</td><td colspan="3">2%</td></tr><tr><td>Manufacturer</td><td colspan="3">SIEMENS</td></tr><tr><td>Model</td><td colspan="3">Ultramat 23</td></tr><tr><td>Serial number</td><td colspan="3">N1H8060</td></tr><tr><td>Starting Period</td><td>26/07/2019</td><td>18/01/2020</td><td>07/02/2020</td></tr><tr><td>Finishing Period</td><td>17/01/2020</td><td>06/02/2020</td><td>02/03/2020</td></tr><tr><td>Calibration frequency</td><td colspan="3">1 year</td></tr><tr><td>Date of Calibration</td><td>18/01/2019</td><td rowspan="2">Delayed</td><td>07/02/2020</td></tr><tr><td>Validity</td><td>17/01/2020</td><td>06/02/2021</td></tr><tr><td>Error used in data discount (%)</td><td>-</td><td>2.00%</td><td>-</td></tr></table>
Measuring/reading/recording frequency:	Continuous recorded and hourly aggregated
Calculation method (if applicable):	Not 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	-

Data/parameter:	T_t
Unit	K
Description	Temperature of the gaseous stream in time interval t
Measured/calculated/default	Measured by Project Participant using temperature sensor
Source of data	Measured as part of the operation of the project activity by applying appropriate monitoring instruments (temperature sensor)
Value(s) of monitored parameter	The CERs calculation spreadsheet includes all records of measurement data of this parameter during the considered monitoring period.

Monitoring equipment	<table><tr><td>Parameter name</td><td colspan="2">LFG Temperature (TT06)</td></tr><tr><td>Range</td><td colspan="2">0.3 to 400 sfps</td></tr><tr><td>Accuracy</td><td colspan="2">2%</td></tr><tr><td>Manufacturer</td><td>FCI</td><td>FCI</td></tr><tr><td>Model</td><td>ST51</td><td>ST51</td></tr><tr><td>Serial number</td><td>662114</td><td>678921</td></tr><tr><td>Starting Period</td><td>26/07/2019</td><td>31/01/2020</td></tr><tr><td>Finishing Period</td><td>30/01/2020</td><td>02/03/2020</td></tr><tr><td>Calibration frequency</td><td colspan="2">18 months</td></tr><tr><td>Date of Calibration</td><td>19/11/2018</td><td>18/11/2019</td></tr><tr><td>Validity</td><td>18/05/2020</td><td>17/05/2021</td></tr><tr><td>Error used in data discount (%)</td><td>-</td><td>-</td></tr></table>
Measuring/reading/recording frequency:	Continuous
Calculation method (if applicable):	Not 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	Measurements by Project participant using a pressure meter
Source of data	Measured as part of the operation of the project activity by applying appropriate monitoring instruments (pressure meter)
Value(s) of monitored parameter	The CERs calculation spreadsheet includes all records of measurement data of this parameter during the considered monitoring period.

Monitoring equipment	<table><tr><td>Parameter name</td><td>LFG Pressure (PT05)</td></tr><tr><td>Range</td><td>-1 to 3.5 bar</td></tr><tr><td>Accuracy</td><td>0.02%</td></tr><tr><td>Manufacturer</td><td>Honeywell</td></tr><tr><td>Model</td><td>STG 73S</td></tr><tr><td>Serial number</td><td>C4000005594899</td></tr><tr><td>Starting Period</td><td>26/07/2019</td></tr><tr><td>Finishing Period</td><td>02/03/2020</td></tr><tr><td>Calibration frequency</td><td>2 years</td></tr><tr><td>Date of Calibration</td><td>19/06/2018</td></tr><tr><td>Validity</td><td>18/06/2020</td></tr><tr><td>Error used in data discount (%)</td><td>-</td></tr></table>
Measuring/reading/recording frequency:	Continuous
Calculation method (if applicable):	Not applicable
QA/QC procedures	Periodic calibration against a primary device must be performed periodically and records of calibration procedures must be kept available as well as the primary device and its calibration certificate. Pressure transducers (either capacitive or resistive) must be calibrated monthly. 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	Measured by Project Participant
Source of data	Flame detector
Value(s) of monitored parameter	-
Monitoring equipment	UV flame detector
Measuring/reading/recording frequency:	Continuous
Calculation method (if applicable):	Not applicable
QA/QC procedures	-
Purpose of data/parameter	(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"

Methodological tool "Project emissions from flaring"

Data/parameter:	$Flame_m$
Unit	Flame on or Flame off
Description	Flame detection of flare in the minute m
Measured/calculated/default	Measurements by project participants using a continuous Ultra Violet flame detector
Source of data	Whenever flame is detected in the flare, flame status "on" or "1" value is attributed. Whenever no flame is detected in the flare, flame status "off" or "0" is attributed.
Value(s) of monitored parameter	The CERs calculation spreadsheet includes all records of measurement data of this parameter during the considered monitoring period.
Monitoring equipment	UV flame detectors in each flare
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):	Not 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[19].
Additional comments	-

Data/parameter:	$Maintenance_y$
Unit	Calendar dates
Description	Maintenance events completed in year y
Measured/calculated/default	-
Source of data	Project participants maintenance logs
Value(s) of monitored parameter	As per the applied maintenance practice for the project activity, general inspection services on the flares are performed daily. Performed maintenance and overhauling services in the flare are performed under by specialized technical service team under conformance with maintenance requirements for the flares (as established by equipment manufacturer) and as required by the ex-ante determined parameter SPECflare. Further details about the parameter SPECflare are included in Section D.1.
Monitoring equipment	Not applicable
Measuring/reading/recording frequency:	Daily
Calculation method (if applicable):	Not applicable
QA/QC procedures	Records must be kept in a maintenance log for two years beyond the life of the flare

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

Purpose of data/parameter	Calculation of baseline and project emissions when the flame is on[20].
Additional comments	Monitoring of this parameter is required for the case of enclosed flares and the project participant selects Option B to determine flare efficiency. These dates are required so that they can be compared to the maintenance schedule to check that maintenance events were completed within the minimum time between maintenance events specified by the manufacturer ($SPEC_{,flare}$).

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

Data/parameter:	$T_{EG,m}$
Unit	º C
Description	Temperature in the exhaust gas of the enclosed flare in minute m
Measured/calculated/default	Measurements by project participants with thermocouples installed in each enclosed flares
Source of data	Measured as part of the operation of the project activity by applying appropriate monitoring instruments (thermocouples)
Value(s) of monitored parameter	The CERs calculation spreadsheet includes all records of measurement data of this parameter during the considered monitoring period.
Monitoring equipment	<table><tr><td>Parameter name</td><td colspan="2">Exhaust gas temperature (TT09)</td></tr><tr><td>Range</td><td>0 to 1600°C</td><td>0 to 1260 °C</td></tr><tr><td>Accuracy</td><td>2.704 °C</td><td>0.40%</td></tr><tr><td>Manufacturer</td><td>ELSI</td><td>ECIL</td></tr><tr><td>Model</td><td>M1 - Type S</td><td>Tipo K</td></tr><tr><td>Serial number</td><td>08-14/67559</td><td>N1922.933353</td></tr><tr><td>Starting Period</td><td>26/07/2019</td><td>15/08/2019</td></tr><tr><td>Finishing Period</td><td>14/08/2019</td><td>02/03/2020</td></tr><tr><td>Calibration frequency</td><td>1 year</td><td>1 year</td></tr><tr><td>Date of Calibration</td><td rowspan="2">Delayed</td><td>23/07/2019</td></tr><tr><td>Validity</td><td>22/07/2020</td></tr><tr><td>Error used in data discount (%)</td><td>2.704 °C</td><td>-</td></tr></table>
Measuring/reading/recording frequency:	Once per minute
Calculation method (if applicable):	Not applicable
QA/QC procedures	Thermocouples will be replaced or calibrated every year
Purpose of data/parameter	(b) Calculation of project emissions or actual net GHG removals by sinks;
Additional comments	-

Data/parameter:	$v_{i,RG,m} = v_{i,t,db}$
Unit	-
Description	Volumetric fraction of component i in the residual gas on a dry basis in the minute
Measured/calculated/default	Measurements by project participants using a continuous gas analyser
Source of data	Measurements by project participants using a continuous gas analyser
Value(s) of monitored parameter	The CERs calculation spreadsheet includes all records of measurement data of this parameter during the considered monitoring period.

Monitoring equipment	<table><tr><td>Parameter name</td><td colspan="3">Methane fraction in the landfill gas</td></tr><tr><td>Range</td><td colspan="3">0 - 100% CH4</td></tr><tr><td>Accuracy</td><td colspan="3">2%</td></tr><tr><td>Manufacturer</td><td colspan="3">SIEMENS</td></tr><tr><td>Model</td><td colspan="3">Ultramat 23</td></tr><tr><td>Serial number</td><td colspan="3">N1H8060</td></tr><tr><td>Starting Period</td><td>26/07/2019</td><td>18/01/2020</td><td>07/02/2020</td></tr><tr><td>Finishing Period</td><td>17/01/2020</td><td>06/02/2020</td><td>02/03/2020</td></tr><tr><td>Calibration frequency</td><td colspan="3">1 year</td></tr><tr><td>Date of Calibration</td><td>18/01/2019</td><td rowspan="2">Delayed</td><td>07/02/2020</td></tr><tr><td>Validity</td><td>17/01/2020</td><td>06/02/2021</td></tr><tr><td>Error used in data discount (%)</td><td>-</td><td>2.00%</td><td>-</td></tr></table>
Measuring/reading/recording frequency:	Once per minute
Calculation method (if applicable):	Not applicable
QA/QC procedures	Analysers must be periodically calibrated according to the manufacturer's recommendation. A zero check and a typical value check should be performed by comparison with a standard certified gas
Purpose of data/parameter	(b) Calculation of project emissions or actual net GHG removals by sinks;
Additional comments	-

Data/parameter:	$V_{RG,m} = V_{t,db}$
Unit	m^3
Description	Volumetric flow of the residual gas on a dry basis at reference conditions in the minute m
Measured/calculated/default	Measurements by project participants using a flow meter
Source of data	Measurements by project participants using a flow meter
Value(s) of monitored parameter	The CERs calculation spreadsheet includes all records of measurement data of this parameter during the considered monitoring period.
Monitoring equipment	<table><tr><td>Parameter name</td><td colspan="2">Amount of landfill gas to generators - FT03 (**Main line**)</td><td>Amount of landfill gas flared - FT04 (**Flare 1**)</td></tr><tr><td>Range</td><td colspan="2">0.3 to 400 sfps</td><td>0 - 3600 Nm³/h</td></tr><tr><td>Accuracy</td><td colspan="2">2%</td><td>0.50%</td></tr><tr><td>Manufacturer</td><td colspan="2">FCI</td><td>ABB</td></tr><tr><td>Model</td><td colspan="2">ST51</td><td>TRIO WIRL ST42</td></tr><tr><td>Serial number</td><td>662114</td><td>678921</td><td>242540862/X001</td></tr><tr><td>Starting Period</td><td>26/07/2019</td><td>01/02/2020</td><td>26/07/2019</td></tr><tr><td>Finishing Period</td><td>31/01/2020</td><td>02/03/2020</td><td>02/03/2020</td></tr><tr><td>Calibration frequency</td><td colspan="2">3 years</td><td>3 years</td></tr><tr><td>Date of Calibration</td><td>19/11/2018</td><td>18/11/2019</td><td>25/08/2017</td></tr><tr><td>Validity</td><td>18/11/2021</td><td>17/11/2022</td><td>24/08/2020</td></tr><tr><td>Error used in data discount (%)</td><td>-</td><td>-</td><td>-</td></tr></table>
Measuring/reading/recording frequency:	Once per minute
Calculation method (if applicable):	Not applicable
QA/QC procedures	Flow meters are to be periodically calibrated according to the manufacturer's recommendation

Purpose of data/parameter	(b) Calculation of project emissions or actual net GHG removals by sinks;
Additional comments	-

Data/parameter:	$M_{RG,m}$
Unit	kg
Description	Mass flow of the residual gas on a dry basis at reference conditions in the minute m
Measured/calculated/default	Calculated by project participants using a flow meter and gas density
Source of data	Measurements by project participants using a flow meter
Value(s) of monitored parameter	The CERs calculation spreadsheet includes all records of measurement data of this parameter during the considered monitoring period.
Monitoring equipment	
Measuring/reading/recording frequency:	Once per minute
Calculation method (if applicable):	Multiplication of gas volume by gas density
QA/QC procedures	Flow meters are to be periodically calibrated according to the manufacturer's recommendation
Purpose of data/parameter	(b) Calculation of project emissions or actual net GHG removals by sinks;
Additional comments	-

Parameter name	Amount of landfill gas to generators - FT03 (**Main line**)		Amount of landfill gas flared - FT04 (**Flare 1**)
Range	0.3 to 400 sfps		0 - 3600 Nm³/h
Accuracy	2%		0.50%
Manufacturer	FCI		ABB
Model	ST51		TRIO WIRL ST42
Serial number	662114	678921	242540862/X001
Starting Period	26/07/2019	01/02/2020	26/07/2019
Finishing Period	31/01/2020	02/03/2020	02/03/2020
Calibration frequency	3 years		3 years
Date of Calibration	19/11/2018	18/11/2019	25/08/2017
Validity	18/11/2021	17/11/2022	24/08/2020
Error used in data discount (%)	-	-	-

Data/parameter:	$v_{O2,EG,m}$
Unit	-
Description	Volumetric fraction of O2 in the exhaust gas on a dry basis at reference conditions in the minute m
Measured/calculated/default	Measurements by project participants using a continuous gas analyser
Source of data	Measurements by project participants using a continuous gas analyser
Value(s) of monitored parameter	The CERs calculation spreadsheet includes all records of measurement data of this parameter during the considered monitoring period.

Monitoring equipment	<table><tr><td>Parameter name</td><td colspan="3">Values of the Volumetric fraction of O2 in the exhaust gas of the flare / Concentration of methane in the exhaust gas of the flare</td></tr><tr><td>Range</td><td colspan="3">0 - 2500 ppm CH4 0 - 25% O2</td></tr><tr><td>Accuracy</td><td colspan="3">2% CH4 0.05% O2</td></tr><tr><td>Manufacturer</td><td colspan="3">SIEMENS</td></tr><tr><td>Model</td><td colspan="3">Ultramat 23</td></tr><tr><td>Serial number</td><td colspan="3">N1C7779</td></tr><tr><td>Starting Period</td><td>26/07/2019</td><td>22/01/2020</td><td>07/02/2020</td></tr><tr><td>Finishing Period</td><td>21/01/2020</td><td>06/02/2020</td><td>02/03/2020</td></tr><tr><td>Calibration frequency</td><td colspan="3">1 year</td></tr><tr><td>Date of Calibration</td><td>22/01/2019</td><td rowspan="2">Delayed</td><td>07/02/2020</td></tr><tr><td>Validity</td><td>21/01/2020</td><td>06/02/2021</td></tr><tr><td>Error used in data discount (%)</td><td>-</td><td>2% CH4 0.05% O2</td><td>-</td></tr><tr><td>Calibration coverage status</td><td>ok</td><td>error</td><td>ok</td></tr><tr><td>Maximum permissible error from manufacturer (%)</td><td></td><td>2% CH4 0.05% O2</td><td></td></tr><tr><td>Error identified in the delayed calibration test (%)</td><td></td><td>0.6% CH4 0.2% O2</td><td></td></tr></table>
Measuring/reading/recording frequency:	Once per minute
Calculation method (if applicable):	Not applicable
QA/QC procedures	Analysers must be periodically calibrated according to the manufacturer's recommendation. A zero check and a typical value check should be performed by comparison with a standard certified gas
Purpose of data/parameter	(b) Calculation of project emissions or actual net GHG removals by sinks;
Additional comments	-

Data/parameter:	$fc_{CH4,EG,m}$
Unit	mg/m3
Description	Concentration of methane in the exhaust gas of the flare on a dry basis at reference conditions in the minute m
Measured/calculated/default	Measurements by project participants using a continuous gas analyser
Source of data	Measurements by project participants using a continuous gas analyser
Value(s) of monitored parameter	The CERs calculation spreadsheet includes all records of measurement data of this parameter during the considered monitoring period.

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</table>

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

>>

Baseline emission calculation

The table below shows the consolidated collected and calculated data for the current monitoring period.

	BE,y	BEEC,y	BECH4,y	FCH4PJ,y	FCH4BL,y	FCH4flared,y	FCH4EL,y	% CH4	FCH4 sentflare,y	ECBL	Total methane for Group generators	Total methane to Flare	FCH4RG,t	PEflare,y
	tCO2	tCO2	tCO2	tCH4	tCH4	tCH4	tCH4	%	tCH4	MWh	Nm³CH4	Nm³CH4	kg	tCO2
07/2019	493	36	457	26	5	0.0	26	53.4%	81.9	217	36,490	114,432	82	2,048
08/2019	11,260	746	10,515	601	120	0.0	601	49.4%	7.2	4,486	839,148	10,097	7	181
09/2019	15,267	954	14,314	818	164	0.2	818	48.0%	10.2	5,736	1,142,098	14,228	10,187	250
10/2019	28,977	1,247	27,731	1,585	317	47.7	1,537	52.2%	90.1	7,503	2,146,473	125,786	90,063	1,058
11/2019	27,795	1,424	26,372	1,507	301	39.9	1,467	51.1%	65.7	8,563	2,048,935	91,753	65,695	644
12/2019	25,971	1,373	24,598	1,406	281	12.5	1,393	52.8%	95.5	8,262	1,945,652	133,329	95,464	2,074
01/2020	26,946	1,394	25,553	1,460	292	55.7	1,404	49.6%	131.6	8,386	1,961,527	183,850	131,637	1,898
02/2020	24,203	1,476	22,727	1,299	260	4.2	1,294	46.3%	19.6	8,877	1,807,951	27,436	19,644	386
Until 02/03/2020	2,302	104	2,199	126	25	0.2	125	50.4%	3.8	623	175,217	5,370	3,845	91

The baseline emission was calculated according to the following formula:

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

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)

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

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

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

Where:

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

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

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

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

The following requirements apply:

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

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

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

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

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

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

Where:

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

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

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

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

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 (m³ 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 (m³ gas *i*/m³ dry gas)
$\rho_{i,t}$ = Density of greenhouse gas i in the gaseous stream in time interval *t* (kg gas *i*/m³ gas *i*)
P_t = Absolute pressure of the gaseous stream in time interval *t* (Pa)
MM_i = Molecular mass of greenhouse gas *i* (kg/kmol)
R_u = Universal ideal gases constant (8,314 Pa.m³/kmol.K)
T_t = Temperature of the gaseous stream in time interval *t* (K)

$PE_{flare,y}$ 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.

Enclosed flare(s) have been installed in the project activity to increase the destruction efficiency. Those flares reach 99% (minimum)[21] of methane destruction efficiency.

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;

[21] The document about the specification of the flare efficiencies has been provided to DOE.

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.

Step 2: Determination of flare efficiency

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

Option A: Apply a default value for flare efficiency

Option B: Measure the flare efficiency.

The project participant has chosen Option B.

In the present project activity the flare efficiency for minute m (ηflare,m) will be determined by Option B.1 of the methodological tool "Project emissions from flaring", where the flare efficiency is measured in a biannual basis or, if the biannual measurements are not available, Option A of the methodological tool "Project emissions from flaring" will be used. Both options are described below:

For enclosed flares that are defined as low height flares, which is the case of the project activity, the flare efficiency in the minute m ($n_{flare,m}$) shall be adjusted, as a conservative approach, by subtracting 0.1 from the efficiency as determined in Option A. For example, the default value applied should be 80%, rather than 90%, and if for example the measured value was 99%, then the value to be used shall correspond to 89%.

Option A: Default value

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

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

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

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

Option B: Measured flare efficiency

The flare efficiency in the minute *m* is a measured value ($n_{flare,m} = n_{flare,calc,m}$) when the following three conditions are met to demonstrate that the flare is operating:

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

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

In applying Option B, the project participants chose to determine $n_{flare,calc,m}$ using Option B.2 where the measurement of flare efficiency are conducted in each minute.

Option B.2: Measurement of flare efficiency in each minute

The flare efficiency ($\eta_{flare,calc,m}$) is determined based on monitoring the methane content in the exhaust gas, the residual gas, and the air used in the combustion process during the minute m in year y, as follows:

$$\eta_{flare,calc,m} = 1 - \frac{F_{CH4,EG,m}}{F_{CH4,RG,m}}$$

Where:

$\eta_{flare,calc,m}$	=	Flare efficiency in the year y
$F_{CH4,EG,m}$	=	Mass flow of methane in the exhaust gas of the flare on a dry basis at reference conditions in the minute m (kg)
$F_{CH4,RG,m}$	=	Mass flow of methane in the residual gas on a dry basis at reference conditions in the minute m (kg)

$F_{CH4,\ EG,t}$ is measured according to an appropriate national or international standard. $F_{CH4,RG,t}$ is calculated according to Step 1, and consists of the sum of methane flow in the minutes *m* that make up the time period *t*.

Step 2.1: Determine the methane mass flow in the exhaust gas on a dry basis

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

$$F_{CH4,EG,m} = V_{EG,m} \times fc_{CH4,EG,m} \times 10^{-6}$$

Where:

$F_{CH4,EG,m}$	=	Mass flow of methane in the exhaust gas of the flare on a dry basis at reference conditions in the minute m (kg)
$V_{EG,m}$	=	Volumetric flow of the exhaust gas of the flare on a dry basis at reference conditions in minute m (m^3)
$fc_{CH4,EG,m}$	=	Concentration of methane in the exhaust gas of the flare on a dry basis at reference conditions in minute m (mg/m^3)

Step 2.2: Determine the volumetric flow of the exhaust gas ($V_{EG,m}$)

Determine the average volume flow of the exhaust gas in minute m based on a stoichiometric calculation of the combustion process. This depends on the chemical composition of the residual gas, the amount of air supplied to combust it and the composition of the exhaust gas. It is calculated as follows:

$$V_{EG,m} = Q_{EG,m} \times M_{RG,m}$$

Where:

$V_{EG,m}$	=	Volumetric flow of the exhaust gas of the flare on a dry basis at reference conditions in minute m (m^3)
$Q_{EG,m}$	=	Volume of the exhaust gas on a dry basis at reference conditions per kilogram of residual gas on a dry basis at reference conditions in minute m (m^3 exhaust gas/kg residual gas)
$M_{RG,m}$	=	Mass flow of the residual gas on a dry basis at reference conditions in the minute m (kg)

Step 2.3: Determine the mass flow of the residual gas ($M_{RG,m}$)

Project participants may select to monitor the mass flow of the residual gas in minute m directly (see monitored parameter $M_{RG,m}$) or, according to the procedure given in this step, calculate $M_{RG,m}$ based on the volumetric flow and the density of the residual gas. The density of the residual gas is determined based on the volumetric fraction of all components in the gas.

$$M_{RG,m} = \rho_{RG,ref,m} \times V_{RG,m}$$

Where:

$M_{RG,m}$	=	Mass flow of the residual gas on a dry basis at reference conditions in the minute m (kg)
$\rho_{RG,ref,m}$	=	Density of the residual gas at reference conditions in minute m (kg/m^3)
$V_{RG,m}$		Volumetric flow of the residual gas on a dry basis at reference conditions in the minute m (m^3)

And

$$\rho_{RG,ref,m} = \frac{P_{ref}}{\frac{R_u}{MM_{RG,m}} \times T_{ref}}$$

$\rho_{RG,ref,m}$	=	Density of the residual gas at reference conditions in minute m (kg/m^3)
P_{ref}	=	Atmospheric pressure at reference conditions (Pa)
R_u	=	Universal ideal gas constant ($Pa.m^3/kmol.K$)
$MM_{RG,m}$	=	Molecular mass of the residual gas in minute m (kg/kmol)
T_{ref}	=	Temperature at reference conditions (K)

Use the equation below to calculate $MM_{RG,m}$. When applying this equation, project participants may choose to either a) use the measured volumetric fraction of each component i of the residual gas, or b) as a simplification, measure the volumetric fraction of methane and consider the difference to 100% as being nitrogen (N_2). The same equation applies, irrespective of which option is selected.

$$MM_{RG,m} = \sum_i (v_{i,RG,m} \times MM_i)$$

$MM_{RG,m}$	=	Molecular mass of the residual gas in minute m (kg/kmol)
MM_i	=	Molecular mass of residual gas component i (kg/kmol)
$v_{i,RG,m}$	=	Volumetric fraction of component i in the residual gas on a dry basis at reference conditions in the hour h
i	=	Components of the residual gas. If Option (a) is selected to measure the volumetric fraction, then i = CH_4, CO, CO_2, O_2, H_2, H_2S, NH_3, N_2 or if Option (b) is selected then i = CH_4 and N_2

Step 2.4: Determine the volume of the exhaust gas on a dry basis at reference conditions per kilogram of residual gas ($Q_{EG,m}$)

$Q_{ECO2,EG,m}$ shall be determined as follows:

$$Q_{EG,m} = Q_{CO_2,EG,m} + Q_{O_2,EG,m} + Q_{N_2,EG,m}$$

$Q_{EG,m}$	=	Volume of the exhaust gas on a dry basis per kg of residual gas on a dry basis at reference conditions in the minute m (m^3/kg residual gas)
$Q_{CO2,EG,m}$	=	Quantity of CO_2 volume in the exhaust gas per kg of residual gas on a dry basis at reference conditions in the minute m (m^3/kg residual gas)
$Q_{N2,EG,m}$	=	Quantity of N_2 volume in the exhaust gas per kg of residual gas on a dry basis at reference conditions in the minute m (m^3/kg residual gas)
$Q_{O2,EG,m}$	=	Quantity of O_2 volume in the exhaust gas per kg of residual gas on a dry basis at reference conditions in the minute m (m^3/kg residual gas)

With

$$Q_{O_2,EG,m} = n_{O2,EG,m} \times VM_{ref}$$

$Q_{O2,EG,m}$	=	Quantity of O_2 volume in the exhaust gas per kg of residual gas on a dry basis at reference conditions in the minute m (m^3/kg residual gas)
$n_{O2,EG,m}$	=	Quantity of O_2 (moles) in the exhaust gas per kg of residual gas flared on a dry basis at reference conditions in minute m (kmol/kg residual gas)
VM_{ref}	=	Volume of one mole of any ideal gas at reference temperature and pressure (m^3/kmol)

$$Q_{N2,EG,m} = VM_{ref} \times \left\{ \frac{MF_{N,RG,m}}{2 \times AM_N} + \left(\frac{1 - v_{O2,air}}{v_{O_2,air}} \right) \times \left[F_{O2,RG,m} + n_{O2,EG,m} \right] \right\}$$

$Q_{N2,EG,m}$	=	Quantity of N_2 (volume) in the exhaust gas per kg of residual gas on a dry basis at reference conditions in the minute m (m^3/kg residual gas)
VM_{ref}	=	Volume of one mole of any ideal gas at reference temperature and pressure (m^3/kmol)
$MF_{N,RG,m}$	=	Mass fraction of nitrogen in the residual gas in the minute m
AM_N	=	Atomic mass of nitrogen (kg/kmol)
$v_{O2,ai}$	=	Volumetric fraction of O_2 in air
$F_{O2,RG,m}$	=	Stochiometric quantity of moles of O_2 required for a complete oxidation of one kg residual gas in minute m (kmol/kg residual gas)
$n_{O2,EG,m}$	=	Quantity of O_2 (moles) in the exhaust gas per kg of residual gas flared on a dry basis at reference conditions in minute m (kmol/kg residual gas)

$$Q_{CO_2,EG,m} = \frac{MF_{C,RG,m}}{AM_C} \times VM_{ref}$$

$Q_{CO2,EG,m}$	=	Quantity of O_2 (moles) in the exhaust gas per kg of residual gas flared on a dry basis at reference conditions in minute m (kmol/kg residual gas)
$v_{O2,EG,m}$	=	Volumetric fraction of O_2 in the exhaust gas on a dry basis at reference conditions in the minute m
$v_{O2,air}$	=	Volumetric fraction of O_2 in the air
$MF_{C,RG,m}$	=	Mass fraction of carbon in the residual gas in the minute m
AM_C	=	Atomic mass of carbon (kg/kmol)
$MF_{N,RG,m}$	=	Mass fraction of nitrogen in the residual gas in the minute m
AM_N	=	Atomic mass of nitrogen (kg/kmol)
$F_{O2,RG,m}$	=	Stochiometric quantity of moles of O_2 required for a complete oxidation of one kg residual gas in minute m (kmol/kg residual gas)

$$n_{O2,EG,m} = \frac{v_{O2,EG,m}}{\left(1 - \left(v_{O2,EG,m}/v_{O2,air}\right)\right)} \times \left[\frac{MF_{C,RG,m}}{AM_C} + \frac{MF_{N,RG,m}}{2 \times AM_N} + \left(\frac{1 - v_{O2,air}}{v_{O2,air}}\right) \times F_{O2,RG,m}\right]$$

$nO2,EG,m$	=	O2 (moles) in the exhaust gas per kg of residual gas flared on a dry basis at reference conditions in minute m (kmol/kg residual gas)
$vO2,EG,m$	=	Volumetric fraction of O2 in the exhaust gas on a dry basis at reference conditions in the minute m
$vO2,air$	=	Volumetric fraction of O2 in the air
MFC,RG,m	=	Mass fraction of carbon in the residual gas in the minute m
AMC	=	Atomic mass of carbon (kg/kmol)
MFN,RG,m	=	Mass fraction of nitrogen in the residual gas in the minute m
AMN	=	Atomic mass of nitrogen (kg/kmol)
$FO2,RG,m$	=	Stochiometric quantity of moles of O2 required for a complete oxidation of one kg residual gas in minute m (kmol/kg residual gas)

$$F_{O2,RG,m} = \frac{MF_{C,RG,m}}{AM_C} + \frac{MF_{H,RG,m}}{4AM_H} - \frac{MF_{O,RG,m}}{2AM_O}$$

$F_{O2,RG,m}$	=	Stochiometric quantity of moles of O_2 required for a complete oxidation of one kg residual gas in minute m (kmol/kg residual gas)
$MF_{C,RG,m}$	=	Mass fraction of carbon in the residual gas in the minute m
AM_C	=	Atomic mass of carbon (kg/kmol)
$MF_{O,RG,m}$	=	Mass fraction of oxygen in the residual gas in the minute m
AM_O	=	Atomic mass of oxygen (kg/kmol)
$MF_{H,RG,m}$	=	Mass fraction of hydrogen in the residual gas in the minute m
AM_H	=	Atomic mass of hydrogen (kg/kmol)

Determine the mass fractions of carbon, hydrogen, oxygen and nitrogen in the residual gas, using the volumetric fraction of component *i* in the residual gas and applying the equation below. In applying this equation, the project participants may choose to either a) use the measured volumetric fraction of each component *i* of the residual gas, or (b) as a simplification, measure the volumetric

fraction of methane and consider the difference to 100% as being nitrogen (N_2). The same equation applies, irrespective of which option is selected.

$$MF_{j,RG,m} = \frac{\sum_i v_{i,RG,m} \times AM_j \times NA_{j,i}}{MM_{RG,m}}$$

$MF_{j,RG,m}$	=	Mass fraction of element j in the residual gas in the minute m
$v_{i,RG,m}$	=	Volumetric fraction of component i in the residual gas on a dry basis in the minute m
AM_j	=	Atomic mass of element j (kg/kmol)
$NA_{j,i}$	=	Number of atoms of element j in component i
$MM_{RG,m}$	=	Molecular mass of the residual gas in minute m (kg/kmol)
j	=	elements C, O, H and N
i	=	Component of residual gas. If Option (a) is selected to measure the volumetric fraction, then i = CH4, CO, CO2, O2, H2, H2S, NH3, N2 or if Option (b) is selected then i= CH4 and N2

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:

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

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 4 – Parameters[22] 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	0.008314472	$Pa.m^3/kmol.K$
T_{ref}	Temperature at reference conditions	273.15	K
GWP_{CH4}	Global warming potential of methane valid for the commitment period	25[23]	tCO_2/tCH_4
$\rho_{CH4,n}$	Density of methane at reference conditions	0.716	kg/m^3

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

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:

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

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

$$F_{CH4,BL,y} = F_{CH4,BL,sys,y} = F_{CH4,sent\_flare,y}$$

Where:

$F_{CH4,BL,sys,y}$	=	Amount of methane in the LFG that would be flared in the baseline in year y for the case of an existing LFG capture system (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)

The amount of methane captured with the existing system will be monitored along with the amount captured under the project activity and there is no historic data on the amount of methane that was captured in the year prior to the implementation of the project activity. Thus, the situation to determine $F_{CH4,BL,y}$ is:

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

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

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)
$EF_{EL,k,y}$[24]	=	Emission factor for electricity generation for source *k* in year *y* (tCO2/MWh)
$TDL_{k,y}$	=	Average technical transmission and distribution losses for providing electricity to source *k* in year *y*.

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".

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

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The table below shows the consolidated collected and calculated data for the current monitoring period.

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

	PE,y	PEEC1	PEEC2	ECPJ1	ECPJ2
	tCO2	tCO2	tCO2	MWh	MWh
07/2019	1.00	0.85	0.00	5.13	0.00
08/2019	1.00	0.35	0.00	2.08	0.00
09/2019	1.00	0.14	0.00	0.85	0.00
10/2019	1.00	0.04	0.00	0.25	0.00
11/2019	1.00	0.18	0.00	1.08	0.00
12/2019	2.00	1.24	0.00	7.43	0.00
01/2020	1.00	0.47	0.00	2.81	0.00
02/2020	1.00	0.08	0.00	0.46	0.00
Until 02/03/2020	1.00	0.01	0.00	0.05	0.00

Project emissions:

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

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)

There is no consumption of fossil fuels due to the project activity for purpose other than electricity generation, in year y (tCO2/yr), therefore PEFC,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), a conservative approach was adopted and the option B2 of the scenario B was chosen because: "The electricity consumption source is a project or leakage electricity consumption source". Therefore, the value used will be 1.3 tCO2/MWh for project emission from diesel generator(s).

$$PE_{EC2,y} = EC_{PJ2,y} \times EF_{diesel\_generatory} \times (1 + TDL_y)$$

Where:

$EC_{PJ2,y}$ = quantity of electricity consumed from diesel generator by the project activity during the year y (MWh);
$EF_{diesel\_generator,y}$ = the emission factor for the diesel generator 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.

E.3. Calculation of leakage emissions

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Not applicable

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

	Baseline GHG emissions or baseline net GHG removals (t CO_2e)	Project GHG emissions or actual net GHG removals (t CO_2e)	Leakage GHG emissions (t CO_2e)	GHG emission reductions or net anthropogenic GHG removals (t CO_2e)		
				Before 01/01/2013	From 01/01/2013	Total amount
Total	163,214	10	-	-	163,204	163,204

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)
163,204	616,856[25]

[25]Calculated using the PDD estimation for 2018 (101,253), plus PDD estimation for 2019 (438,408), plus PDD estimation for 2020 (455,697) times the number of days in this monitoring period for this year (62 days) divided by the number of days in the year (366 days).

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

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Calculated using the PDD estimation for 2018 (101,253), plus PDD estimation for 2019 (438,408), plus PDD estimation for 2020 (455,697) times the number of days in this monitoring period for this year (62 days) divided by the number of days in the year (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 -74%.

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

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

Decision Class: Regulatory
Document Type: Form
Business Function: Issuance
Keywords: monitoring report