Monitoring report form for CDM programme of activities (Version 05.0)

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

MONITORING REPORT			
Title of the PoA	Caixa Econômica Federal Solid Waste Management and Carbon Finance Project		
UNFCCC reference number of the PoA	6573		
Version number of the PoA-DD applicable to this monitoring report	3.0 (Second Renewable Period 05 Oct 19 - 04 Oct 26)		
Version number of this monitoring report	1		
Completion date of this monitoring report	01/12/2021		
Monitoring period number	10th Monitoring Period		
Duration of this monitoring period	03/03/2020 to 31/12/2020		
Monitoring report number for this monitoring period	2		
Coordinating/managing entity	Caixa Econômica Federal		
Host Parties	Host Party of the PoA	Is this the host Party of a CPA covered in this monitoring report? (yes/no)	
	Brazil	Yes	
Applied methodologies and standardized baselines	Methodology: ACM0001 – "Flaring or use of landfill gas – Version 19.0"		
Sectoral scopes	Sectoral Scope 13 – Waste handling and disposal		
Amount of GHG emission reductions or net anthropogenic GHG removals achieved by all CPAs covered in this monitoring report 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
	-	14,966 tCO_2e	-
Amount of GHG emission reductions or net anthropogenic GHG removals estimated ex ante for this monitoring period in the CPA-DDs for the CPAs covered in this monitoring report	5,767 tCO2e		

PART I Monitoring of programme of activities (PoA)

SECTION A. Description of PoA

A.1. General description of PoA

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According to the Brazilian Ministry of Environment, Brazil has 5570 municipalities, of which, 3355 have its waste disposed in dumpsites with no management, gas collection or water treatment and usually without any license or under no control by the environmental agencies concerned. This corresponds to 74,7 million inhabitants or 37% of Brazil population1.

Brazil's National Energy Plan 20302, states that solid urban wastes are an important source of renewable energy generation and therefore Brazil's solid waste policy should target its use as a source for energy. In this sense the Brazilian Government has worked to design a program that promotes sustainable energy recovery from Municipal Solid Waste (MSW), bringing together the actions of various governmental entities involved. This program shall be in line with the established National Sanitation Policy3, the guidelines for the management of municipal solid waste and will take into account the opportunities arising from the Law of Public Consortia.

Since current practice of uncontrolled GHG emissions in landfills is largely prevalent today, the PoA contribute to achieve the goals outlined in both the National Sanitation Policy and Brazil's National Energy Plan. Furthermore, the PoA will help to promote the implementation of LFG capture and combustion/energy generation/distribution systems through the CDM to mitigate the GHG emissions that would have otherwise been completely vented to the atmosphere.

This PoA generates emission reductions by avoiding methane emissions through the destruction of the methane generated by the landfill, and through generation of renewable energy and upgrade of biogas. As of today, the PoA includes 2 CPAs: CPA-1: Landfill gas recovery, energy generation and biogas distribution from CTR Santa Rosa and the CPA-2: CTR São Gonçalo, which both has implemented the first component of the project, gas flare.The conception, specifications and design for the other components (electricity generation and LFG distribution) are in process and the new components are expected to be implemented in the future. Therefore, during this monitoring period, emission reductions are only generated by the flaring system and only CPA-1 is running this monitoring report.

A.1.1. Corresponding generic component project activities (CPAs)

Title and reference number of the corresponding generic CPA	Version of the PoA-DD	Sectoral scopes	Applied methodologies and standardized baselines
CPA-[XX landfill name] CPA-[XX]	3.0	Sectoral Scope 13	*ACM0001 – "Flaring or use of landfillgas – Version 19.0"*

A.1.2. CPAs included in the PoA

Title and UNFCCC reference number of the CPA	Version of the PoA-DD	Title and reference number of the corresponding generic CPA	Crediting period type and duration	Covered in this monitoring report? (yes/no)
CPA-03 CTR Petrolina Landfill Gas Project 6573-P2-0003-CP1	3.0	CPA-[XX landfill name] CPA-[XX]	7 years Renewable 13/08/2020 - 12/08/2027	YES
CPA-1: Landfill gas recovery, energy generation and biogas distribution from CTR Santa Rosa 6573-P2-0001-CP2	3.0	CPA-[XX landfill name] CPA-[XX]	7 years Renewable 05/10/2019 - 04/10/2026	NO

A.2. Coordinating/managing entity

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Caixa Econômica Federal

SECTION B. Implementation of PoA

B.1. Description of implemented PoA

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The management system of the PoA has been implemented by CAIXA, the CME of the PoA, as described in the PoA-DD.

CAIXA Economica Federal has followed the topics bellow for the management system:
-screened and validated the projects for inclusion in the PoA;
-carried out the inclusion process;
-trained the CPA Implementers;
-managed the records of CPA including data required to calculate emission reductions;
-ensured rigorous reporting of the CPA Entity;
-verified information sent by the CPA Entity;
-prepared the monitoring report at PoA level.

B.2. Post-registration changes to PoA

B.2.1. Corrections

>>
N/A

B.2.2. Inclusion of monitoring plan

>>
N/A

B.2.3. 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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N/A

B.2.4. Changes to programme design

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N/A

B.2.5. Changes specific to afforestation or reforestation activities

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N/A

PART II Monitoring of CPAs

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SECTION C. Implementation of CPAs

C.1. Description of implemented CPAs

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The proposed CPA consists of CTR Petrolina Landfill LFG flaring and using for generating electricity. CTR Petrolina Landfill receives over 6,500 tons per month of domestic solid waste and was opened since 2014. In the CTR Petrolina CPA, the baseline scenario consists in the LFG only vented and partial released to the atmosphere, comprehending a passive collection and burning system. Without the additional financial incentive of the emissions reductions revenues, the high cost of modern methane capture, flaring and electricity generation technologies preclude their implementation in Brazilian landfills. The lifetime of the landfill considered from 2020 is almost 29 years.

The technology to be employed in CPA-03 CTR Petrolina Landfill Gas Project involves improvement of landfill gas collection and flaring, through the installation of an active recovery system composed by:

- Gas extraction wells with wellhead flow control and monitoring;
- A wellfield gas conveyance system (“laterals” and “header”);
- A Gas Station and/or an upgrading gas facility;
- A flaring system
- A LFG electricity generator

The following list summarizes the relevant dates for CPA-3:

- May 2014, start of the landfill operations
- March 2019, start date, construction of the LFG collection and flaring system.
- August 2019 start of operations of the LFG collection and flaring system (initial tests).
- November 15, 2019 start of operations of electricity generator (initial tests)
- November 27, 2019 plant commissioning.
- August 13, 2020 CPA registration.

The total volume of emission reductions achieved in this monitoring period was 14,966 tCO_2e.

During the period, the system was also turned off in some occasions for preventive maintenance, inspection, cleaning or to replace a part.

C.2. Location of CPAs

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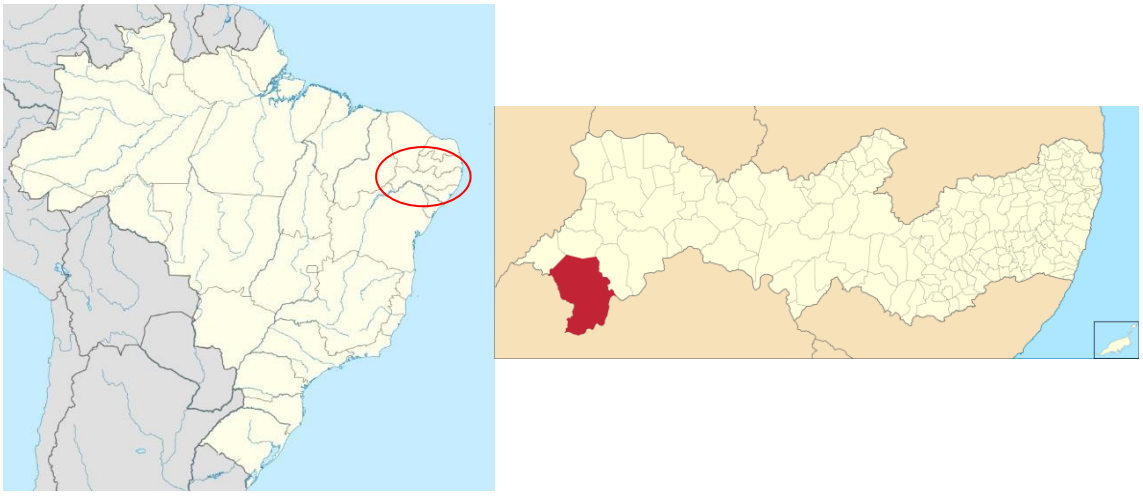
The CPA is is located in Petrolina municipality, Pernambuco state, Norwest region of Brazil. The geographic coordinates of the CPA are as follows.

Longitude (West) -40.37' 59.97300'' Latitude (South) -9.11' 55.50400''



C.3. Post-registration changes to CPAs

C.3.1. Temporary deviations from the monitoring plans in the included CPA-DDs, applied methodologies, standardized baselines or other methodological regulatory documents

>>
N/A

C.3.2. Corrections

>>
N/A

C.3.3. Changes to the start date of the crediting period

>>
N/A

C.3.4. Inclusion of monitoring plan

>>
N/A

C.3.5. Permanent changes to the included monitoring plans, or permanent deviation of monitoring from the applied methodologies, standardized baselines, or other methodological regulatory documents

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N/A

C.3.6. Changes to project design

>>
N/A

C.3.7. Changes specific to afforestation or reforestation CPA

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N/A

SECTION D. Description of monitoring system of CPAs

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General monitoring:

The following instruments/equipment will be used to monitor required data along the operation of CPA-03 CTR Petrolina Landfill Gas Project (depending on the applied measurement options and calculation approaches - to be chosen ex-post)[26]:

Instrument or Source of data	Parameter	Description
FLOW METER	$V_{t,db}$	Volumetric flow of LFG in time interval t on a dry basis (in m^3 dry gas/h) used for the determination of $F_{CH4,BL,R,y}F_{CH4,NG-cons,y}$, $F_{CH4,NG\ TR,y}$, $F_{CH4,NG,y}$, $M_{RG,m}$ and $V_{RG,m}$.
	$V_{t,wb}$	Volumetric flow of LFG in time interval *t* on a wet basis (in m^3 wet gas/h) used for the determination of $F_{CH4,BL,R,y}F_{CH4,NG-cons,y}$, $F_{CH4,NG\ TR,y}$, $F_{CH4,NG,y}$, $M_{RG,m}$ and $V_{RG,m}$.
GAS ANALYZER	$v_{i,RG,m} = v_{k,t,db}/v_{k,t,dw}$	Volumetric fraction of component *i* / k in the residual gas in the minute m (i = CH_4, CO, CO_2, O_2, H_2, H_2S, NH_4, N_2). As a simplified approach, the CME and/or CPA implementer may only measure the content CH_4, CO and CO_2 of the residual gas and consider the remaining part as N_2.
CH_4 content gas analyser unit(s)	$v_{i,t,db/wb}$	Volumetric fraction of methane on the LFG send to flares and/or each processing element of the biogas upgrading facility and/or each delivery pipeline supplying upgraded LFG to consumer(s) (through natural gas distribution network or by using trucks or through a combination of both of these LFG transportation options) in a time interval *t* on a dry basis (in m^3 CH_4/m^3 dry or wet gas) used for the determination of $F_{CH4,BL,R,y}$, $F_{CH4,NG-cons,y}$, $F_{CH4,NG,TR,y}$, $F_{CH4,NG,y}$, $fc_{CH4,EG,m}$, $v_{i,RG,m}$ and $F_{CH4,EG,t}$ (enclosed flares).
Flame detector	$Flame_m$	Flame detection of flare in the minute *m* (Flame "*on*" orFlame "*off*").
Flame detector devices	Status of biogas destruction device	Operational status of biogas destruction devices (flares).
LFG pressure sensor(s)	P_t	Pressure of the LFG send to flare(s) and/or each processing element of the biogas upgrading facility and/or each delivery pipeline supplying upgraded LFG to consumer(s) (through natural gas distribution network or by using trucks or through a combination of both of these LFG transportation options) in time interval *t* (in Pa or mbar).
LFG temperature sensor(s)	$T_t = T_{EG,m}$	Temperature of the LFG send to the flare(s) and/or each processing element of the biogas upgrading facility and/or each delivery pipeline supplying upgraded LFG to consumer(s) (through natural gas distribution network or by using trucks or through a combination of both of these LFG transportation options) in time interval t (in K or ºC).
Not based on measurements. Literature data.	$p_{H20,t,Sat}$	Saturation pressure of H_2O at temperature Tt,j in timeinterval *t* . This parameter is solely a function of the LFG temperature Tt and can be found at referenced literature.
Electricity meter(s)	$EC_{PJ,j,y}$;	Quantity of electricity consumed by the project electricity

[26] Measurement options defined in the methodological tool "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" when referring to "*Adequate volumetric or mass flow meter(s)*" and defined in the methodological tool "Project emissions from flaring" in other cases. Different measurement options are indeed defined in the methodological tool "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" when referring to "*Adequate volumetric or mass flow meter(s)*". The applicable guidance of the methodological tool "Project emissions from flaring" also refers to different measurement and calculation options.

Instrument or Source of data	Measurement option	Parameter	Description
	electricity consumption – TOOL05	$EC_{LE,I,y}$	consumption source j in year y / Net increase in electricity consumption of source i in year y as a result of leakage.
Electricity meter(s)	Option B1 of TOOL05	$EG_{PJ,grid,y}$ or $EG_{PJ,facility,I,y}$ or $EC_{BL,k,y}$	Amount of electricity generated and supplied by the CPA-[XX landfill name] in year y (in MWh).
Not based on measurements. The Brazilian DNA (official source of data)	Option c) of TOOL07	$EF_{grid,OM,y} = EF_{grid,OM-DD,y}$	Operation margin CO_2 emission factor in year *y* (tCO_2/MWh). Dispatch data analysis method based on data from the Brazilian DNA.
Not based on measurements.	Option a) from step 6 of TOOL07	$EF_{grid,CM,y}$	Combined margin emission factor for the grid in year y (tCO_2/MWh).
Default value from TOO05, official source of data, distribution and transmission utilities	Calculated or application of default value	$TDL_{grid,y}$ / $TDL_{captive,y}$	Use of recent, accurate and reliable data available within the host country or selection of the applicable default value as per TOOL05. Data shall not be older than 5 years.
Not based on measurements. Design of the landfill, technical specifications, local or national regulations, etc	Applicable to all CPAs	Mgmt of SWDS	The design and operational conditions of the [Landfill name] landfill will be annually monitored applicable sources.
Meter, equipment electronics or system	Applicable to all CPAs	$Op_{j,h}$	Operation of the equipment that consumes LFG: electricity generators, flares and/or each delivery pipeline with upgraded LFG supply to consumer(s) (natural gas distribution network, dedicated pipeline or by using trucks or through a combination of both of these LFG transportation options).

As part of the operation of the CPA-03 CTR Petrolina Landfill Gas Project, all continuously measured LFG destruction/utilization related parameters as well as measurements related to the exhaust gas of the flare(s) (temperature in the exhaust gas of the flare(s) and eventually other parameters related to flare operational conditions will all be recorded electronically via an appropriate data logger / data acquisition system (to be located within the site boundary). The data logger / data acquisition system will have the capability to record all data in a safe and reliable manner (thus ensuring the required data reliability and validity). Data recording and reporting frequency for these parameters will be at least every one minute.

Records of electricity consumed and/or, if applicable, generated by the CPA-03 CTR Petrolina Landfill Gas Project will also be recorded electronically via an appropriate data logger / data control / data acquisition system (to be located within the site boundary). Data from related grid-sourced electricity purchase invoices and/or historical reports (issued by local electricity transmission/commercialization company) will also be used as cross-checking. Moreover, if applicable, records of electricity generated by the backup captive off-grid electricity generator(s) (fuelled by diesel) may also be regularly recorded (depending on the approach applied for the determination of project emissions from consumption of electricity source by such backup electricity generator(s)).

If applicable, records of quantity of fossil fuel eventually consumed by the CPA-03 CTR Petrolina Landfill Gas Project (for purpose other than electricity generation and/or transportation of upgraded LFG) will be aggregated manually or automatically (depending on the specifications of related measurement instrument to be applied). Accumulated related measurement records will be reported at with an at least every-month frequency. Data from related eventual fossil fuel purchasing receipts or invoices (to be issued by local distributor/supplier for the consumed fossil fuel) will also be used as cross-checking if applicable.

By the use of appropriate software application, recorded monitoring data will be regularly retrieved, aggregated and reported in order to be considered in the context of calculations of emission reduction achieved by the CPA-03 CTR Petrolina Landfill Gas Project.

Monitoring records available in the data logger/data acquisition system might be regularly retrieved remotely by modem or directly on site. If automatic data logging by the logger / data acquisition system fails, measurement data might be recorded manually (whenever it is possible). If data is not properly recorded or cannot be retrieved, no emissions reductions will be claimed for the period encompassing such data recording/reporting failure.

All monitoring data will be recorded and backed-up in a central database. As per the applicable monitoring procedure, data records will be summarized into emission reduction calculations prior to each periodic CDM verification. All data recorded by the data logger / data acquisition system will be made available to the Designated Operational Entities (DOEs) responsible for each periodic verification for the CPA-03 CTR Petrolina Landfill Gas Project. This will ensure that data integrity and reliability for related monitoring data.

As per the monitoring procedure to be adopted by CPA-03 Implementer, access to monitoring data will be restricted and controlled. All monitoring records will be kept archived until at least two years after the last issuance of CER's for the CPA-03 CTR Petrolina Landfill Gas Project, whichever occurs later.

It will be the responsibility of the appointed monitoring team manager to ensure that all monitoring data is properly measured and recorded as part of operation of the CPA-03 CTR Petrolina Landfill Gas Project.

Technical specifications for monitoring instruments/equipment (e.g. manufacturer, model, serial numbers, accuracy, etc.) will be detailed in the Monitoring Reports for each periodic verification.

Maintenance and calibration for monitoring instruments/equipment and CPA's equipment/components in general:

All maintenance service and routines will include all preventive and corrective actions necessary for ensuring good functioning of all project related equipment, such as:

- Visual control of the equipment state and real-time check of displayed parameters,
- Cleaning up the equipment and the sensors,
- Lubrication and greasing,
- Replacement or overhauling of defective parts (including regular welding service in the HDPE pipelines and manifolds).

Calibration events in monitoring instruments/equipment will be periodically and appropriately performed as per applicable frequency, procedures and methods established or recommended by instrument/ equipment manufacturer, applicable national/international standards and/or best practice, as available.

General malfunction of equipment: if monitoring instruments/equipment or CPA's equipment/components present failure or malfunction, applicable repair or replacement actions will be carried out. Spare units for some of the monitoring instruments/equipment may be kept on site.

Operational and management structure for the CPA-03 CTR Petrolina Landfill Gas Project:

An appropriate operational and management structure will be made available as part of the operation of the CPA-03 CTR Petrolina Landfill Gas Project.

The CPA's operational and management structure will rely on trained staff (incl. contractors) with responsibilities clearly defined. All collaborators and employees involved with operation of the CP and/or monitoring will be trained internally and/or externally. Training efforts may include *inter alia*:

a) General competence development about LFG generation and collection;
b) Review of equipment operational principles and captors;

c) Maintenance and calibration requirements for project's related equipment;
d) Procedures for monitoring data gathering and handling;
e) Emergency and safety procedures;
f) General competence development about LFG combustion in high temperature enclosedflares
g) General competence development about the utilization of LFG as gaseous fuel forelectricity generation

The monitoring plan will be implemented by reflecting the best practice in terms of monitoring efforts for LFG collection and destruction/utilization project-based initiatives under de CDM.

Monitoring of the management of the landfill:
As required by ACM0001, the design and operational conditions of the CTR Petrolina Landfill landfill during the duration of the CPA-03 CTR Petrolina Landfill Gas Project will be monitored on the basis of different sources, including *inter alia*:

- Original design of the CTR Petrolina Landfill landfill;
- Technical specifications for the management of the CTR Petrolina Landfill landfill;
- Applicable local or national regulations

Original operational design of the CTR Petrolina Landfill landfill should be confirmed not to be modified in order to ensure that no practice to increase methane generation at the landfill have been occurring, when compared to the landfill management and operation condition prior to implementation of the CPA-03 CTR Petrolina Landfill Gas Project. As required by ACM0001, any change in the management of the landfill after the implementation of the CPA-03 CTR Petrolina Landfill Gas Project should be justified by referring to technical or regulatory specifications and impacts of such changes in the determination of baseline emissions should in this case be taken into account appropriately. Such monitoring requirement will be used for the determination/confirmation of baseline emissions and/or confirmation of the CPA's implementation as described in the CPA-DD (in terms of operation and management conditions of the landfill from which LFG is combusted).
Further monitoring details are included under details for parameter "Management of SWDS".

Monitoring is the responsibility of CPA-3 implementer, including:

•Establish and maintain a reliable and accurate monitoring system;
•Provide guidance for the participants on the implementation of necessary measurement and record management procedures;
•Provide guidance for properly transmit Monitoring Reports to Caixa Econômica Federal;
•Guidance for meeting or exceeding CDM requirements for verification and certification purposes

The monitoring plan covers:
1)Monitoring team members' duties and routine reminders;
2)Monitoring schedules;
3)QA/QC procedures;
4)Service forms for data reporting;
5)Corrective action and maintenance plans;

The monitoring methodology is based on direct measurement of the amount of LFG captured and destroyed at the flare(s), LFG utilized as fuel in electricity generation infrastructure in order to determine the amount of methane effectively destroyed. The monitoring plan provides for continuous measurement of the quantity of LFG used and quality of LFG flared/utilized.

LFG flow meter(s) and CH4 content gas analyzer(s) will be recording continuously the amount of methane flared/utilized as part of the operation of CPA-03.

Devices and Methods for Data Collection:

Electricity consumption: Standard electricity meter(s) will be used for monitoring electricity consumption by CPA-03.

LFG measurements: LFG flow meter(s), gas analyser(s), thermocouple(s), LFG temperature sensor(s) and LFG pressure meter(s) will be used to determine the amount of methane that is flared/used at CPA-03. Meters shall be subject to regular maintenance, testing and calibration.
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Monitored Data:

Project participant staff has operational and data collection obligations to fulfill, in order to maximize the GHG emissions reductions, ensuring that sufficient information is available to calculate ERs in a transparent and verifiable manner, allowing a fast and successful verification of these ERs.

Caixa Econômica Federal will take responsibility for the collection of monitored data in CPA-03, the emission reduction estimates, producing the Monitoring Reports and reporting to the DOE. Caixa Econômica Federal will also maintain all necessary data to undertake this PoA monitoring plan, such as a list of all projects under review for inclusion in the PoA and the performing data and parameters for each included CPA.

All data provided by CPA-03 operators will be checked for completeness and quality and placed on a central database owned by Caixa Econômica Federal. All data recording of the monitored data will include paper and electronic versions, backup systems and periodic checking for data entry mistakes. All records will be kept for at least 2 years after the end of the duration of the PoA.

SECTION E. Data and parameters

E.1. Data and parameters fixed ex ante

Data/Parameter	OX_{top_layer}
Unit	Dimensionless
Description	Fraction of methane that would be oxidized in the top layer of theSWDS in the baseline
Source of data	Default value from ACM0001
Value(s) applied	0.1
Choice of data or measurement methods and procedures	Consistent with how oxidation is accounted for TOOL04.
Purpose of data/parameter	Calculation of baseline emissions of methane from SWDS ($BE_{CH4,y}$).
Additional comments	$OX_{top-layer}$ is the fraction of the methane in the LFG that would oxidize in the top layer of the SWDS in the absence of the project activity. Under the project activity, this effect is reduced as a part of the LFG is captured and does not pass through the top layer of the SWDS. This oxidation effect is also accounted for in TOOL04. In addition to this effect, the installation of a LFG capture system under the project activity may result in the suction of additional air into the SWDS. In some cases, such as with a high suction pressure, the air may decrease the amount of methane that is generated under the project activity. However, in most circumstances where the LFG is captured and used this effect was very small, as the operators of the SWDS have in most cases an incentive to maintain a high methane concentration in the LFG. For these reasons, the oxidation factor shall be included in the calculation of baseline emissions whereas the effect of oxidation is, as a conservative assumption, neglected under the project activity.

Data/Parameter	GWP_{CH4}
Unit	tCO_2e/tCH_4
Description	Global warming potential of CH_4
Source of data	IPCC Fourth Assessment Report (AR4)
Value(s) applied	25
Choice of data or measurement methods and procedures	Default value.
Purpose of data/parameter	Calculation of baseline emissions and/or project emissions.
Additional comments	The applied value shall be updated according to any future CDM-EBor COP/MOP decisions.

Data/Parameter	η_{PJ}
Unit	Dimensionless
Description	Efficiency of the LFG capture system that will be installed in the CPA
Source of data	Value obtained from technical literature[23]

Value(s) applied	85%
Choice of data or measurement methods and procedures	Based on LFG capture system literature information
Purpose of data/parameter	Calculation of baseline emissions of methane from SWDS ($BE_{CH4,y}$).
Additional comments	Based on Collection efficiency 0.85 & Load Factor 0.95 - USEPA Handbook EPA-LFG.pdf - Item 2.2.2. page 2-8.)

Data/Parameter	**f_y**
Unit	-
Description	Fraction of methane captured at the SWDS and flared, combusted or used in another manner that prevents the emissions of methane tothe atmosphere in year y
Source of data	Select the maximum value from the following: (a) contract or regulation requirements specifying the amount of methane that must be destroyed/used (if available) and (b) historic data on the amount captured
Value(s) applied	0
Choice of data or measurement methods and procedures	According to ACM0001, fy in the tool shall be assigned a value of 0 because the amount of LFG that would have been captured and destroyed is already accounted for in equation (2) of the methodology.
Purpose of data/parameter	Calculation of (ex-ante) baseline emissions of methane from SWDS ($BE_{CH4,y}$).
Additional comments	-

Data/Parameter	**$\Phi_{default}$**
Unit	-
Description	Default value for the model correction factor to account for model uncertainties
Source of data	TOO04
Value(s) applied	0.75
Choice of data or measurement methods and procedures	Applicable to application A while applying option 1 of TOOL04.
Purpose of data/parameter	Calculation of (ex-ante) baseline emissions of methane from SWDS ($BE_{CH4,y}$).
Additional comments	-

Data/Parameter	**OX**
Unit	-
Description	Oxidation factor (reflecting the amount of methane from SWDS that is oxidized in the soil or other material covering the waste)
Source of data	Based on an extensive review of published literature on this subject, including the IPCC 2006 Guidelines for National Greenhouse Gas Inventories
Value(s) applied	0.1
Choice of data or measurement methods and procedures	Default value of TOOL04.
Purpose of data/parameter	Calculation of (ex-ante) baseline emissions of methane from SWDS ($BE_{CH4,y}$).

Additional comments	-

Data/Parameter	**F**
Unit	-
Description	Fraction of methane in the SWDS gas (volume fraction)
Source of data	IPCC 2006 Guidelines for National Greenhouse Gas Inventories
Value(s) applied	0.5
Choice of data or measurement methods and procedures	Default value of TOOL04.
Purpose of data/parameter	Calculation of baseline emissions of methane from SWDS ($BE_{CH4,y}$).
Additional comments	Upon biodegradation, organic material is converted to a mixture of methane and carbon dioxide

Data/Parameter	**$DOC_{f,default}$**
Unit	Weight fraction
Description	Default value for the fraction of degradable organic carbon (DOC) inMSW that decomposes in the SWDS
Source of data	IPCC 2006 Guidelines for National Greenhouse Gas Inventories
Value(s) applied	0.5
Choice of data or measurement methods and procedures	Default value of TOOL04.
Purpose of data/parameter	Calculation of baseline emissions of methane from SWDS ($BE_{CH4,y}$).
Additional comments	This factor reflects the fact that some degradable organic carbon does not degrade, or degrades very slowly, in the SWDS. This default value can only be used for: (a) Application A; or (b) Application B if the tool is applied to MSW. An alternative to using the default factor is to estimate $DOC_{f,y}$ or $DOC_{f,m}$ using equations (9), (10) and (11) of TOOL04.

Data/Parameter	**$MCF_{default}$**
Unit	-
Description	Methane correction factor
Source of data	IPCC 2006 Guidelines for National Greenhouse Gas Inventories.
Value(s) applied	1.0
Choice of data or measurement methods and procedures	Applicable to anaerobic managed solid waste disposal sites. These must have controlled placement of waste (i.e.waste directed to specific deposition areas, a degree of control of scavenging and a degree of control of fires) and will include at least one of the following: (i) cover material; (ii) mechanical compacting; or (iii) levelling of the waste.
Purpose of data/parameter	Calculation of baseline emissions of methane from SWDS ($BE_{CH4,y}$).

Additional comments	MCF accounts for the fact that unmanaged SWDS produce less methane from a given amount of waste than managed SWDS, because a larger fraction of waste decomposes aerobically in the top layers of unmanaged SWDS. In case of a water table above the bottom of the SWDS, a larger proportion of the SWDS is anaerobic and MCF shall be estimated according to equation 12 of TOOL04.

Data/Parameter	**DOCj**
Unit	-
Description	Fraction of degradable organic carbon in the waste type j (weight fraction)
Source of data	IPCC 2006 Guidelines for National Greenhouse Gas Inventories (adapted from Volume 5, Tables 2.4 and 2.5).
Value(s) applied	Waste type j / DOCj (% wet waste): Wood and wood products 43; Pulp, paper and cardboard (other than sludge) 40; Food, food waste, beverages and tobacco (other than sludge) 15; Textiles 24; Garden, yard and park waste 20; Glass, plastic, metal, other inert waste 0
Choice of data or measurement methods and procedures	Default value of TOOL04
Purpose of data/parameter	Calculation of baseline emissions of methane from SWDS ($BE_{CH4,y}$).
Additional comments	-

Data/Parameter	**k_j**
Unit	1/yr
Description	Decay rate for the waste type j
Source of data	IPCC 2006 Guidelines for National Greenhouse Gas Inventories (adapted from Volume 5, Table 3.3)

Value(s) applied	<table><tr><th colspan="2" rowspan="2">Waste type j</th><th>Tropical (MAT > 20 °C)</th></tr><tr><th>Dry (MAP< 1000mm)</th></tr><tr><td rowspan="2">Slowly degrading</td><td>Pulp, paper, cardboard (other than sludge), textiles</td><td>0.045</td></tr><tr><td>Wood, wood products and straw</td><td>0.025</td></tr><tr><td>Moderately degrading</td><td>Other (non-food) organic putrescible garden and park waste</td><td>0.065</td></tr><tr><td>Rapidly degrading</td><td>Food, food waste, sewagesludge, beverages and tobacco</td><td>0.085</td></tr></table>
Choice of data or measurement methods and procedures	Default value of TOOL04
Purpose of data/parameter	Calculation of baseline emissions of methane from SWDS ($BE_{CH4,y}$).
Additional comments	The mean annual temperature (MAT) is 26.4ºC and the mean annual precipitation (MAP) 376 mm. Source (http://labmet.univasf.edu.br/)

Data/Parameter	Waste composition
Unit	%
Description	Waste composition
Source of data	Regional scientific article24
Value(s) applied	<table><tr><th colspan="2">Composition of the waste</th></tr><tr><td>A) Wood and wood products</td><td>0.00%</td></tr><tr><td>B) Pulp, paper and carboard (other than sludge)</td><td>3.78%</td></tr><tr><td>C) Food, food waste, beverages and tobacco (other than sludge)</td><td>53.98%</td></tr><tr><td>D) Textiles</td><td>0.00%</td></tr><tr><td>E) Garden, yard and park waste</td><td>0.00%</td></tr><tr><td>F) Glass, plastic, metal, other inert waste</td><td>42.24%</td></tr><tr><td>TOTAL</td><td>100.00%</td></tr></table>
Choice of data or measurement methods and procedures	Scientific article
Purpose of data/parameter	Calculation of baseline emission
Additional comments	Used for projection of methane avoidance

Data/Parameter	$\eta_{flare,m}$
Unit	%
Description	Flare efficiency for minute m
Source of data	TOOL06
Value(s) applied	50%

Choice of data or measurement methods and procedures	Default value for open flares.
Purpose of data/parameter	Calculation of project emissions from flaring ($PE_{flare,y}$)
Additional comments	Open flares: 50%

Data/Parameter	**Ru**
Unit	$Pa.m^3$ /kmol.K
Description	Universal ideal gases constant
Source of data	TOOL08
Value(s) applied	8,314
Choice of data or measurement methods and procedures	Default value
Purpose of data/parameter	Calculation of baseline emissions and/or project emissions.
Additional comments	-

Data/Parameter	**MMi**
Unit	kg/kmol
Description	Molecular mass of greenhouse gas i
Source of data	TOOL08
Value(s) applied	16.04 for methane
Choice of data or measurement methods and procedures	Default value
Purpose of data/parameter	Calculation of baseline emissions and/or project emissions.
Additional comments	-

Data/Parameter	**MMk**
Unit	kg/kmol
Description	Molecular mass of gas k
Source of data	TOOL08
Value(s) applied	

For gases k that are greenhouse gases apply values for MMi:

Compound	Structure	Molecular mass (kg / kmol)
Nitrogen	N_2	28.01
Oxygen	O_2	32.00
Carbon monoxide	CO	28.01
Hydrogen	H_2	2.02
Nitric oxide	NO	30.01
Nitrogen dioxide	NO_2	46.01
Sulphur dioxide	SO_2	64.06

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

Data/Parameter	**MM_{H2O}**
Unit	kg/kmol
Description	Molecular mass of water
Source of data	TOOL08
Value(s) applied	18.0152
Choice of data or measurement methods and procedures	Default value
Purpose of data/parameter	Calculation of baseline emissions and/or project emissions.
Additional comments	-

Data/Parameter	**$EF_{grid,BM,y}$**
Unit	Build margin CO_2 emission factor in year y
Description	tCO_2/MWh
Source of data	The Brazilian DNA
Value(s) applied	0.1370
Choice of data or measurement methods and procedures	Option 1 of the TOOL07 for $EF_{grid,BM,y}$, i.e. ex-ante data vintage.The updated value is used, i.e. 2018 year.
Purpose of data/parameter	Calculation of baseline emissions and/or project emissions
Additional comments	While applying Option 1, the build margin emission factor should be updated based on the most recent information available at the time of the submission of the PoA-DD request for renewal and the time of thesubmission of the CPA-DD.

Data/Parameter	**W_{BM}**
Unit	%
Description	Weighting of build margin emissions factor
Source of data	Default from TOOL07
Value(s) applied	50
Choice of data or measurement methods and procedures	Default value applied for the first crediting period according toTOOL07.
Purpose of data/parameter	Calculation of baseline emissions and/or project emissions
Additional comments	-

Data/Parameter	**W_{OM}**
Unit	%
Description	Weighting of operating margin emissions factor

Source of data	Default from TOOL07
Value(s) applied	50
Choice of data or measurement methods and procedures	Default value applied for the first crediting period according toTOOL07.
Purpose of data/parameter	Calculation of baseline emissions and/or project emissions
Additional comments	-

E.2. Data and parameters monitored

Data/Parameter	**Management of SWDS**
Unit	Dimensionless
Description	Management of the SWDS
Measured/calculated/ default	Measured
Source of data	Monitoring is performed on the basis of one of the following sources: a) Original design of the landfill; b)Technical specifications for the management of the SWDS;Local or national regulations
Value(s) of monitored parameter	The current configuration and operational conditions of the Petrolina landfill were compared against the previously conceived design and operational conditions of the landfill (prior to the occurred implementation of the CPA) on the basis of different sources and assessments including inter alia: - The original design documents of the landfill (as described in the technical design description documentation required for all phases of the environmental licensing and operational permitting for the CTR Petrolina landfill); - Applicable local or national regulations. The Environmental Agency of Pernambuco State performs annual site visits to confirm that the project is in line with the approved project design. This is required for the renovation of the operation permits of the landfill.
Monitoring equipment	Original construction and operational design of the CTR Petrolina landfill is confirmed as not being modified, ensuring that nopractice aiming to increase methane generation in the landfill has been occurring after the implementation of the CPA.
Measuring/reading/recording frequency	Annually.
Calculation method (if applicable)	Not applicable.
QA/QC procedures	Not applicable.
Purpose of data/parameter	Data will be used for the determination of baseline emissions.
Additional comments	-

Data/Parameter	**$V_{t,wb}$**
Unit	m^3 wet gas/h
Description	Volumetric flow of the gaseous stream in time interval t on a wet basis
Measured/calculated/ default	Measured

Source of data	Measured as part of the operation of the CPA by applying appropriate monitoring instruments (with recordable electronic signal).
Value(s) of monitored parameter	Measurements are performed by the installed LFG flow meters, one for the Flare and one for the electricity generator The monthly emission reduction calculation spreadsheets report all data of LFG flow sent to the flare during the monitoring period. Measurement data is recorded and reported every minute (60s frequency).
Monitoring equipment	LFG Volumetric flow to the Flare Manufacturer: ABB Model: 266 DSH Accuracy: ±0.075% Serial Number: 3K646619001181 Required calibration frequency as per manufacture's specification: 4 years and 1 month. Initial Calibration: 10/01/2019Calibration validity: 09/02/2023 LFG Volumetric flow to the Generator Manufacturer: ABB Model: 266 DSH Accuracy: ±0.075% Serial Number: 3K646619001180 Required calibration frequency as per manufacturer's specification: 4 years and 1 month. Initial Calibration: 10/01/2019 Calibration validity: 09/02/2023
Measuring/reading/recording frequency	Continuous measurements is recorded and reported with an every-minute frequency.
Calculation method (if applicable)	Not applicable
QA/QC procedures	Periodic calibration events for the LFG flow meter(s) will be performed by using a reference primary device provided by a third party independent accredited calibration laboratory. Calibration events will be performed in a frequency as per instrument specifications and/or instrument manufacturer's recommendations. Instrument will be subject to a regular maintenance and testing regime in accordance to appropriate national / international standards/requirements and/or best practice.
Purpose of data/parameter	Data will be used for the determination of baseline emissions.
Additional comments	This parameter will be monitored in case Options B or C of the methodological tool "Tool to determine the mass flow of a greenhouse gasin a gaseous stream" is applied for the determination of $F_{CH4,flared,y.}$ and $F_{CH4,EL,y}$.

Data/Parameter	**$V_{t,db}$**
Unit	m^3 dry gas/h
Description	Volumetric flow of the gaseous stream in time interval t on a dry basis
Measured/calculated/ default	Measured
Source of data	Measured as part of the operation of the CPA by applying appropriate monitoring instruments (with recordable electronic signal).

Value(s) of monitored parameter	Measurements are performed by the installed LFG flow meters, one for the Flare and one for the electricity generator The monthly emission reduction calculation spreadsheets report all data of LFG flow sent to the flare during the monitoring period. Measurement data is recorded and reported every minute (60s frequency).
Monitoring equipment	LFG Volumetric flow to the Flare Manufacturer: ABB Model: 266 DSH Accuracy: ±0.075% Serial Number: 3K646619001181 Required calibration frequency as per manufacture's specification: 4 years and 1 month. Initial Calibration: 10/01/2019 Calibration validity: 26/12/2023 LFG Volumetric flow to the Generator Manufacturer: ABB Model: 266 DSH Accuracy: ±0.075% Serial Number: 3K646619001180 Required calibration frequency as per manufacture's specification: 4 years and 1 month. Initial Calibration: 10/01/2019 Calibration validity: 26/12/2023
Measuring/reading/recording frequency	Continuous measurements will be recorded and reported with an every-minute frequency.
Calculation method (if applicable)	Not applicable
QA/QC procedures	Periodic calibration events for the LFG flow meter(s) will be performed by using a reference primary device provided by a third party independent accredited calibration laboratory. Calibration events will be performed in a frequency as per instrument specifications and/or instrument manufacturer's recommendations. Instrument will be subject to a regular maintenance and testing regime in accordance to appropriate national / international standards/requirements and/or best practice.
Purpose of data/parameter	Data will be used for the determination of baseline emissions.
Additional comments	This parameter will be monitored in case Option A of the methodological tool "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" is applied for the determination of $F_{CH4,flared,y}$ and $F_{CH4,EL,y}$.

Data/Parameter	$v_{i,t,db}$
Unit	m^3CH_4/m^3 dry gas
Description	Volumetric fraction of greenhouse gas i in a time interval t on a dry basis
Measured/calculated/ default	Measured
Source of data	Measured as part of the operation of the CPA-03 CTR Petrolina Landfill Gas Project by applying an appropriate continuous CH_4 content gas analyzer.

Value(s) of monitored parameter	Measurements are performed by the installed CH4 gas analizer The monthly emission reduction calculation spreadsheets report all data of CH4 volumetric fraction of the LFG during the monitoring period. Measurement data is recorded and reported every minute (60s frequency).
Monitoring equipment	CH4 volumetric fraction of the LFG Manufacturer: Siemens Model: Ultramat 23 Serial Number: N1KN773 Accuracy: ±1% Required calibration frequency: 1 year LFG plant comissioning date: 27/11/2019 Date(s) and validity of performed calibration event(s) valid for the considered monitoring period: Manufacture's calibration: 29/01/2019 (validity 26/11/2020) Calibration: 30/11/2020 (validity 29/11/2020)
Measuring/reading/recording frequency	Continuous measurements will be recorded and reported with an every-minute frequency.
Calculation method (if applicable)	Not applicable
QA/QC procedures	Periodic calibration events in the continuous CH_4 content gas analyzer will be performed by utilization of calibration span gas with certified CH_4 content (for span checking/adjustment). Utilization of an inert calibration gas (e.g. N_2) will also occur (for span checking/adjustment). All calibration gases (span gases) must have a certificate provided by the gas supplier and must be under their validity period. Periodic calibration events will be performed in a frequency as per instrument specifications and/or instrument manufacturer's recommendations. Instrument will be subject to a regular maintenance and testing regime in accordance to appropriate national / international standards/requirements and/or best practice.
Purpose of data/parameter	Data will be used for the determination of baseline emissions.
Additional comments	For the period from 27/11/2020 to 29/11/2020 the instrument was out of the previous calibration validity period. This has been taken into account accordingly in the ER calculations.

Data/Parameter	$v_{k,t,db}$
Unit	m^3 gas k/m^3 dry gas
Description	Volumetric fraction of gas k in the gaseous stream in time interval t on a dry basis
Measured/calculated/ default	Measured
Source of data	Measured as part of the operation of the CPA-03 CTR Petrolina Landfill Gas Project by applying appropriate continuous CH_4 content gas analyzer
Value(s) of monitored parameter	The monthly emission reduction calculation spreadsheets report all data of CH4 volumetric fraction of the LFG during the monitoring period. Measurement data is recorded and reported every minute (60s frequency).

Monitoring equipment	Continuous gas analyser operating in dry-basis It is assumed that gas i and k are the same (methane). Thus, $v_{k,t,db} = v_{i,t,db}$ CH4 volumetric fraction of the LFG Manufacturer: Siemens Model: Ultramat 23 Serial Number: N1KN773 Accuracy: ±1% Required calibration frequency: 1 year LFG plant comissioning date: 27/11/2019 Date(s) and validity of performed calibration event(s) valid for the considered monitoring period: Manufacture's calibration: 29/01/2019 (validity 26/11/2020) Calibration: 30/11/2020 (validity 29/11/2020)
Measuring/reading/recording frequency	Continuous measurements will be recorded and reported with an every-minute frequency.
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	Calculation of baseline emissions and/or project emissions
Additional comments	It is assumed that gas i and k are the same (methane). Thus, $v_{k,t,db} = v_{i,t,db}$

Data/Parameter	**T_t**
Unit	K
Description	Temperature of the gaseous stream in time interval t
Measured/calculated/ default	Measured
Source of data	Measured as part of the operation of the CPA-03 CTR Petrolina Landfill Gas Project by applying appropriate LFG temperature sensor(s).
Value(s) of monitored parameter	Measurements are performed by the installed LFG temperature sensors The monthly emission reduction calculation spreadsheets report all data of of the LFG temperature during the monitoring period. Measurement data is recorded and reported every minute (60s frequency).
Monitoring equipment	LFG temperature sensors Manufacturer: ELSI Model: PT100 Serial Number: E19TP0072 Accuracy: ±0.3% ºC Required calibration frequency: 2 years Date(s) and validity of performed calibration event(s) valid for the considered monitoring period: Manufacture's calibration: 06/02/2019 (validity 05/02/2021)
Measuring/reading/recording frequency	Continuous measurements will be recorded and reported with an every-minute frequency.

Calculation method (if applicable)	N/A
QA/QC procedures	Periodic calibration events will be performed in the LFG temperature sensor(s) by a third party independent accredited calibration laboratory in a frequency as per instrument specifications and/or instrument manufacturer's recommendations. Instrument(s) will be subject to a regular maintenance and testing regime in accordance to appropriate national/international standards/requirements and/or best practice.
Purpose of data/parameter	Data will be used for the determination of baseline emissions.
Additional comments	In case of measurements for the applicable LFG flow parameter(s) are automatically converted and recorded in normalized cubic meters (by considering standard temperature and pressure (STP) conditions), monitoring of this parameter may not be required.

Data/Parameter	**P_t**
Unit	Pa
Description	Pressure of the gaseous stream in time interval t *t*
Measured/calculated/ default	Measured
Source of data	Measured as part of the operation of the CPA-03 CTR Petrolina Landfill Gas Project by applying appropriate LFG pressure sensor(s).
Value(s) of monitored parameter	Continuously measurements are performed by a LFG pressure sensor installed along the LFG pipeline of the CPA The monthly emission reduction calculation spreadsheets report all data of of the LFG pressure during the monitoring period. Measurement data is recorded and reported every minute (60s frequency).
Monitoring equipment	LFG pressure sensors Manufacturer: ABB Model: 266 HSH Accuracy: ±0.06% Serial Number: 3K646619001186 Required calibration frequency: 4 years and 7 months Initial Calibration: 10/01/2019 Calibration validity: 09/08/2023
Measuring/reading/recording frequency	Continuous measurements will be recorded and reported with an every-minute frequency.
Calculation method (if applicable)	N/A
QA/QC procedures	Periodic calibration events will be performed in the LFG pressure sensor(s) by a third party independent accredited calibration laboratory in a frequency as per instrument specifications and/or instrument manufacturer's recommendations. Instrument(s) will be subject to a regular maintenance and testing regime in accordance to appropriate national/international standards/requirements and/or best practice. Spare instrument(s) may be kept.
Purpose of data/parameter	Data will be used for the determination of baseline emissions.
Additional comments	-

Data/Parameter	$EC_{PJ,j,y}$
Unit	MWh
Description	Quantity of electricity consumed by the project electricity consumption source j in year y
Measured/calculated/ Default	Measured
Source of data	Measured.The project activity has a dedicated electricity meter installed by the CELPE, the local utility company.
Value(s) of monitored parameter	36.17 MWh from August 13 2020 to December 31 2020
Monitoring equipment	Manufacturer: ELSTER Model: A1055 IND Accuracy: Class C ±1% Serial Number: 3180676154 Required calibration frequency: Every 5 years Date of installation: 10/02/2020 Validity of the calibration: 09/02/2025
Measuring/reading/recording frequency	Continuous measurement and at least monthly recording
Calculation method (if applicable)	N/A
QA/QC procedures	Periodic calibration events will be performed in a frequency as per instrument specifications and/or instrument manufacturer's recommendations. Instrument(s) will be subject to a regular maintenance and testing regime in accordance to appropriate national / international standards/requirements and/or best practice. The accuracy class of the meters should be in accordance with the stipulation of the meter supplier and/or as per the requirements set by the grid operators or national requirements.
Purpose of data/parameter	Data will be used for the determination of project emissions.
Additional comments	The meter from the utility company, CELPE, is not managed by the PE. Measurement records can be crosschecked against available grid-sourced electricity purchasing receipts/invoices.

Data/Parameter	$EG_{EC,y}$
Unit	MWh
Description	Amount of electricity consumed by the project activity in year y
Measured/calculated/ default	Measured
Source of data	Measure.The project activity has a dedicated electricity meter installed by the CELPE, the local utility company. This is a bidirectional meter, i.e. the meter is used for both electricity consumption from the grid and electricity injected into the grid by the project
Value(s) of monitored parameter	36.17 MWh from August 13 2020 to December 31 2020
Monitoring equipment	Manufacturer: ELSTER Model: A1055 IND Accuracy: Class C ±1% Serial Number: 3180676154 Required calibration frequency: Every 5 years Date of installation: 10/02/2020 Validity of the calibration: 09/02/2025

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 ofthe meter supplier) maintenance and testing to ensure accuracy. The readings will be double checked by the electricity distribution company
Purpose of data/parameter	Calculation of project emissions due to electricity consumption ($BE_{EC,y}$)
Additional comments	$EG_{EC,y} = EC_{PJ,j,y}$ (CPA consumes only electric energy from the grid)

Data/Parameter	**$EF_{grid,OM,y}$**
Unit	tCO_2/MWh
Description	Operating margin CO2 emission factor for the project electricity system in year y
Measured/calculated/ default	Calculated
Source of data	Brazilian Ministry of Science, Technology and Innovation (MSTI) https://antigo.mctic.gov.br/mctic/opencms/ciencia/SEPED/clima/textogeral/emissao_despacho.html Calculated according to TOOL07
Value(s) of monitored parameter	0.4539
Monitoring equipment	N/A
Measuring/reading/recording frequency	yearly compiled
Calculation method (if applicable)	Calculated as the average of the monthly opering margins reported by the MSTI
QA/QC procedures	Official source of data
Purpose of data/parameter	Calculation of baseline emissions associated with electricity generation ($BE_{EC,y}$)
Additional comments	**$EF_{grid,OM,y} = EF_{grid,OM-DD,y}$**

Data/Parameter	**$EF_{grid,CM,y}$**
Unit	tCO_2/MWh
Description	Combined margin emission factor for the grid in year y
Measured/calculated/ default	Calculated
Source of data	Calculated according to TOOL07
Value(s) of monitored parameter	0.29545
Monitoring equipment	Value will be determined at an individual/specific CPA level as per applicable guidance for dispatch data analysis operating margin CO_2 emission factor of the “Tool to calculate the emission factor for an electricity system”.
Measuring/reading/recording frequency	Yearly
Calculation method (if applicable)	$EF_{grid,CM,y} = EF_{grid,BM,y} * 50\% + EF_{grid,CM,y} * 50\%$
QA/QC procedures	Official source of data
Purpose of data/parameter	Calculation of baseline emissions and/or project emissions.
Additional comments	Applicable to scenarios A and C (cases C.I and C.III).

Data/Parameter	**$Op_{j,h}$**
Unit	-
Description	Operation of the equipment that consumes the LFG
Measured/calculated/ default	Measured
Source of data	Available every-minute records of the status of the Flare and the Generator are reported by the monitoring software every minute
Value(s) of monitored parameter	See details in the applicable monitoring details table
Monitoring equipment	Flare: The system monitors the temperature of the flare and the LFG. Please refer to **$Flame_m$** Generator: The system monitors the electricity generated to ensure that the equipment is in operation. Please refer to **$EG_{PJ,y}$** $O_{pj,h}$ = 0 when: • Flame is not detected continuously in hour *h* (instantaneous measurements are made at least every minute); • Electricity is not generated in the hour *h.* Otherwise, $O_{pj,h}$ = 1
Measuring/reading/recording frequency	Hourly or continuously (every minute)
Calculation method (if applicable)	Not Applicable
QA/QC procedures	-
Purpose of data/parameter	Calculation of baseline emissions and project emissions.
Additional comments	In the particular case of the CPA-03 CTR Petrolina Landfill Gas Project the only equipment that may consume LFG within the project boundary are the engine-generator set(s) of the electricity generation infrastructure.

Data/Parameter	**$p_{H20,t,Sat}$**
Unit	Pa
Description	Saturation pressure of H_2O at temperature $T_{t,j}$ in time interval *t*
Measured/calculated/ default	Default as per the literature
Source of data	Data as per the literature "*Fundamentals of Classical Thermodynamics*"; Authors: Gordon J. Van Wylen, Richard E. Sonntag and Borgnakke; 4º Edition 1994. Published by John Wiley & Sons, Inc. (normative reference for the methodological tool "Tool to determine the mass flow of greenhouse gas in a gaseous stream")
Value(s) of monitored parameter	No estimated value is required for the determination of ex-ante estimation of emission reduction to be achieved by the CPA-03 CTR Petrolina Landfill Gas Project
Monitoring equipment	This parameter is solely a function of the LFG stream temperature $T_{t,j}$ and can be found at above-referenced literature for a total pressure equal to 101,325 Pa.
Measuring/reading/recording frequency	-

Calculation method (if applicable)	N/A
QA/QC procedures	-
Purpose of data/parameter	Data will be used for the determination of baseline emissions.
Additional comments	-

Data/Parameter	**$EC_{BL,k,y}$**
Unit	MWh/yr
Description	Quantity of electricity that would be consumed by the baseline electricity consumption source k in year y
Measured/calculated/ default	Calculated
Source of data	Calculated as the measured gross electricity produced by the generator minus the measured electricity consumed internally by the generator, minus other consumptions from the LFG plant.
Value(s) of monitored parameter	3,022.68 MWh from August 13 2020 to December 31 2020
Monitoring equipment	Meter A: Gross Electricity generated Manufacturer: ABB Model: A44 112-100 Accuracy: ±1% Serial Number: 2CMA1002481000 Required calibration frequency: Every 5 years Date of installation: 15/11/2019 Validity of the calibration: 14/11/2024 Meter B: Generator Internal Electricity consumption Manufacturer: IME Model: CE4DMID01 Accuracy: ±1% Serial Number: NA Date of installation: 15/11/2019 Validity of the calibration: 14/11/2024 Meter C: LFG plant electricity consumption (same as $EG_{EC,y} = EC_{PJ,j,y}$) Manufacturer: ELSTER Model: A1055 IND Accuracy: Class C ±1% Serial Number: 3180676154 Required calibration frequency: Every 5 years Date of installation: 10/02/2020 Validity of the calibration: 09/02/2025
Measuring/reading/recording frequency	Continuous measurement and at least monthly recording
Calculation method (if applicable)	N/A

QA/QC procedures	Periodic calibration events will be performed in a frequency as per instrument specifications and/or instrument manufacturer's recommendations. Instrument will be subject to a regular maintenance and testing regime in accordance to appropriate national/international standards/requirements and/or best practice. The accuracy class of the meters should be in accordance with the stipulation of the meter supplier and/or as per the requirements set by the grid operators or national requirements. Measurement records will be cross-checked against available electricity sales receipts/invoices issued by the local electricity commercialization/distribution company.
Purpose of data/parameter	Data will be used for the determination of baseline emissions.
Additional comments	$EC_{BL,k,y} = EG_{PJ,y} = EG_{PJ,grid,y}$

Data/Parameter	**$EG_{PJ,y}$**
Unit	MWh
Description	Amount of electricity generated using LFG by the project activity in year y
Measured/calculated/ default	Calculated
Source of data	Calculated as the measured gross electricity produced by the generator minus the measured electricity consumed internally by the generator, minus other consumptions from the LFG plant.
Value(s) of monitored parameter	3,022.68 MWh in 2020 from August 13 2020 to December 31 2020
Monitoring equipment	Meter A: Gross Electricity generated Manufacturer: ABB Model: A44 112-100 Accuracy: ±1% Serial Number: 2CMA1002481000 Required calibration frequency: Every 5 years Date of installation: 15/11/2019 Validity of the calibration: 14/11/2024 Meter B: Generator Internal Electricity consumption Manufacturer: IME Model: CE4DMID01 Accuracy: ±1% Serial Number: NA Date of installation: 15/11/2019 Validity of the calibration: 14/11/2024 Meter C: LFG plant electricity consumption (same as $EG_{EC,y} = EC_{PJ,j,y}$) Manufacturer: ELSTER Model: A1055 IND Accuracy: Class C ±1% Serial Number: 3180676154 Required calibration frequency: Every 5 years Date of installation: 10/02/2020 Validity of the calibration: 09/02/2025
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	Calculation of baseline emissions associated with electricity generation ($BE_{EC,y}$)
Additional comments	$EC_{BL,k,y} = EG_{PJ,y} = EG_{PJ,grid,y}$

Data/Parameter	**$EG_{PJ,grid,y}$**
Unit	MWh/year
Description	Quantity of electricity generated and supplied by the project power plant to the grid in year y
Measured/calculated/ default	Calculated
Source of data	Calculated as the measured gross electricity produced by the generator minus the measured electricity consumed internally by the generator, minus other consumptions from the LFG plant.
Value(s) of monitored parameter	3,022.68 MWh from August 13 2020 to December 31 2020
Monitoring equipment	Meter A: Gross Electricity generated Manufacturer: ABB Model: A44 112-100 Accuracy: ±1% Serial Number: 2CMA1002481000 Required calibration frequency: Every 5 years Date of installation: 15/11/2019 **Validity of the calibration:** 14/11/2024 Meter B: Generator Internal Electricity consumption Manufacturer: IME Model: CE4DMID01 Accuracy: ±1% Serial Number: NA Date of installation: 15/11/2019 **Validity of the calibration:** 14/11/2024 Meter C: LFG plant electricity consumption (same as $EG_{EC,y} = EC_{PJ,j,y}$) Manufacturer: ELSTER Model: A1055 IND Accuracy: Class C ±1% Serial Number: 3180676154 Required calibration frequency: Every 5 years Date of installation: 10/02/2020 **Validity of the calibration:** 09/02/2025
Measuring/reading/recording frequency	Continuous measurement and at least monthly recording
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	Calculation of baseline emissions and/or project emissions.
Additional comments	$EC_{BL,k,y} = EG_{PJ,y} = EG_{PJ,grid,y}$

Data/Parameter	$Flame_m$
Unit	Flame on or Flame off
Description	Flame detection of flare in the minute m
Measured/calculated/ default	Measured
Source of data	Available every-minute records of the status of the flame are reported by the monitoring software every minute. The system has a flame detection system to ensure that the equipment is in operation; As per the logic within the monitoring system, the flame is detected when the system measures an increase over the ambient temperature by means of the flare thermocouple. This information is checked against the LFG flow to the flare. When both informations are aligned, the system records the flame detection as ON. Otherwise, the system records the flame as OFF.
Value(s) of monitored parameter	See details in the applicable monitoring ER calculation table
Monitoring equipment	Thermocouple: Manufacturer: TEMA Model: TC-K Serial Number: 1920530 Required calibration frequency: not required LFG Volumetric flow to the Flare Manufacturer: ABB Model: 266 DSH Accuracy: ±0.075% Serial Number: 3K646619001181 Required calibration frequency as per manufacture's specification: 4 years and 1 month from the date of commissioning. Initial Calibration: 10/01/2019 Calibration validity: 09/08/2023
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)	N/A
QA/QC procedures	Equipment shall be maintained and calibrated in accordance with manufacturer's recommendations
Purpose of data/parameter	Calculation of project emissions from flaring ($PE_{flare,y}$)
Additional comments	-

Data/Parameter	Status of biogas destruction device
Unit	-
Description	Operational status of biogas destruction devices
Measured/calculated/ default	Measured
Source of data	Available every-minute records of the status of the Flare and the Generator are reported by the monitoring software every minute
Value(s) of monitored parameter	See details in the applicable monitoring details table

Monitoring equipment	Flare: The system monitors the temperature of the flare and the LFG. Please refer to **$Flame_m$** Generator: The system monitors the electricity generated to ensure that the equipment is in operation. Please refer to **$EG_{PJ,y}$** $O_{pj,h}$ = 0 when: • Flame is not detected continuously in hour *h* (instantaneous measurements are made at least every minute); • Electricity is not generated in the hour *h.* Otherwise, $O_{pj,h}$ = 1
Measuring/reading/recording frequency	Continuous if not specified in the underlying methodology/tool
Calculation method (if applicable)	N/A
QA/QC procedures	-
Purpose of data/parameter	Calculation of project emissions from flaring ($PE_{flare,y}$)
Additional comments	For Flame detector devices refer to TOOL06.

Data/Parameter	**$TDL_{j,y}$ and $TDL_{k,y}$**
Unit	-
Description	Average technical transmission and distribution losses for providing electricity to source j and k in year y
Measured/calculated/ default	Default
Source of data	Default value as 20% from TOOL05 - Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricitygeneration
Value(s) of monitored parameter	20%
Monitoring equipment	N/A
Measuring/reading/recording frequency	N/A
Calculation method (if applicable)	N/A
QA/QC procedures	-
Purpose of data/parameter	Calculation of baseline emissions and/or project emissions.
Additional comments	-

E.3. Implementation of sampling plan

>>

Not applicable.

SECTION F. Calculation of emission reductions or net anthropogenic removals

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

>>

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

$$BEy = BE_{CH4,y} + BE_{EC,y} + BE_{HG,y} + BE_{NG,y}$$ **Equation 1 (PoA-DD)**

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)

- Since heat generation is not include in the PoA boundaries, $BE_{HG,y}$ parameter is zero.
- Since natural gas use is not included this CPA, $BE_{NG,y}$ parameter is zero.
- Since heat generation is not included this CPA, $BE_{HG,y}$ parameter is zero.

Thus,

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

Baseline emissions of methane from the SWDS (BECH4,y)

Baseline emissions of methane from the SWDS are determined, based on the amount of methane that is captured under the project activity and the amount that would be captured and destroyed in the baseline (such as due to regulations). In addition, the effect of methane oxidation that is present in the baseline and absent in the project is taken into account[1].

$$BE_{CH4,y} = ((1 - OX_{top\_layer}) \times F_{CH4,PJ,y} - F_{CH4,BL,y}) \times GWP_{CH4}$$ **Equation 2 (PoA-DD)**

Where:

$BE_{CH4,y}$ = Baseline emissions of methane from the SWDS in year *y* (tCO_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* (tCH_4/yr) ;

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

$F_{CH4,BL,y}$ = Amount of methane in the LFG that would be flared in the baseline in year *y* (tCH_4/yr) ;
GWP_{CH4} = Global warming potential of CH_4 ($t\ CO_2e/t\ CH_4$).

- ***Determination of $F_{CH4,BL,y}$***

$F_{CH4,BL,y}$ is determined depending on the requirement to destroy methane and the existence of methane capture system in the baseline:

Table 1: ACM0001 cases available for the determination of the methane that would be flared in the baseline.

Situation at the start of the project activity	Requirement to destroy methane	Existing LFG capture and destruction system
Case 1	No	No
Case 2	Yes	No
Case 3	No	Yes
Case 4	Yes	Yes

Case 4 is the applicable case for this CPA.

Case 4: Requirement to destroy methane exists and LFG capture system exists

$$F_{CH4,BL,y} = \max\left(F_{CH4,BL,R,y}; F_{CH4,BL,sys,y}\right)$$ **Equation 13 (PoA -DD)**

Where,

$F_{CH4,BL,R,y}$ = Amount of methane in the LFG which is flared in the baseline due to a requirement in year y (tCH_4/yr);
$F_{CH4,BL,sys,y}$ = 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 (tCH_4/yr).

$F_{CH4,BL,R,y}$ and $F_{CH4,BL.sys,y}$ are determined according to the respective procedures for Case 2 and Case 3 above.

According to Case 2 procedures:

- If the requirement does not specify the amount or percentage of LFG that should be destroyed but requires the installation of a capture system, without requiring the captured LFG to be flared then:

$F_{CH4,BL,R,y} = 0$

According to Case 3 procedures:

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

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

In determining $F_{CH4,hist,y}$ it is assumed that the fraction of LFG that was recovered in the year prior to the implementation of the project activity will be the same fraction recovered under the project activity:

$$F_{CH4,hist,y} = \frac{F_{CH4,BL,x-1}}{F_{CH4,PJ,y}} \cdot F_{CH4,x-1}$$

Where:

$F_{CH4,hist,y}$	=	Historical amount of methane in the LFG which is captured and destroyed (tCH_4/yr)
$F_{CH4,BL,x-1}$	=	Historical amount of methane in the LFG which is captured and destroyed in the year prior to the implementation of the project activity (tCH_4/yr)
$F_{CH4,x-1}$	=	Amount of methane in the LFG generated in the SWDS in the year prior to the implementation of the project activity (tCH_4/yr)
$F_{CH4,PJ,y}$	=	Amount of methane in the LFG which is captured in the project activity in year y (tCH_4/yr)

$F_{CH4,BL,x-1}$ can be evaluated as a fraction of $F_{CH4,x-1}$, therefore:

$$F_{CH4,BL,x-1} = MD_{BL} \cdot F_{CH4,x-1}$$

Where:

$F_{CH4,BL,x-1}$	=	Historical amount of methane in the LFG which is captured and destroyed in the year prior to the implementation of the project activity (tCH_4/yr)
MD_{BL}	=	Methane destruction efficiency in the baseline (-)
$F_{CH4,x-1}$	=	Amount of methane in the LFG generated in the SWDS in the year prior to the implementation of the project activity (tCH_4/yr)

According to the study "*Reducing the uncertainty of methane recovered (R) in GHG inventories from waste sector and of adjustment factor (AF) in landfill gas projects under CDM"*, 154 Brazilian municipal solid waste landfills were analyzed, and those which have available historic data (from reliable sources, as Brazilian Ministry of Cities, Brazilian Ministry of Environment and from landfill managers) had their methane destruction efficiency in the baseline (MD_{BL}) calculated, following the methodology *ACM0001*. Then, an average of this value was found among those landfills, in order to contribute for better estimating MD_{BL} in landfill gas destruction projects in Brazil, under the CDM. Project participants decided to use this study in order to contribute for better calculation of the $F_{CH4,hist,y}$ parameter.

As per the studies, a collection efficiency of 85% was attributed to the passive systems, what the authors acknowledge to be a conservative approach, not reflecting the reality of existent passive systems commonly used in Brazil, and the sampled average MD_{BL} for those projects was 0.0176 and weighted average MD_{BL} was 0.0040 or, respectively, 1.76% and 0.40%. Regarding that the use of the sampled average MD_{BL} from the cited study is more conservative, for the project activity a methane destruction efficiency of 1.76% will be used for estimating the $F_{CH4,BL,x-1}$.

Therefore, the equation is updated to:

$$F_{CH4,BL,x-1} = 1.76\% \cdot F_{CH4,x-1}$$

The equation is then updated to:

$$F_{CH4,hist,y} = \frac{1.76\% \cdot F_{CH4,x-1}}{F_{CH4,PJ,y}} \cdot F_{CH4,x-1}$$

Or

$F_{CH4,hist,y} = 1.76\% \cdot F_{CH4,PJ,y}$

Since the amount of methane in the LFG which is flared in the baseline ($F_{CH4,BL,y}$) shall be the major value, between those given in equations above and it is then determined that:

$F_{CH4,BL,y} = 1.76\% \cdot F_{CH4,PJ,y}$

- ***Ex-ante determination of $F_{CH4,PJ,y}$***

An *ex-ante* estimate of $F_{CH4,PJ,y}$ is required to estimate baseline emission of methane from the SWDS as follows:

$$F_{CH4,PJ,y} = \frac{\eta_{PJ} \times BE_{CH4,SWDS,y}}{GWP_{CH4}}$$ **Equation 14 (PoA-DD)**

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);

η_{PJ} = Efficiency of the LFG capture system that will be installed in the project activity;

$BE_{CH4,SWDS,y}$ = Amount of methane in the LFG that is generated from the SWDS in the baseline scenario in year y (tCO_2e/yr);

GWP_{CH4} = Global warming potential of CH_4 (tCO_2e/tCH_4).

$BE_{CH4,SWDS,y}$ shall be determined following TOOL04 while using Application A as follows:

$$BE_{CH_4,SWDS,y} = \varphi_y \times (1 - f_y) * GWP_{CH_4} * (1 - OX) * \frac{16}{12} * F * DOC_{f,y} * MCFy * \sum_{x=1}^{} \sum_{j} (W_{j,x} * DOC_j \times e^{-k_j(y-x)} * (1 - e^{-k_j}))$$ **Equation 15 (PoA-DD)**

Where:

$BE_{CH4,SWSD,y}$ = Baseline methane emissions occurring in year y generated from waste disposal at the solid waste disposal site (SWDS) during a period ending in year y (tCO_2e/y);

φ = Model correction factor to account for model uncertainties (default value of 0.75), Option 1 in the Tool has been selected, value as per Table 3 of the Tool (Application A);

f = Fraction of methane captured at the SWDS and flared, combusted or used in another manner that prevents the emissions of methane to the atmosphere in year y. As this is already accounted for in ***$F_{CH4,BL,y}$***, "f" in the Tool shall be assigned a value of 0;

GWP_{CH4} = Global Warming Potential (GWP) of methane, valid for the relevant commitment period;

OX = Oxidation factor (reflecting the amount of methane from SWDS that is oxidized in the soil or other material covering the waste) (default Tool value 0.1);

F = Fraction of methane in the SWDS gas (volume fraction) (0.5);

$DOC_{f,y}$ = Fraction of degradable organic carbon (DOC) that decomposes under the specific conditions occurring in the SWSD for year y (weight fraction). Default value of 0.5 used as per page 14 of the Tool;

MCF_y = Methane correction factor for year y (1);
$W_{j,x}$ = Amount of solid waste type j disposed or prevented from disposal in the SWDSin the year *x* (t);
DOC = Fraction of degradable organic carbon (by weight fraction) in the waste type *j;*
k_j = Decay rate for the waste type *j (1/yr);*
j = Type of residual waste or types of waste in the MSW;
x = Years in the time period in which waste is disposed at the SWSD, extendingfrom the first year in the time period (x=1) to year (x = y);
y = Year for which methane emissions are calculated (considering a consecutiveperiod of 12 months).

While following TOOL04, ACM0001 requires:

(a) f_y in the tool shall be assigned a value of 0 because the amount of LFG that would have been captured and destroyed is already accounted for in equation 2 above;
(b) In the tool, x begins with the year that the SWDS started receiving wastes (e.g. the first yearof SWDS operation); and
(c) Sampling to determine the fractions of different waste types is not necessary because thewaste composition can be obtained from previous studies.

- ***Ex-post determination of $F_{CH4,PJ,y}$***

During the crediting period, $F_{CH4,PJ,y}$ is to be determined as the sum of the quantities of methane flared and forwarded to the electricity generation plant, considering the following equation:

$$F_{CH4,PJ,y} = F_{CH4,flared,y} + F_{CH4,EL,y}$$ **Equation 16 (PoA-DD)**

Where:

$F_{CH4,PJ,y}$ = Amount of methane in the LFG which is flared and/or used in the project activity in year *y* (tCH_4/yr);
$F_{CH4,flared,y}$ = Amount of methane in the LFG which is destroyed by flaring in year *y* (tCH_4/yr);
$F_{CH4,EL,y}$ = Amount of methane in the LFG which is used for electricity generation in year *y* (tCH_4/yr);

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

$$F_{CH4,flared,y} = F_{CH4,sent\_flare,y} - \frac{PE_{flare,y}}{GWP_{CH4}}$$ **Equation 17 (PoA-DD)**

Where:

$F_{CH4,flared,y}$ = Amount of methane in the LFG which is destroyed by flaring in year *y* (tCH_4/yr);
$F_{CH4,sent\_flare,y}$ = Amount of methane in the LFG which is sent to the flare in year *y* (tCH_4/yr);
$PE_{flare,y}$ = Project emissions from flaring of the residual gas stream in year *y* (tCO_2e/yr);
GWP_{CH4} = Global warming potential of CH_4 ($tCO_2e/t\ CH_4$).

$F_{CH4,sent\_flare,y}$ is determined directly using TOOL08 and $PE_{flare,y}$ is determined while using TOOL06. If LFG is flared through more than one flare, then $PE_{flare,y}$ is the sum of the emissions for each flare determined separately.

$F_{CH4,EL,y}$ is determined using TOOL08 and monitoring the working hours of the power plant, so that no emission reduction are claimed for methane destruction during non-working hours. Therefore, working hours shall be monitored for the equipment that consumes the LFG ($Op_{j,h,y}$), following ACM0001 specifications.

TOOL08 presents the following options to determine the mass flow of GHG i in a gaseous stream $F_{i,t}$:

Table 2: Options available for the determination of GHG in a gaseous stream.

Option	Flow of gaseous stream	Volumetric fraction
A	Volume flow – dry basis	dry or wet basis
B	Volume flow – wet basis	dry basis
C	Volume flow – wet basis	wet basis
D	Mass flow – dry basis	dry or wet basis

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 A and B** should be applied instead.

This CPA adopts the options A and B presented in Table 2.

In the Option A, the flow measurement on a dry basis is not doable for a wet gaseous stream, so it is necessary to demonstrate that the gaseous stream is dry to use this option. There are two ways to do this:

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

(b) Demonstrate that the temperature of the gaseous stream (Tt) is less than 60ºC (333.15 K) atthe flow measurement point.

In cases where it cannot be demonstrated that the gaseous stream is dry, according to TOOL08the flow measurement should be assumed to be on a wet basis, due to Option B.

While applying option B, the absolute humidity is required for calculations, which may be calculated based on two options: Option 1, which calculated the humidity trough the measurement of the moisture content and; and Option 2, applied on this CPA, that provides a 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.

If it is conservative to assume that the gaseous stream is dry, then $m_{H2O,t,db}$ is assumed to equal 0. If it is conservative 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 as follows:

$$m_{H2O,t,db,sat} = \frac{p_{H2O,t,sat} \times MM_{H2O}}{(P_t - p_{H2O,t,sat}) \times MM_{t,db}}$$ **Equation 21 (PoA-DD)**

Where:

$m_{H2O,t,db,sat}$ = Saturation absolute humidity in time interval t on a dry basis (kgH_2O/kg dry gas);
$p_{H2O,t,sat}$ = 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).

Equation and methods for each of the options available to calculateare as follows:

Option A: flow of gaseous stream in dry basis and volume fraction in dry or wet basis

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

$$F_{i,t} = V_{t,db} \times v_{i,t,db} \times \rho_{i,t}$$ **Equation 22 (PoA-DD)**

With:

$$\rho_{i,t} = \frac{P_t \times MM_i}{R_u \times T_t}$$ **Equation 23 (PoA-DD)**

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 (Pa.m^3/kmol.K);
T_t = Temperature of the gaseous stream in time interval t (K).

Option B: flow of gaseous stream in wet basis and volume fraction in dry basis

The mass flow of greenhouse gas i ($F_{i,t}$) is determined according to equations 22 and 23. 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:

$$V_{t,db} = \frac{V_{t,wb}}{(1 + \times v_{H2O,t,db})}$$

Equation 24 (PoA-DD)

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).

And:

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

Equation 25 (PoA-DD)

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), calculated using option 1 or 2 above;

$MM_{t,db}$ = Molecular mass of the gaseous stream in time interval t on a dry basis (kg dry gas/kmol dry gas) using equation 21;

MM_{H2O} = Molecular mass of H_2O (kg H_2O/kmol H_2O).

For the considered monitoring period, the accumulated value for $F_{CH4,PJ,y} = F_{CH4,EL} + F_{CH4,flared,y}$ is calculated as 630.9 tCH_4.

For the considered monitoring period, baseline emissions of methane from the SWDS ($BE_{CH4,y}$) are calculated as

$BE_{CH4} = ((1\text{-}OX_{top\_layer}) \times F_{CH4,PJ} - F_{CH4,BL}) \times GWP_{CH4}$
$= [(1\text{-}0.1) * 630.9 – 1.78\%*630.9] * 25 = 13{,}915$ tCO_2e.

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

$BE_{EC,y}$ shall be calculated using TOOL05, where:

(a) The electricity sources k in the tool correspond to the sources of electricity generated identified in the selection of the most plausible baseline scenario; and

(b) $EC_{BL,k,y}$ in the tool is equivalent to the net amount of electricity generated using LFG in year y($EG_{PJ,y}$).

According to TOOL05, the generic approach is as follows:

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

Equation 31 (PoA-DD)

Where:

$BE_{EC,y}$ = Baseline emissions from electricity consumption in year y (tCO_2 / yr);

$EC_{BL,k,y}$ = Net amount of electricity generated using LFG in year *y* (MWh/yr) ;
$EF_{EL,k,y}$ = 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 ;*
k = Sources of electricity generated in the baseline.

$EF_{EL,k,y}$ depends on the scenarios of electricity generation:

Scenario A: Electricity consumption from the grid

- Option A1: calculate de combined margin emission factor of the grid using the steps of TOOL07, where $EF_{EL,j/k/l,y} = EF_{grid,CM,y.}$

Since option chosen is A1 where the combined margin emission factor of the grid is used ($EF_{EL,j/k/l,y}$ = $EF_{grid,CM,y}$), steps of TOOL07 shall be considered as follows:

- STEP 1 – Identify the relevant electricity systems

According to the tool, "*If the DNA of the host country has published a delineation of the project electricity system and connected electricity systems, these delineations should be used. If such delineations are not available, project participants should define the project electricity system and any connected electricity system and justify and document their assumptions in the CDM-PDD*".

The Brazilian DNA published Resolution #8, issued on May 26th, 2008, defines the Brazilian Interconnected Grid as a single system that covers all the five macro-geographical regions of the country (North, Northeast, South, Southeast and Midwest). Hence this figure is used to calculate the baseline emission factor of the grid.

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

Option I of the tool is chosen, which includes only grid power plants in the operating margin and build margin emission factor.

- STEP 3 – Select a method to determine 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 simple operating margin can only be used where low-cost/must-run resources[2] constitute less than 50% of total grid generation in: 1) average of 5 most recent years, or 2) based on long-term

[2] Low operating cost and must run resources typically include hydro, geothermal, wind, low-cost biomass, nuclear and solar generation.

normalities for hydroelectricity production. Figure 1 shows the share of hydroelectricity in the total electricity production for the Brazilian Interconnected System. The results show the non- applicability of the simple operating margin to the proposed CPA.

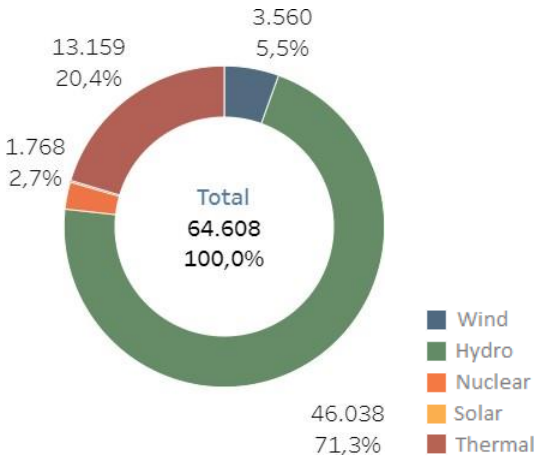

Figure 1: Electricity generation in Brazilian by source, 2014 to 2018(GWh)[3]

The fourth alternative, an average operating margin, is an oversimplification and does not reflect in any way the impact of the project activity on the operating margin. Therefore, option b) and c) are the only available options, which are also calculated and made publicly available by the Brazilian DNA. Following the approach chosen for the first crediting period, option c) is chosen applying the *ex-post* data vintage.

- **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 grid power units that are actually dispatched at the margin during each hour h where the project is displacing grid electricity. This approach is not applicable to historical data and, thus, requires annual monitoring of $EF_{grid,OM-DD,y}$.

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

Equation 35 (PoA-DD)

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 of year y (MWh);
$EF_{EL,DD,h}$	=	CO_2 emission factor for grid 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.

The $EF_{EL,DD,h}$ parameter is calculated and updated by the Brazilian DNA.

[3] http://www.ons.org.br/Paginas/resultados-da-operacao/historico-da-operacao/geracao_energia.aspx

- **STEP 5** – Calculate the build margin (BM) emission factor

The sample group of power units *m* used to calculate the build margin was determined following the procedure provided by the tool and BM emission factor shall be calculated based on the equation below:

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

Equation 36 (PoA-DD)

Where:

$EF_{grid,BM,y}$	=	Build margin CO_2 emission factor in year y (tCO_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 (tCO_2/MWh);
m	=	Power units included in the build margin;
y	=	Most recent historical year for which electricity generation data is available.

The $EF_{grid,BM,y}$ parameter is calculated and updated by the Brazilian DNA.

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 shall 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 emissions 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 1 was chosen for the proposed CPA, in line with the registered PoA-DD.

- **STEP 6** – Calculate the combined margin (CM) emissions factor

The calculation of the combined margin (CM) emission factor is based on one of the followingmethods:

(a) Weighted average CM; or
(b) Simplified CM.

Since power grid is not located in LDC/SIDs/URC and the weighted average CM method (option a) is the preferred option, this method was considered. The combined margin emissions factor is calculated as follows:

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

Equation 37 (PoA-DD)

Where: $EF_{grid,BM,y}$ = Build margin CO_2 emission factor in year y (tCO_2/MWh);
$EF_{grid,OM,y}$ = Operating margin CO_2 emission factor in year y (tCO_2/MWh);
w_{OM} = Weighting of operating margin emissions factor (%);
w_{BM} = Weighting of build margin emissions factor (%).

According to TOOL07, values adopted for w_{OM} and w_{BM} are equal to 0.5 for both parameters during the 1st crediting period.

For the considered monitoring period, the combined margin is calculated as follows:
EFgrid,CM = 0.137 * 50% + 0.4539 * 50% = 0.295 tCO_2/MWh
For the considered monitoring period, baseline emissions from electricity generation are of methane from the SWDS ($BE_{EC,y}$) are calculated as

Period	Net electricity generated (MWh)	Transmission and Distribution Losses (%)	BE_{EC} (tCO_2eq)
Aug-2020	460.1	20%	163
Sep-2020	619.5	20%	220
Oct-2020	660.3	20%	234
Nov-2020	634.0	20%	225
Dec-2020	612.6	20%	217
TOT	**2,986.5**	**20%**	**1,059**

As per the emission reduction calculation spreadsheet for this Monitoring Report:
BE = BE_{CH4} + BE_{EC}
= 13,912 + 1,059 = 14,971 tCO_2eq

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

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Project emissions are calculated as follows:

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

Equation 42 (PoA-DD)

Where:

$PE_{EC,y}$ = Emissions from consumption of electricity due to the project activity in year *y* (tCO_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* (tCO_2/yr);
$PE_{DT,y}$ = Emissions from the distribution of compressed/liquefied LFG using trucks, in year y (tCO_2/yr);
$PE_{SP,y}$ = Emissions from the supply of LFG to consumers through a dedicated pipeline, in year y (tCO_2/yr)

- Since distribution of compressed/liquefied LFG using trucks is not included in this CPA, $PE_{DT,y}$ parameter is zero.

- Since supply of LFG to consumers through a dedicated pipeline is not included this CPA, $PE_{SP,y}$ parameter is zero.
- Since there is no consumption of fossil fuels in this CPA, the parameter $PE_{FC,y}$ is zero.

Thus,

$PE_y = PE_{EC,y}$

Emissions from consumption of electricity ($PE_{EC,y}$)

$PE_{EC,y}$ shall be calculated according to TOOL05 and, while applying the tool, the following shall be considered:

(a) $EC_{PJ,k,y}$ in the tool is equivalent to the amount of electricity consumed by the project activity in year y ($EC_{PJ,y}$); and

(b) If in the baseline a proportion of LFG is destroyed ($F_{CH4,BL,y} > 0$), then the electricity consumption in the tool ($EC_{PJ,j,y}$) should refer to the net quantity of electricity consumption (i.e. the increase due to the CPA).

The generic approach is for $PE_{EC,y}$ calculation is as follows:

$$PE_{EC,y} = \sum EC_{PJ,j,y} \times EF_{EL,j,y} \times (1 + TDL_{j,y})$$ **Equation 43 (PoA-DD)**

Where:

$EC_{PJ,j,}$ = Quantity of electricity consumed by the project electricity consumption source j in year y (MWh/yr);

$EF_{EL,j,y}$ = Emission factor for electricity generation for source *j* in year *y* (tCO_2/MWh);

$TDL_{j,y}$ = Average technical transmission and distribution losses for providing electricity to source *j* in year *y ;*

j = Sources of electricity consumption in the project.

$EF_{EL,k,y}$ depends on the scenarios of electricity consumption:

Scenario A: Electricity consumption from the grid

- Option A1: calculate de combined margin emission factor of the grid using the steps ofTOOL07, where $EF_{EL,j/k/l,y} = EF_{grid,CM,y.}$
- Option A2: use the conservative default value of 1.3tCO_2/MWh.

Considering all scenarios presented in the referred PoA-DD, scenario A1 has been chosen for this CPA, where $EF_{EL,j/k/l,y} = EF_{grid,CM,y} = 0.295$ tCO_2/MWh.

Period	Electricity Consumed (MWh)	Project Emissions (tCO_2eq)
Aug-2020	5.86	1.73
Sep-2020	7.7	2.27
Oct-2020	7.723	2.28
Nov-2020	7.731	2.28
Dec-2020	7.157	2.11
TOT	**36.171**	**10.69**

Emissions from flaring ($PE_{flare,y}$)

Project emissions from flaring shall be calculated according to steps presented in TOOL06 as follows:

- **STEP 1** – Determination of the methane mass flow of the residual gas

The mass flow of methane in the residual gaseous stream in the minute *m* ($F_{CH4,m}$) shall be determined using the procedures set out by TOOL08, following the requirements set out in the applicability of the tool.

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

- **STEP 2** – Determination of flare efficiency

The flare efficiency depends on the combustion efficiency of in the flare and the time that the flare is operating. For determining the efficiency of enclosed flares project participants shall choose to determine the efficiency based on monitored data or the option to apply a default value. For open flares a default value must be applied.

a) 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 from each minute *m* in year *y*, based on the methane flow rate in the residual gas ($F_{CH4,RG,m}$) and the flare efficiency ($\eta_{flare,m}$), as follows:

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

Equation 64 (PoA-DD)

Where:

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

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

$F_{CH4,RG,m}$ = Mass flow of methane in the residual gas in the minute *m* (kg);

$\eta_{flare,m}$ = Flare efficiency in the minute *m.*

The following table summarizes the main variables for the monitored period.

Period	$F_{CH4,PJ}$ (tCH_4)	$F_{CH4,BL}$ (tCH_4)	BE_{CH4} (tCO_2)	$EC_{BL,k}$ (MWh)	BE_{EC} (tCO_2)	BE (tCO_2)	EC_{PJ} (MWh)	PE (tCO_2)	ER (tCO_2)
Aug-20	93.36	1.66	2,059	466	165	2,224	5.86	3	2,221
Sep-20	131.00	2.33	2,889	627	222	3,111	7.70	3	3,108
Oct-20	132.93	2.37	2,932	668	237	3,168	7.72	3	3,165
Nov-20	135.94	2.42	2,998	642	228	3,225	7.73	3	3,222
Dec-20	137.57	2.45	3,034	620	220	3,253	7.16	3	3,250
TOTAL	630.80	11.23	13,912.31	3,022.68	1,071.66	14,981	36.17	15	14,966

F.3. Calculation of leakage emissions

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According to ACM0001, no leakage effects are accounted for under this methodology.

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

CPA UNFCCC reference number	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
6573-P2-0003-CP1	14,981	15	0	0	14,966	0	14,966
Total	14,981	15	0	0	14,966	0	14,966

F.5. Comparison of emission reductions or net anthropogenic removals achieved with estimates in the included CPA-DDs

CPA UNFCCC reference number	Amount achieved during this monitoring period (t CO_2e)	Amount estimated ex ante for this monitoring period in the CPA-DD (t CO_2e)
6573-P2-0003-CP1	14,966	5,767
Total	14,966	5,767

F.5.1. Explanation of calculation of "amount estimated ex ante for this monitoring period in the CPA-DD"

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The amount estimated ex-ante was calculated at the time of validation, considering 6 months of ER generation in 2020 for a total of 7,526 tCO_2e. The CPA was registered on August 13 2020.

Considering only the period from August 13 to December 31, 2020 we have a total of 141 days, compared to 184 days from July 1 to December 31, 2020. Therefore:

Ex-ante estimate = 7,526 *141/184 = 5,767 tCO_2e

F.6. Remarks on increase in achieved emission reductions

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The difference between the ex ante calculations and the amount monitored in this period seems to be linked to inconsistencies in the calculation of baseline emissions related to the FOD model.

F.7. Remarks on scale of small-scale CPAs

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Not Applicable

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Document information

Version	*Date*	*Description*
05.0	8 October 2021	Revision to: • Ensure consistency with version 03.0 of the "CDM project standard for programmes of activities" (CDM-EB93-A07-STAN).
04.0	6 April 2021	Revision to: • Reflect the "Clarification: Regulatory requirements under temporary measures for post-2020 cases" (CDM-EB109-A01-CLAR).
03.0	31 May 2019	Revision to: • Ensure consistency with version 02.0 of the "CDM project standard for programmes of activities" (CDM-EB93-A07-STAN); • Add a section on remarks on the observance of the scale limit of small-scale CPAs during the crediting periods; • Add "changes specific to afforestation or reforestation activities/CPA" as a possible post-registration changes; • Clarify the reporting of net anthropogenic GHG removals for A/R PoAs between two commitment periods; • Make structural and editorial improvements.
02.0	7 June 2017	Revision to: • Ensure consistency with version 01.0 of the "CDM project standard for programmes of activities (CDM-EB93-A07-STAN); • Make editorial improvements.
01.0	1 April 2015	Initial publication.

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