Monitoring report form for CDM programme of activities (Version 04.0)

MONITORING REPORT			
Title of the PoA	Caixa Econômica Federal Solid Waste Management and Carbon Finance Project CPAs running in this Monitoring Period: CPA-1: Landfill gas recovery, energy generation and biogas distribution from CTR Santa Rosa		
UNFCCC reference number of the PoA	6573		
Version numbers of the PoA-DD applicable to this monitoring report	3.0		
Version number of this monitoring report	1		
Completion date of this monitoring report	09/04/2021		
Monitoring period number	9th Monitoring Period		
Duration of this monitoring period	05/10/2019 to 02/03/2020		
Monitoring report number for this monitoring period	1		
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)	
	Brasil	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
	-	Total: 208,242 tCO_2e CPA-1: 208,242 tCO_2e	-
Amount of GHG emission reductions or net anthropogenic GHG removals	Total: 415,554 tCO_2e		

estimated ex ante for this monitoring period in the CPA-DDs for the CPAs covered in this monitoring report	CPA-1: 415,554 tCO_2e

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 population[1].

Brazil's National Energy Plan 2030[2], 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 Policy[3], 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

[1] Ministry of Environment. Resíduos Sólidos. Available at: <https://www.mma.gov.br/mma-em-numeros/residuos-solidos>

[2] Information of the National Energy Plan, PNE 4.0 is available at the following site: http://www.epe.gov.br/PNE/Forms/Empreendimento.aspx

[3] http://www.cidades.gov.br/index.php/apresentacao-plansab.html

Title and reference number of the corresponding generic CPA	Version of the PoA-DD	Sectoral scopes	Applied methodologies and standardized baselines
CPA-1 Landfill gas recovery, energy generation and biogas distribution from CTR Santa Rosa	3.0	Sectorial Scope 13 – Waste handling and disposal	*ACM0001 – "Flaring or use of landfill gas – Version 19.0"* • *"Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation" (version 02.0, EB 87) (https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-05-v2.0.pdf)* • *"Project emissions from flaring" (version 02.0.0, EB 68) (https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-06-v2.0.pdf)* • *"Tool to determine the mass flow of a greenhouse gas in a gaseous stream" (version 03.0, EB 87) (https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-08-v3.0.pdf)* • *"Tool to calculate the emission factor for an electricity system" (version 05.0, EB 87) (https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-07-v5.0.pdf)* • *"Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion" (version 02, EB41) (http://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-03-v2.pdf)*

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)
6573 – 0001 - Landfill gas recovery, energy generation and biogas distribution from CTR Santa Rosa	CPA-1: Landfill gas recovery, energy generation and biogas distribution from CTR Santa Rosa	7.1	Renewable - 05/10/2019 – 04/10/2026	Yes

A.2. Coordinating/managing entity

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Caixa Econômica Federal
Diretoria Executiva de Saneamento e Infraestrutura
Setor Bancário Sul Quadra 4 lotes 3/ 4 - 12º Andar
Edifício Matriz
Brasília DF 70092-900 Brazil
Email: gecoa@caixa.gov.br / gepfi02@caixa.gov.br / geops@caixa.gov.br
Adailton Ferreira Trindade
Manager

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

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Not applicable for the considered monitoring period. There are no corrections encompassed by the considered monitoring period that are to be submitted with or separately from this Monitoring Report as part of the request for issuance.

It is however relevant to note that corrections (in information that do not affect the programme design) were previously approved (under PRC-6573-002) as changes applicable/valid for monitoring period(s) prior to the considered monitoring period (thus not the context of the verification assessment for the considered monitoring period) as follows:

Ref of PRC processes so far encompassed by the CPA	Approval date	Description of the post-registration change(s) under the category "*Corrections (in information that do not affect the programme design)*"
PRC-6573-002	10/01/2019 (prior approval track)	•General text revisions and improvements of PoA design description, including full compliance with currently applicable requirements for completing the latest version of the CDM-PoA-DD form at that time (version 08.1); •Text revisions to comply with applicable requirements of the baseline and monitoring methodology under version 18.0 of

		ACM0001, including the eligibility criteria for CPAs inclusion (section K).

B.2.2. Inclusion of monitoring plan

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Not applicable for the considered and/or previous monitoring periods. There is no inclusion of monitoring plan (and/or applicable methodological tools) encompassed by the considered monitoring period and/or previously approved by the CDM-EB as being applicable for the considered monitoring period.

In fact, no inclusion of monitoring plan was ever addressed in the context of previously performed and approved post-registration changes for the CPA.

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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Not applicable for the considered monitoring period. There are no permanent changes to the registered monitoring plan, or permanent deviation of monitoring from the applied methodologies, standardized baselines, or other methodological regulatory encompassed by the considered monitoring period that are to be submitted with or separately from this Monitoring Report as part of the request for issuance.

It is however relevant to note that permanent changes to the registered monitoring plan, or permanent deviation of monitoring from the applied methodologies, standardized baselines, or other methodological regulatory documents were previously approved (under PRC-6573-001 and PRC-6573-002) as changes applicable/valid for monitoring period(s) prior to the considered monitoring period (thus not the context of the verification assessment for the considered monitoring period) as follows:

Ref of PRC processes so far encompassed by the CPA	Approval date	Description of the post-registration change(s) under the category "*Permanent changes to the registered monitoring plan, or permanent deviation of monitoring from the applied methodologies, standardized baselines, or other methodological regulatory documents*"
PRC-6573-001	04/03/2014 (prior approval track)	• Inclusion of the possibility to use default value from TOOL06 if required data to calculate flaring efficiency is not available at the time of the verification. • Revision to include TDLy (average technical transmission and distribution losses in the grid in year y for the voltage level at which electricity is obtained from the grid at the project site) as a fixed parameter (not monitored). • Inclusion of "other flare operation parameters" as a monitored parameter.
PRC-6573-002	10/01/2019 (prior approval track)	•Revision of the applied monitoring and GHG calculation approaches for determining the baseline and project emissions as per approaches and provisions of ACM0001 (version 19.0) and applied methodological tools. By reflecting the changes in the programme design, the permanent change from the registered monitoring plan applicable for the 8 new generic CPA-DDs includes addition of provisions for accounting (a) associated

		baseline and project emissions due to displacement of natural gas by consumer(s) with upgraded LFG (supplied through natural gas distribution network or by using trucks or through a combination of both of these LFG transportation options) + (b) project emissions due to consumption of electricity sourced by backup captive off-grid electricity generator(s) fueled by diesel + (c) project emissions due to consumption of fossil fuel (for purpose other than generation of electricity and/or transportation of upgraded LFG).

B.2.4. Changes to programme design

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Not applicable for the considered monitoring period. There are no changes to programme design encompassed by the considered monitoring period that are to be submitted with or separately from this Monitoring Report as part of the request for issuance.

It is however relevant to note that changes to programme design were previously approved (under PRC-6573-002) as changes applicable/valid for monitoring period(s) prior to the considered monitoring period (thus not the context of the verification assessment for the considered monitoring period) as follows:

Ref of PRC processes so far encompassed by the CPA	Approval date	Description of the post-registration change(s) under the category "*Changes to programme design*"
PRC-6573-002	10/01/2019 (prior approval track)	•Revision in the programme design by applying the updated version of ACM0001 (v18.0), which scope includes supply of upgraded LFG to consumer(s) using trucks or through a combination of supply via natural gas distribution network and trucks, as the previous version of ACM0001 which the PoA was registered (v11.0) did not include supply of LFG by trucks. • Revision to include the following options/alternatives valid for CPA design scenarios: (i) electricity generated by backup captive off-grid electricity generator(s) fuelled by diesel to meet electricity demand (ii) consumption of fossil fuel (for purpose other than generation of electricity and/or transportation of upgraded LFG).

B.2.5. Changes specific to afforestation or reforestation activities

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Not applicable.

PART II Monitoring of CPAs

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SECTION C. Implementation of CPAs

C.1. Description of implemented CPAs

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CPA-1: Landfill gas recovery, energy generation and biogas distribution from CTR Santa Rosa

The privately operated landfill of Waste Treatment Center (Central de Tratamento de Resíduos - CTR) Santa Rosa is located in Rio de Janeiro state, in Seropédica municipality, close to Rio de Janeiro city, the second most populous Brazilian city. CTR Santa Rosa covers an area of 1,699,512.97 m² and started receiving waste in March 2011, having received all necessary environmental licenses for operation. The landfill receives domestic solid waste from Rio de Janeiro, Seropédica and Itaguaí municipalities.

As per the registered CPA, the LFG collected in CTR Santa Rosa can be used to generate electricity, upgraded and distributed via a natural gas distribution network, or flared, to avoid any methane emissions going into the atmosphere. At the time of this monitoring report, only the flaring component has been implemented.

The LFG collection and flaring system has a total capacity of 17,500 Nm³/h (2,500 Nm³/h Flare#1, 5,000 Nm³/h Flare#2, 5,000 Nm³/h Flare#3 and 5,000 Nm³/h Flare#4). The CPA-1 contains the following components:

Landfill gas pre-treatment station

The state-of-the-art gas collection technology in this CPA includes the items listed below.

•Vertical wells used to extract gas and leachate.
•Horizontal wells used to extract gas.
•Optimal well spacing for maximum gas collection while minimizing costs.
•Wellheads designed for gas measurements.
•Condensate extraction and storage systems designed at strategic low points throughout the gas system.

All LFG collected is pre-treated to remove moisture and other impurities in order to prevent the corrosion of the subsequent systems.

Landfill gas flaring system

CPA-1 CTR Santa Rosa has a flaring system in place. The LFG flare system includes the items provided below:

•Four enclosed flares with controlled combustion systems.
•A blower system used to cause negative pressure in the pipeline (before blower) and positive pressure (after blower) to direct gas for flare.
•Monitoring equipment for continuous monitoring of gas composition, flow and burn temperature.
•Security restart system, in the case of a system shut down.

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

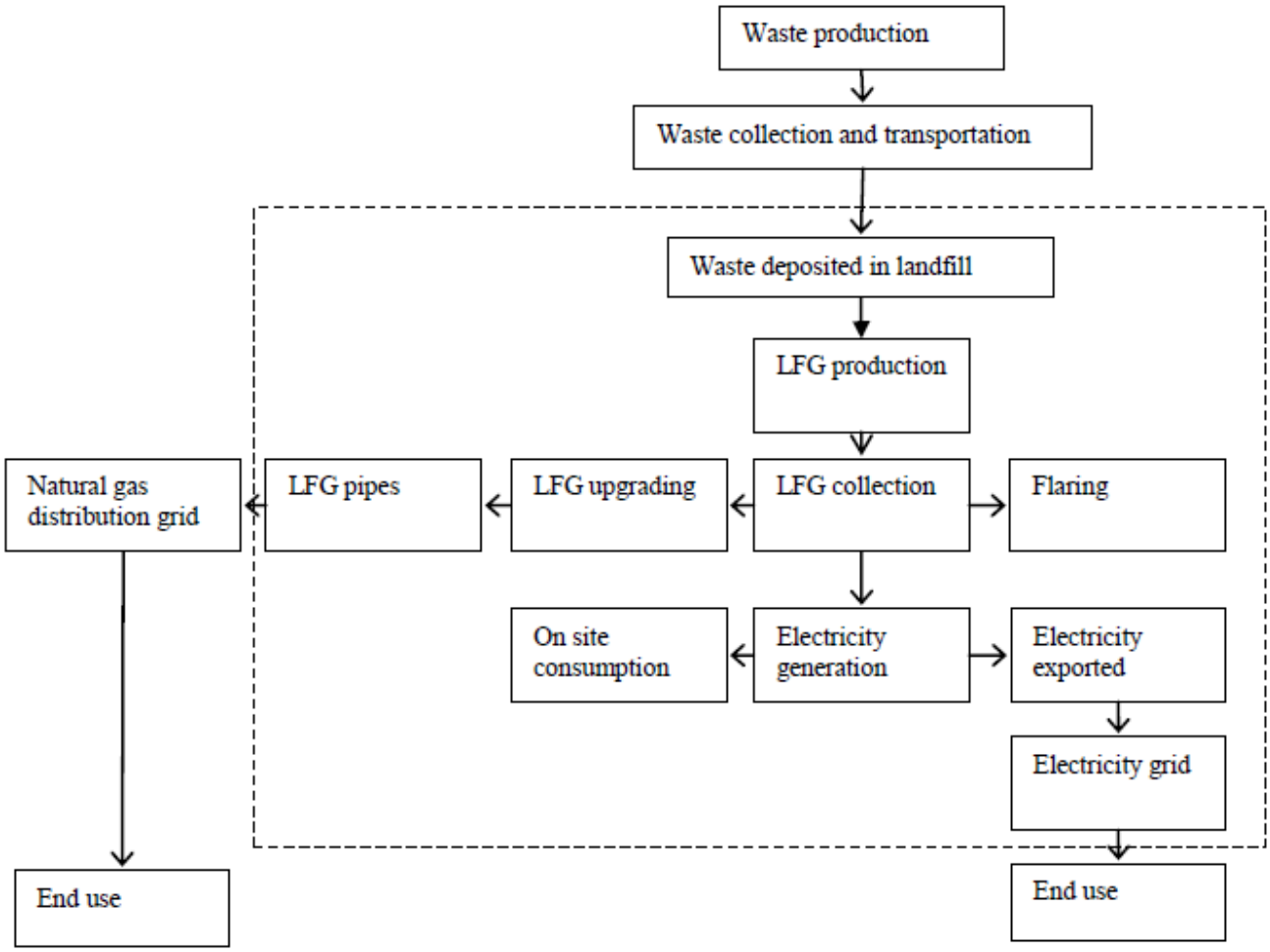

Figure 1 – Simplified schematic representation of the CPA project boundary

The project design considers the implementation of an electricity generation component and/or a LFG upgrading system for selling the gas. As of this monitoring period only the flaring system has been implemented.

The following list summarizes the relevant dates for CPA-1:

- 19/04/2011: Start date of the landfill operations.
- 16/10/2012: Start date, construction of the LFG collection and flaring system.
- 13/11/2012: Start of operations of the LFG collection and flaring system (Flare#1).
- 23/08/2013: Start of operations of Flare #2.
- 21/02/2016: Start of operations of Flare #3.
- 01/04/2017: Start of operations of Flare #4.

The total volume of emission reductions achieved in this monitoring period was 208,242 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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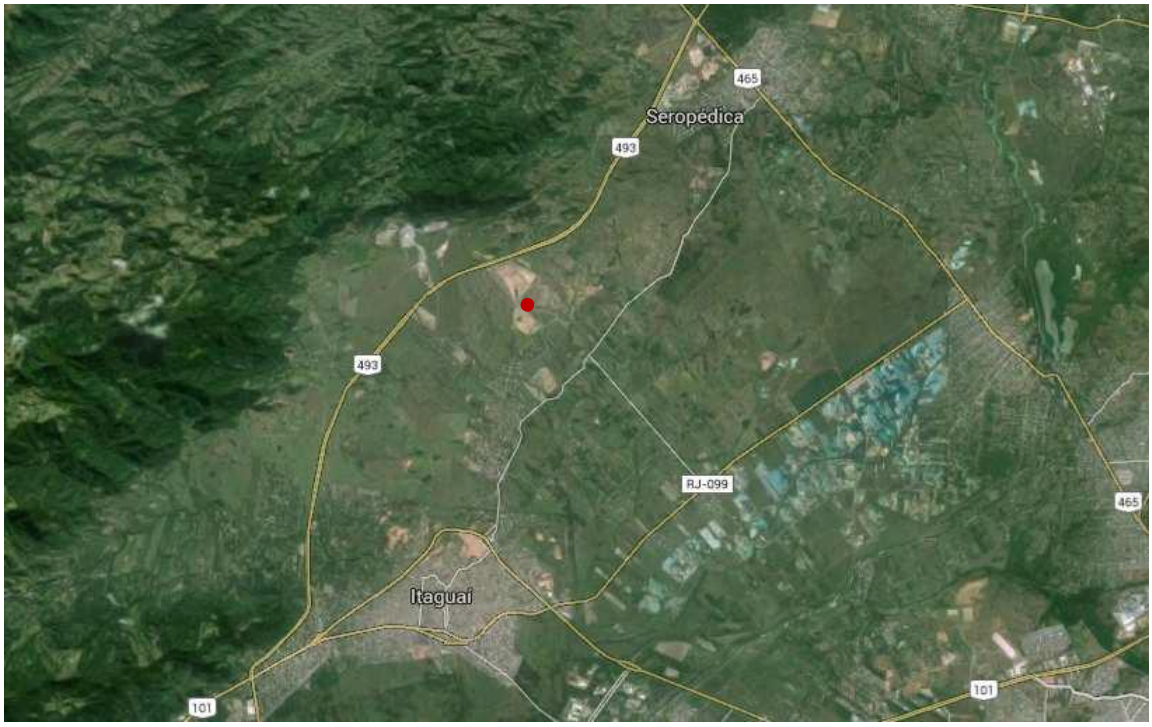
The project boundary of the PoA, and consequentely the CPA-DD, is the country of Brazil.

CPA-1 is located in Rio de Janeiro state, between Seropédica and Itaguaí municipality (22º47'44.53"S and 43º45'38.01" W). Latitude:-22.795703, Longitude:-43.760558).



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

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Not applicable for the considered and/or previous monitoring periods. There are no temporary rary deviations from the monitoring plans in the included CPA-DDs, applied methodologies, standardized baselines or other methodological regulatory documents encompassed by the considered monitoring period and/or previously approved by the CDM-EB.

In fact, no temporary rary deviations from the monitoring plans in the included CPA-DDs, applied methodologies, standardized baselines or other methodological regulatory documents was ever addressed in the context of any previously performed and approved post-registration changes for the CPA.

C.3.2. Corrections

>>
Not applicable for the considered and/or previous monitoring periods. There are no corrections (in information that do not affect the project design) encompassed by the considered monitoring period and/or previously approved by the CDM-EB.

In fact, no corrections (in information that do not affect the project design) was ever addressed in the context of any previously performed and approved post-registration changes for the CPA.

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

>>
Not applicable for the considered and/or previous monitoring periods. There are no changes to start date of the crediting period encompassed by the considered monitoring period and/or previously approved by the CDM-EB.

In fact, no change to start date of the crediting period was ever addressed in the context of any previously performed and approved post-registration changes for the CPA.

C.3.4. Inclusion of monitoring plan

>>
Not applicable for the considered and/or previous monitoring periods. There are no inclusion of monitoring plan encompassed by the considered monitoring period and/or previously approved by the CDM-EB.

In fact, no inclusion of monitoring plan was ever addressed in the context of any previously performed and approved post-registration changes for the CPA.

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

>>
Not applicable for the considered and/or previous monitoring periods. There are no permanent changes to the included monitoring plans, or permanent deviation of monitoring from the applied methodologies, standardized baselines, or other methodological regulatory documents encompassed by the considered monitoring period and/or previously approved by the CDM-EB.

In fact, no permanent changes to the included monitoring plans, or permanent deviation of monitoring from the applied methodologies, standardized baselines, or other methodological regulatory documents was ever addressed in the context of any previously performed and approved post-registration changes for the CPA.

C.3.6. Changes to project design

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Not applicable for the considered and/or previous monitoring periods. There are no changes to project design encompassed by the considered monitoring period and/or previously approved by the CDM-EB.

In fact, no change to project design was ever addressed in the context of any previously performed and approved post-registration changes for the CPA.

C.3.7. Changes specific to afforestation or reforestation CPA

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Not applicable.

SECTION D. Description of monitoring system of CPAs

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The following equipment is used to monitor the operation of the projects and the emission reductions.

The control of maintenance and inspection schedules was defined considering the equipment manufacture´s specifications and orientations.

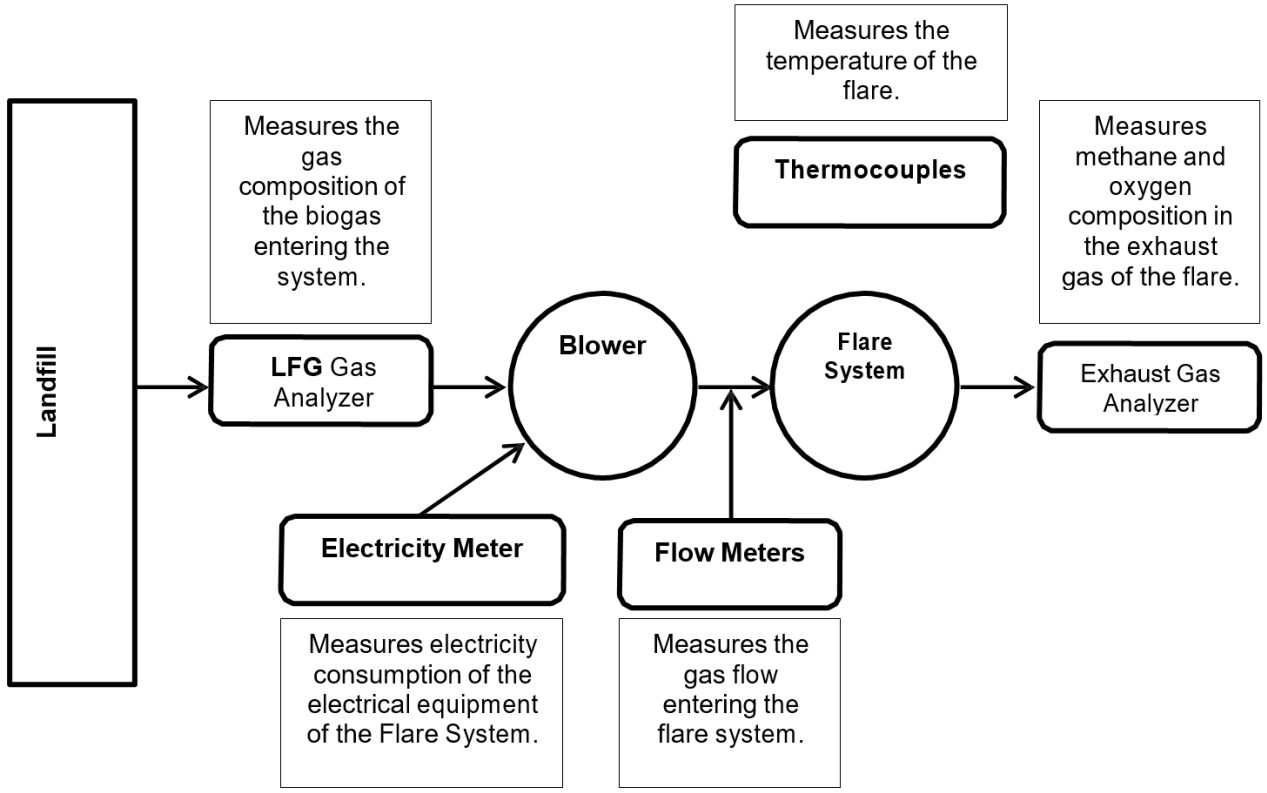


Diagram of the monitoring equipment

Diagram of the monitoring equipment

LFG Gas Analyzer
The LFG gas analyzer is used to measure the biogas composition before the gas enters the flaring system.

Flow Meter
The flow meter is used to measure the gas flow entering the flare system. The Project uses differential pressure flow meters, that operate with a measurement control system of the biogas temperature and pressure in the pipeline to calculate the flow in normal conditions (Nm3/h – normal cubic meter per hour).

Thermocouples
High performance equipment to control the flare temperature is installed in the flare tower.

Exhaust Gas Analyzer
The Exhaust Gas Analyzer provides continuous monitoring of methane and oxygen in the exhaust gas of the flare to calculate the biogas flaring efficiency.

Energy Meter
The Energy Meter of the Project Site operates in order to measure electricity consumption of the Flare System.

Emergency procedures for data monitoring.

The CPA-1 implementer had in place a number of procedures to handle problems with data transfer and/or storage:

PLC continuously receives data from monitoring equipament installed at degassing plant.

Data is stored by Manufacturer's Supervisorio Software, which is installed in 2 computers (PC1 and PC2), located at Control Room. PC2 is only used for controlling and/or storing data in case PC1 is unavailable.

Once a day, the data is transfered to the local server as a back-up copy.

To mitigate the risk of data losses on the local server and/or Supervisorio System, the CPA-1 implementer has a daily automatic backup procedure using an external server.

CAIXA also receives copies of the monthly generation that can be used as a backup in case of need.

Project management responsibility.

Ciclus Ambiental staff has operational and data collection obligations to fulfil, 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 has the responsibility for the collection of monitored data in CPA-1, the emission reduction estimates, producing the monitoring reports and reporting to the DOE. CAIXA also maintain all necessary data to undertake the 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 registered CPA.

All provided data by CPA-1 implementer are checked for completeness and quality.

Data Storage

Both CAIXA and the CPA-1 implementer have in place procedures to archive all relevant documents, and all data recording of the monitored data that include paper and electronic versions, backup systems and periodic checking for data entry mistakes.

All records are kept for at least 2 years after the end of the crediting period.

Operation related documents are stored by the CPA-1 implementer in both hard and soft versions. All commercial documents as well as those related to PoA requirements defined by the CME are stored by CAIXA in both hard and soft versions. All these documents can be accessed and traced for CDM auditing purposes.

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 the SWDS in the baseline
Source of data	Consistent with how oxidation is accounted for in the methodological tool “Emissions from solid waste disposal sites” (version 08.0)
Value(s) applied	0.1
Choice of data or measurement methods and procedures	Default value as per the applied CDM baseline and monitoring methodology ACM0001 - “Flaring or use of landfill gas” (version 19.0)
Purpose of data/parameter	Calculation of baseline emissions.
Additional comments	-

Data/Parameter	**GWP_{CH4}**
Unit	tCO_2e/tCH_4
Description	Global Warming Potential of CH_4
Source of data	"Global Warming Potential for Given Time Horizon" in table 2.14 of the errata to the contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, based on the effects of greenhouse gases over a 100-year time horizon. Available at: www.ipcc.ch/publications_and_data/ar4/wg1/en/ch2s2-10-2.html#table-2-14 The applied value is also in accordance with the "Standard for application of the global warming potential to clean development mechanism project activities and programmes of activities for the second commitment period of the Kyoto Protocol".
Value(s) applied	25
Choice of data or measurement methods and procedures	-
Purpose of data/parameter	Calculation of baseline emissions.
Additional comments	The applied value shall be updated according to any future COP/MOP decisions and/or decision by the CDM-EB.

Data/Parameter	**R_u**
Unit	$Pa.m^3/kmol.K$
Description	Universal ideal gases constant
Source of data	Default value as per the "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" (version 03.0)
Value(s) applied	8,314
Choice of data or measurement methods and procedures	-
Purpose of data/parameter	Calculation of baseline emissions.
Additional comments	-

Data/Parameter	**MM_k**
Unit	kg/kmol
Description	Molecular mass of gas *k*
Source of data	Default values as per the "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" (version 03.0)
Value(s) applied	For considered gases *k* that are greenhouse gases (GHGs), the values below are applied for MMi. As per the "Tool to determine the mass flow of a greenhouse gas in a gaseous stream": *"The determination of the molecular mass of the gaseous stream ($MM_{t,db}$) requires measuring the volumetric fraction of all gases (k) in the considered gaseous stream. However as a simplification, only the volumetric fraction of gases k that are greenhouse gases and are considered in the emission reduction calculation in the underlying methodology must be monitored and the difference to 100% may be considered as pure nitrogen. The simplification is not acceptable if it is differently specified in the underlying methodology.* ACM0001 (version 19.0) does not include any restriction to such simplification. Thus, only the volumetric fraction of gases that are greenhouse gases and are considered in related calculations (CH_4 in the particular case of the CPA) and the difference to 100% is just considered as pure nitrogen. Compound: Nitrogen; Structure: N_2; Molecular mass (kg/kmol): 28.01
Choice of data or measurement methods and procedures	-

Purpose of data/parameter	Calculation of baseline emissions.
Additional comments	-

Data/Parameter	**MM_i**
Unit	kg/kmol
Description	Molecular mass of greenhouse gas *I*
Source of data	Default values as per the "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" (version 03.0)
Value(s) applied	The following values of molecular mass are applicable for CH_4 (the only GHG which is considered): Compound | Structure | Molecular mass (kg/kmol) Methane | CH_4 | 16.04
Choice of data or measurement methods and procedures	-
Purpose of data/parameter	Calculation of baseline emissions.
Additional comments	-

Data/Parameter	**P_n**
Unit	Pa
Description	Total pressure at normal conditions
Source of data	Default value as per the "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" (Version 03.0)
Value(s) applied	101,325
Choice of data or measurement methods and procedures	-
Purpose of data/parameter	Calculation of baseline emissions.
Additional comments	-

Data/Parameter	**T_n**
Unit	K
Description	Temperature at normal conditions
Source of data	Default value as per the "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" (version 03.0)
Value(s) applied	273.15
Choice of data or measurement methods and procedures	-
Purpose of data/parameter	Calculation of baseline emissions.
Additional comments	-

Data/Parameter	**MM_{H2O}**
Unit	kg/kmol
Description	Molecular mass of water
Source of data	Default value as per the "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" (version 03.0)
Value(s) applied	18.0152
Choice of data or measurement methods and procedures	-
Purpose of data/parameter	Calculation of baseline emissions.
Additional comments	-

Data/Parameter	**$SPEC_{flare}$**
Unit	°C (for temperature values) Nm^3/h (for LFG flow values) Number of days (for maintenance schedule interval values)
Description	Manufacturer's flare specifications for temperature, flow rate and maintenance schedule interval.
Source of data	Flare manufacturer

Value(s) applied

The specifications of the currently installed flares (Flare 1, Flare 2, Flare 3 and Flare 4)[4] are listed below:

$SPEC_{flare,flare-1}$	**Min.**	**Max.**
Operational LFG flow (for continuous operation):	500 Nm^3/h	2,500 Nm^3/h
Required temperature of the exhaust gas of the flare (to ensure LFG destruction (combustion) under high CH_4 destruction efficiency):	500 ^oC	1,200 ^oC
Required minimum frequency for inspection and maintenance service (incl. inspection in the conditions of the flare isolation ceramics revetment material):	Min. six months (min each 180 days)	
Required/recommended minimum frequency for replacement of the flare isolation ceramics revetment material:	After 10 years of regular and appropriate operation	

$SPEC_{flare,flare-2}$ **$SPEC_{flare,flare-3}$** **$SPEC_{flare,flare-4}$**	**Min.**	**Max.**
Operational LFG flow (for continuous operation):	1,000 Nm^3/h	5,000 Nm^3/h
Required temperature of the exhaust gas of the flare (to ensure LFG destruction (combustion) under high CH_4 destruction efficiency):	500 ^oC	1,200 ^oC
Required minimum frequency for inspection and maintenance service (incl. inspection in the conditions of the flare isolation ceramics revetment material):	Min. six months (min each 180 days)	
Required/recommended minimum frequency for replacement of the flare isolation ceramics revetment material:	After 10 years of regular and appropriate operation	

[4] Values applicable for the flares (as per the currently applicable configuration) are selected based on technical information/specifications details for the flares as provided by equipment manufacturers Hofstetter B.V. (Flare 1 and Flare 2) and Biotecnogas s.l.r. (Flare 3 and Flare 4).

Choice of data or measurement methods and procedures	As established by the methodological tool "Project emissions from flaring" (version 03.0), the flare specifications and operational + maintenance requirements (as set/recommended by the equipment manufacturer) are documented and considered for the ex-ante determination of applicable values for the parameter SPECflare. During the 2nd 7-year crediting period of CPA-1 Santa Rosa, ex-ante selected data will be compared against monitored data related to the operation of the flares, including: a) Minimum and maximum monitoring records for data regarding inlet LFG flow rate, (b) Minimum and maximum monitoring records for data of temperature in the exhaust gas of each individual high temperature enclosed flare; and (c) Duration in days of time periods between maintenance events for each individual high temperature enclosed flare.
Purpose of data/parameter	Calculation of baseline emissions[5].
Additional comments	All flare specification and operation details/requirements are based on information provided by the equipment manufacturer.

Data/Parameter	**$EF_{EL,grid,PJ,y}$**
Unit	tCO_2/MWh
Description	Emission factor for grid-sourced electricity for project emissions in year y
Source of data	Applicable default values as per the methodological tool "Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation" (version 03.0)
Value(s) applied	1.3

[5] It is important to note that residual project emissions of CH4 due to the combustion of LFG in enclosed flares are considered in the context of the determination of baseline emissions (although ACM0001 (version 19.0) refers to the term "project emissions from flaring").

Choice of data or measurement methods and procedures	The selection of the default value is under conformance with applicable guidance of ACM0001 (version 19.0). The emission factor for grid-sourced electricity consumed by CPA-1 Santa Rosa through the electricity grid to which the CPA is connected to (EFEL,grid,PJ,y,) is determined by considering the following applicable guidance of Option A.2 of the methodological tool "Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation" (version 03.0): "*Option A2: Use the following conservative default values:* *(a) A value of 1.3 tCO2/MWh if:* *(i) Scenario A applies only to project and/or leakage electricity consumption sources but not to baseline electricity consumption sources; or* (ii) *Scenario A applies to: both baseline and project (and/or leakage) electricity consumption sources; and the electricity consumption of the project and leakage sources is greater than the electricity consumption of the baseline sources; (…)*"
Purpose of data/parameter	Calculation of project emissions.
Additional comments	-

Ex-ante determined parameters not used in the context of ex-post determination and calculation of emission reductions achieved by the CPA:

The following ex-ante determined parameters (that are also included in the CPA-DD) are not used for the purpose of ex-post determination of baseline emissions and project emissions achieved by the CPA during the considered monitoring period:

- Efficiency of the LFG capture system that will be installed in the CPA (η_{PJ})

- Fraction of methane captured at the SWDS and flared, combusted or used in another manner that prevents the emissions of methane to the atmosphere in year y (f_y)

- Default value for model correction factor to account for model uncertainties ($\varphi_{default}$)

- Oxidation factor (reflecting the amount of methane from the considered SWDS that is oxidized in the soil (or other material covering the waste)) (OX)

- Fraction of methane in the SWDS gas (volume fraction) (F)

- Fraction of degradable organic carbon (DOC) in MSW that decomposes in the considered SWDS ($DOC_{f,default}$)

- Methane correction factor ($MCF_{default}$)

- Fraction of degradable organic carbon in the waste type j (weight fraction) (DOC_j)

- Decay rate for the waste type *j* (k_j)

- Weight fraction of the waste type *j* (W_j)

- Emission factor for grid-sourced electricity for baseline emissions in year y ($EF_{EL,grid,BL,y}$)

As also outlined in the CPA-DD, data for the above-listed parameters are used only in the context of ex-ante estimation of annual accumulated values for the "Amount of methane in the LFG which is destroyed or utilized by the CPA" ($F_{CH4,PJ,y}$) (in the context of ex-ante estimation of emission reductions to be achieved by the CPA during the 2nd 7-year renewable crediting period). Due to that, details for the above-listed parameters are not included in this Section as they are not relevant in the context of determination of emission reductions achieved by the CPA during the considered monitoring period. Relevant details for such not reported parameters are included in Section B.6.2 of the CPA-DD.

Moreover the parameter "Emission factor for grid-sourced electricity for baseline emissions in year y ($EF_{EL,grid,BL,y}$)" is not included in this monitoring period, because the project acitivity does not includes any use of LFG besides the flaring infrastructure.

E.2. Data and parameters monitored

Data/Parameter	**Management of SWDS**
Unit	Dimensionless
Description	Management of the SWDS

Measured/calculated/ default	As per the adopted monitoring procedure for the CPA, the management of the Santa Rosa landfill is yearly compared against the previously conceived original construction and operational design for the Santa Rosa landfill in order to confirm that the overall management and operation for the landfill (including relevant aspects related to landfilling practice) were not deliberately modified with the unique aim to intentionally increase the generation of methane at the landfill. By performing the checking annually, it is monitored whether any practice aiming to increase methane generation in the landfill has occurred or promoted. As required by ACM0001 (version 19.0), any change in the management of the Santa Rosa landfill after the implementation of the CPA should be justified by referring to applicable technical or regulatory specifications.
Source of data	Three technical evaluation assessments valid for the considered monitoring period were performed by a independent 3rd-party engineering service company on 31/001/2020. The findings and summaries from the performed technical evaluation assessments are reported in a technical statement report issued by this engineering service company dated 01/02/2020. As part of the performed evaluations, the current configuration and operational conditions of the Santa Rosa 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 Santa Rosa landfill); - Applicable local or national regulations. Since 2018 the 3rd-party engineering company has performed regular technical inspections at the Santa Rosa landfill (inter alia as part of the continuously performed monitoring/control of the geotechnical stability for the landfill's cells). Related monitoring/control (which is performed by the 3rd-party engineering company) is part of the regular environmental monitoring for the landfill which is a prerequisite for keeping the validity of the environmental and safety permit/licensing for the whole Santa Rosa landfill.

Value(s) of monitored parameter	As outlined in the issued technical statement report for the technical evaluation assessments valid for the considered monitoring period, the previously conceived original design of the Santa Rosa landfill (dated prior to the implementation of the CPA) is confirmed as not to being deliberately modified since the CPA started to operate until 31/12/2020. Furthermore, no modification in the previously conceived original design of the Santa Rosa landfill has occurred or was promoted during the period. The content of the issued technical report confirms that no practice to deliberately increase methane generation at the Santa Rosa landfill have occurred or have been promoted (when compared to management and MSW landfilling practices prior to implementation of the CPA). Aspects, conditions and circumstances related to management of the landfill (e.g. waste disposal, waste covering, waste compacting, management of leachate, draining of rainwater, etc.) were not changed with an aim to increase methane generation on site. It is relevant to note that MSW management business (collection and disposal of MSW) in Brazil (and in most of the developing countries) has its own economics, dynamics, politics and related regulations. That makes MSW disposal activity for the Santa Rosa landfill and other similar landfills in Brazil completely independent from the CDM mechanism and/or revenues of commercialization of CERs generated by project-based destruction of methane in landfills. In the particular case of the Santa Rosa landfill, it is important to note that this landfill was designed and has operated inter alia as per terms and conditions for solid waste disposal contracts established with the different municipalities and private companies. The design and operation of the landfill is also under conformance with terms and conditions for the environmental licensing that were previously defined and are regularly monitored by the competent environmental authority from the State of Rio de Janerio (Secretaria de Estado do Ambiente e Sustentabilidade - SEAS). Currently, there is still no regional or national climate change of waste management policy in Brazil which would provide an incentive or a mandate to have MSW being disposed in landfills with better/improved LFG collection/destruction systems (such as the project's LFG collection and destruction system currently implemented at the Santa Rosa landfill as a CDM CPA).
Monitoring equipment	Not applicable. No measuring equipment is used for monitoring management of the Santa Rosa landfill.
Measuring/reading/recording frequency	Annual checking is performed.
Calculation method (if applicable)	Not applicable.
QA/QC procedures	Monitoring equipment/instruments are to be calibrated and maintained as per instrument specifications and/or recommendations of their manufacturer.
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	As required by ACM0001 (version 19.0), any change in the management of the landfill after the implementation of the CPA will 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 project's implementation as described in the CPA-DD (in terms of operation and management conditions of the landfill from which LFG is combusted).

Data/Parameter	**$V_{t,wb}$**
Unit	m^3 wet gas/h
Description	Volumetric flow of LFG stream in time interval *t* on a wet basis.
Measured/calculated/ default	Continuously measured by LFG flow meter sets.
Source of data	Measured as part of the operation of the CPA by applying appropriate monitoring instruments (4 flow meters) (with recordable electronic signal).
Value(s) of monitored parameter	While measurements are performed by installed 4 LFG flow meter sets (one set for each individual installed flare), the monitoring parameter $V_{t,wb}$ is thus measured, recorded and reported on the basis of the following sub-parameters: - $V_{t,wb,flare-1}$: Volumetric flow of LFG to Flare 1 - $V_{t,wb,flare-2}$: Volumetric flow of LFG to Flare 2 - $V_{t,wb,flare-3}$: Volumetric flow of LFG to Flare 3 - $V_{t,wb,flare-4}$: Volumetric flow of LFG to Flare 4 The monthly emission reduction calculation spreadsheets (that are enclosed to this Monitoring Report) report all records of measurement data of LFG flow sent to the installed high temperature enclosed flares during the considered monitoring period. Measurement data is recorded and reported with an every-minute frequency.

Monitoring equipment	*Specifications and calibration details for the LFG flow meters used during the considered monitoring period for measuring the flow of LFG sent to the flares ($V_{t,wb,flare-1}$, $V_{t,wb,flare-2}$, $V_{t,wb,flare-3}$, and $V_{t,wb,flare-4}$):* *Specifications and calibration details for the installed flow meter used for measuring $V_{t,wb,flare-1}$ (Flare 1):* -Manufacturer: Endress + Hauser -Model: Deltabar S -Accuracy: ±0.696% -Serial Number: H901DB0109D -Calibration frequency (as per the application of the monitoring plan and recommendations from the equipment manufacturer): Calibration events are to be performed every year. -Date(s) and validity of performed calibration event(s) valid for the considered monitoring period: •Calibration event performed on 17/07/2019 by CTJ (as indicated in the Calibration Certificate Number P-4772/19). The performed calibration event is valid until 16/07/2020. *Specifications and calibration details for the installed flow meter used for measuring $V_{t,wb,flare-2}$ (Flare 2):* -Manufacturer: Endress + Hauser -Model: Deltabar S -Accuracy: ±0.696% -Serial Number: F804240109D -Calibration frequency (as per the application of the monitoring plan and recommendations from the equipment manufacturer): Calibration events are to be performed every year. -Date(s) and validity of performed calibration event(s) valid for the considered monitoring period: Calibration event performed on 17/07/2019 by CTJ (as indicated in the Calibration Certificate Number P-4770/19). The performed calibration event is valid until 16/07/2020. *Specifications and calibration details for the installed flow meter used for measuring $V_{t,wb,flare-3}$ (Flare 3):* -Manufacturer: ABB S.p.A. -Model: 266DSH -Accuracy: ±0.075% -Serial Number: 3K646615009427 -Calibration frequency (as per the application of the monitoring plan and recommendations from the equipment manufacturer): Calibration events are to be performed every year. -Date(s) and validity of performed calibration event(s) valid for the considered monitoring period: •Calibration event performed on 17/07/2019 by CTJ (as indicated in the Calibration Certificate Number P-4774/19). The performed calibration event is valid until 16/07/2020. *Specifications and calibration details for the installed flow meter used for measuring $V_{t,wb,flare-4}$ (Flare 4):* -Manufacturer: ABB S.p.A. -Model: 266DSH -Accuracy: ±0.075% -Serial Number: 3K646616045657 -Calibration frequency (as per the application of the monitoring plan and

	recommendations from the equipment manufacturer): Calibration events are to be performed every year. -Date(s) and validity of performed calibration event(s) valid for the considered monitoring period: •Calibration event performed on 17/07/2019 by CTJ (as indicated in the Calibration Certificate Number P-4786/19). The performed calibration event is valid until 16/07/2020.
Measuring/reading/recording frequency	Continuous measurements are recorded and reported with an every-minute frequency.
Calculation method (if applicable)	Not applicable.
QA/QC procedures	Monitoring equipment/instruments are to be calibrated and maintained as per instrument specifications and/or recommendations of their manufacturer. Procedures related to collection/gathering, recording, storing and reporting of monitoring data for the CPA are performed at Ciclus Ambiental in accordance with detailed working instructions.
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	-

Data/Parameter	**$v_{CH4,t,wb}$**
Unit	m^3 CH_4/m^3 wet gas
Description	Volumetric fraction of CH_4 in the collected LFG in time interval *t* on a wet basis.
Measured/calculated/ default	Continuously measured by continuous CH_4 content gas analyzer.
Source of data	Measured as part of the operation of the CPA by applying appropriate monitoring instruments (CH_4 content gas analyser) (with continuous measurements being electronically recorded).
Value(s) of monitored parameter	The monthly emission reduction calculation spreadsheets (that are enclosed to this Monitoring Report) include measurement data for $v_{CH4,t,wb}$ that are recorded and reported with an every-minute frequency.

Monitoring equipment	*Specifications and calibration details for the continuous CH_4 content gas analyzer unit used during the considered monitoring period for measuring the fraction of CH_4 in the collected LFG:* -Manufacturer: Siemens -Model: Ultramat 23 -Accuracy: ±1% -Serial Number: N1F3920 -Calibration frequency (as per the application of the monitoring plan and recommendations from the equipment manufacturer): Calibration events are to be performed every year -Dates and validity of performed calibration event(s) valid for the considered monitoring period: •Calibration event for the continuous CH_4 gas analyzer unit performed on 27/08/2019 by Fazit (as indicated in the Calibration Certificate Number 4899B-19). The performed calibration event is valid until 26/08/2020. The calibration events were performed by using certified span gas cylinder with a known CH_4 composition (as outlined in the Calibration Certificate).
Measuring/reading/recording frequency	Continuous measurements are recorded and reported with an every-minute frequency.
Calculation method (if applicable)	Not applicable.
QA/QC procedures	Monitoring equipment/instruments are to be calibrated and maintained as per instrument specifications and/or recommendations of their manufacturer. Procedures related to collection/gathering, recording, storing and reporting of monitoring data for the CPA are performed at Ciclus Ambiental in accordance with detailed working instructions.
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	-

Data/Parameter	**T_t**
Unit	K
Description	Temperature of the LFG stream in time interval *t*
Measured/calculated/ default	Measured
Source of data	Continuously measurements are performed by a set of 4 LFG temperature sensors which are installed in different positions along the LFG pipeline of the CPA as follows: - 4 LFG temperature sensor within the LFG collection and flaring infrastructure (one for each installed flare) Measurements of LFG temperature are primarily recorded and reported in ^oC. Recorded/reported data is converted into Kelvin (K) and data is also reported in this unit, thus meeting the related monitoring requirement as per the CPA-DD.
Value(s) of monitored parameter	While measurements are performed by 4 LFG temperature sensors installed in different sections of the LFG pipeline along the LFG pipeline of the CPA

	within the flaring facility, the monitoring parameter T_t is thus measured, recorded and reported on the basis of the following sub-parameters: -$T_{t,flare-1}$: Temperature of LFG sent to flare 1 -$T_{t,flare-2}$: Temperature of LFG sent to flare 2 -$T_{t,flare-3}$: Temperature of LFG sent to flare 3 -$T_{t,flare-4}$: Temperature of LFG sent to flare 4 The monthly emission reduction calculation spreadsheets (that are enclosed to this Monitoring Report) include measurement data for T_t that are recorded and reported with an every-minute frequency.

Monitoring equipment	Measurements of temperature of LFG sent to the flares are performed by four installed LFG temperature sensor (that is installed in each one of the LFG pipeline within the flaring facility in a section between the centrifugal blowers and the high temperature enclosed flares). *<u>Specifications and calibration details for the LFG temperature sensors used for measuring temperature of LFG sent to the flares:</u>* *LFG temperature sensor used for measuring $T_{t,flare-1}$ (Flare 1):* -Manufacturer: Endress + Hauser -Model: Omnigrad M TR10 -Accuracy: ±0.15% -Serial Number (S/N): J5049A14152 -Required calibration frequency: calibration events are to be performed yearly -Date(s) and validity of performed calibration event(s) valid for the considered monitoring period: -Calibration event dated 17/07/2019 valid until 16/07/2020 (Calibration Certificate T-4358/19, issued by CTJ). *LFG temperature sensor used for measuring $T_{t,flare-2}$ (Flare 2):* -Manufacturer: Endress + Hauser -Model: Omnigrad M TR10 -Accuracy: ±0.15% -Serial Number (S/N): F7091014152 -Required calibration frequency: calibration events are to be performed yearly -Date(s) and validity of performed calibration event(s) valid for the considered monitoring period: -Calibration event dated 17/07/2019 valid until 16/07/2020 (Calibration Certificate T-4356/19, issued by CTJ). *LFG temperature sensor used for measuring $T_{t,flare-3}$ (Flare 3):* -Manufacturer: Elsi s.r.l. -Model: Y1-SEM203 -Accuracy: ± 0.5 ^{o}C -Serial Number (S/N): E15TP0582 -Required calibration frequency: calibration events are to be performed yearly -Date(s) and validity of performed calibration event(s) valid for the considered monitoring period: -Calibration event dated 17/07/2019 valid until 16/07/2020 (Calibration Certificate T-4359/19, issued by CTJ). *LFG temperature sensor used for measuring $T_{t,flare-4}$ (Flare 4):* -Manufacturer: Elsi s.r.l. -Model: Y1-SEM203 -Accuracy: ± 0.5 ^{o}C -Serial Number (S/N): E17TP0002 -Required calibration frequency: calibration events are to be performed yearly -Date(s) and validity of performed calibration event(s) valid for the considered monitoring period: -Calibration event dated 17/07/2019 valid until 16/07/2020 (Calibration Certificate T-4360/19, issued by CTJ).

Measuring/reading/recording frequency	Continuous measurements are recorded and reported with an every-minute frequency.
Calculation method (if applicable)	Not applicable.
QA/QC procedures	Monitoring equipment/instruments are to be calibrated and maintained as per instrument specifications and/or recommendations of their manufacturer. Procedures related to collection/gathering, recording, storing and reporting of monitoring data for the CPA are performed at Ciclus Ambiental in accordance with detailed working instructions.
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	-

Data/Parameter	**P_t**
Unit	Pa
Description	Pressure of the LFG stream in time interval *t*
Measured/calculated/ default	Continuously measured by a pressure sensor installed along the LFG pipeline of the CPA within the flaring facility. Measurements of pressure of LFG are primarily recorded and reported in mbar. Recorded/reported data is converted into Pascal and data is also reported in this unit, thus meeting the related monitoring requirement as per the CPA-DD.
Source of data	Continuously measurements are performed by 4 LFG pressure sensors which are installed in different positions along the LFG pipeline of the CPA as follows: - 4 LFG pressure sensor within the LFG collection and flaring infrastructure (on each installed high temperature enclosed flare). Measurements of LFG pressure are primarily recorded and reported in millibars (mbar). Recorded/reported data is converted into Pascal (Pa) and data is also reported in this unit, thus meeting the related monitoring requirement as per the CPA-DD.
Value(s) of monitored parameter	While measurements are performed by 4 LFG pressure sensors (one each installed high temperature enclosed flare) installed in different sections along the LFG pipeline along the CPA within the LFG flaring facility, the monitoring parameter P_t is thus measured, recorded and reported on the basis of the following sub-parameters: -$P_{t,flare-1}$: Pressure of the LFG sent to Flare 1 -$P_{t,flare-2}$: Pressure of the LFG sent to Flare 2 -$P_{t,flare-3}$: Pressure of the LFG sent to Flare 3 -$P_{t,flare-4}$: Pressure of the LFG sent to Flare 4 The monthly emission reduction calculation spreadsheets (that are enclosed to this Monitoring Report) include measurement data for P_t that are recorded and reported with an every-minute frequency.

Monitoring equipment	Measurements of pressure of LFG which is sent to the flares are performed by 4 pressure sensors that is installed in the main LFG pipeline within the flaring facility. *<u>Specifications and calibration details for the LFG pressure sensors used for measuring temperature of LFG sent to the flares:</u>* *LFG pressure sensor used for measuring $P_{t,flare-1}$ (Flare 1):* -Manufacturer: Endress + Hauser -Model: Cerabar M -Accuracy: ±0.15% -Serial Number: J6000491128 -Required calibration frequency: calibration events are to be performed yearly. -Date(s) and validity of performed calibration event(s) valid for the considered monitoring period: -Calibration event dated 17/07/2019 valid until 16/07/2020 (Calibration Certificate P-4773/19, issued by CTJ). *LFG pressure sensor used for measuring $P_{t,flare-2}$ (Flare 2):* -Manufacturer: Endress + Hauser -Model: Cerabar M -Accuracy: ±0.15% -Serial Number: F800BE01128 -Required calibration frequency: calibration events are to be performed yearly. -Date(s) and validity of performed calibration event(s) valid for the considered monitoring period: -Calibration event dated 17/07/2019 valid until 16/07/2020 (Calibration Certificate P-4771/19, issued by CTJ). *LFG pressure sensor used for measuring $P_{t,flare-3}$ (Flare 3):* -Manufacturer: ABB S.p.A. -Model: 266HSH -Accuracy: ±0.6% -Serial Number: 3K646615009417 -Required calibration frequency: calibration events are to be performed yearly. -Date(s) and validity of performed calibration event(s) valid for the considered monitoring period: -Calibration event dated 17/07/2019 valid until 16/07/2020 (Calibration Certificate P-4787/19, issued by CTJ). *LFG pressure sensor used for measuring $P_{t,flare-4}$ (Flare 4):* -Manufacturer: ABB S.p.A. -Model: 266HSH -Accuracy: ±0.6% -Serial Number: 3K646616045656 -Required calibration frequency: calibration events are to be performed yearly. -Date(s) and validity of performed calibration event(s) valid for the considered monitoring period: -Calibration event dated 17/07/2019 valid until 16/07/2020 (Calibration Certificate P-4775/19, issued by CTJ).
Measuring/reading/recording frequency	Continuously measurements are recorded/reported every minute.

Calculation method (if applicable)	Not applicable.
QA/QC procedures	Monitoring equipment/instruments are to be calibrated and maintained as per instrument specifications and/or recommendations of their manufacturer. Procedures related to collection/gathering, recording, storing and reporting of monitoring data for the CPA are performed at Ciclus Ambiental in accordance with detailed working instructions.
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	-

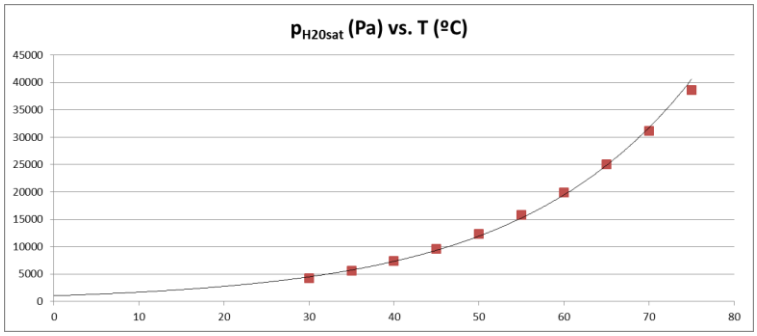
Data/Parameter	**$EC_{PJ,grid,y}$**
Unit	MWh
Description	Amount of grid electricity consumed by the CPA during the year *y*
Measured/calculated/ default	Measured as part of the operation of the CPA by applying appropriate electricity meter.
Source of data	Measured as part of the operation of the CPA by applying appropriate monitoring instrument (one electricity meter with recordable electronic signal).
Value(s) of monitored parameter	Available monthly records of grid-sourced electricity consumption valid for the considered monitoring period:

Month	Total amount of consumed grid electricity (MWh)
Oct./2019 (from 05/10 to 31/10/2019)	196.690
Nov./2019	213.021
Dec./2019	228.134
Jan./2020	176.728
Feb./2020	203.853
Mar./2020 (from 01/03 to 02/03/2020)	8.607

Monitoring equipment	*Specifications and calibration details for the electricity meter used alternately for measuring consumption of grid-sourced electricity:* -Manufacturer: Schneider Electric -Model: PM1200 -Accuracy: ±1.0% -Serial Number (S/N): CO34151170401 -Required calibration frequency (as specified by the monitoring methodology/ methodological tool): As per the CPA-DD, all monitoring equipment must be calibrated periodically. The "Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation" establishes the following regarding maintenance and calibration for electricity meters: "*(...) meters should be installed, maintained and calibrated according to equipment manufacturer instructions and be in line with national standards, or, if these are not available, international standards (e.g. IEC, ISO)*". -Calibration frequency (as per the recommendation of the meter manufacturer): it is important to note that the installed meter is approved/certified by INMETRO (The Brazilian national authority for metrology and standardization issues), and it is thus in conformance with INMETRO's requirements for maintenance and testing of electricity meters. According to the instrument's manufacturer, the meter is to be calibrated every 5 years. A calibration frequency of 5 years is thus adopted. -Date(s) and validity of performed calibration event(s) valid for the considered monitoring period: -Calibration event dated 15/03/2015 (valid until 14/03/2020), as indicated in the Calibration Certificate with no number, issued by Schneider Electric.
Measuring/reading/recording frequency	Accumulated monthly measurement values for consumption of grid-sourced electricity are recorded once a month.
Calculation method (if applicable)	Not applicable.
QA/QC procedures	Periodic calibration events in the electricity meter 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. Procedures related to collection/gathering, recording, storing and reporting of monitoring data for the CPA are performed at Ciclus Ambiental in accordance with detailed working instructions.
Purpose of data/parameter	Calculation of project emissions (due to consumption of grid-sourced electricity by the CPA).
Additional comments	The project's major source for the consumption of grid-sourced electricity is the centrifugal blower (powered by electric motor) used for forced collection of LFG from the project's LFG collection wells. Electricity consumption also represents the major operational cost for the CPA. All monthly measurement records for $EC_{PJ,grid,y}$ and calculations for the determination of accumulated values applicable for the considered monitoring period are reported in the summarized emission reduction calculation spreadsheet that is enclosed to this Monitoring Report.

Data/Parameter	**$Op_{j,h}$**
Unit	-
Description	Operation of the equipment j that consumes LFG
Measured/calculated/ default	Every-minute records of the status of the flare are reported based on the flame status of the flare (parameter $Flame_m$).
Source of data	Available every-minute records of the status of the Flare 1, Flare 2, Flare 3 and Flare 4 are reported based on the flame status of both flares (monitoring parameter $Flame_m$)
Value(s) of monitored parameter	See details in the applicable monitoring details table for the parameter $Flame_{m.}$.
Monitoring equipment	Specification details for the UV flame detectors used in Flare 1, Flare 2, Flare 3 and Flare 4 during the considered monitoring period are presented in the applicable monitoring details table for the parameter $Flame_m$ (with related measurements being recorded and reported on the basis of the sub-parameters $Flame_{m,flare-1}$, $Flame_{m,flare-2}$, $Flame_{m,flare-3}$ and $Flame_{m,flare-4}$)
Measuring/reading/recording frequency	Continuous measurements will be recorded and reported with an every minute frequency. See details in the applicable monitoring details table for the parameter $Flame_{m.}$.
Calculation method (if applicable)	Not applicable
QA/QC procedures	See details in the applicable monitoring details table for the parameter $Flame_{m.}$.
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	-

Data/Parameter	**$p_{H20,t,Sat}$**
Unit	Pa
Description	Saturation pressure of H_2O at temperature T_t in time interval *t*
Measured/calculated/ default	Default values as per selected literature.
Source of data	Data selected as per the literature "*Fundamentals of Classical Thermodynamics*". Authors: Gordon J. Van Wylen, Richard E. Sonntag and Borgnakke; 4th Edition. Published by John Wiley & Sons, Inc.
Value(s) of monitored parameter	$p_{H2O,t,Sat}$ is determined as a function of temperature of LFG (T_t by the equation: $p_{H2O,t,sat} = 1{,}031.3 * e^{(0.049 * Tt)}$, with a correlation coefficient of $R^2 = 0.998$. Further details are presented below in "Calculation Method".

<table>
<tr><td>Monitoring equipment</td><td>Not applicable.</td></tr>
<tr><td>Measuring/reading/recording frequency</td><td>Not applicable</td></tr>
<tr><td>Calculation method (if applicable)</td><td>The Absolute Vapor Pressure of Water was obtained from the mentioned literature and is presented in the following table within the rage of interest for the required calculations:
<table>
<tr><th>Temperature</th><th>$p_{H2O,t,Sat}$</th></tr>
<tr><td>ºC</td><td>Pa</td></tr>
<tr><td>30</td><td>4,246</td></tr>
<tr><td>35</td><td>5,628</td></tr>
<tr><td>40</td><td>7,384</td></tr>
<tr><td>45</td><td>9,593</td></tr>
<tr><td>50</td><td>12,349</td></tr>
<tr><td>55</td><td>15,758</td></tr>
<tr><td>60</td><td>19,940</td></tr>
<tr><td>65</td><td>25,030</td></tr>
<tr><td>70</td><td>31,190</td></tr>
<tr><td>75</td><td>38,580</td></tr>
</table>
The following graphic represents the above data and the regression calculated to adjust data:


As $p_{H2O,t,Sat}$ is a function of temperature and best represented by an exponential function, the exponential regression method is applied to the above data and the following equation is obtained:

$p_{H2O,t,sat} = 1{,}031.3 * e^{(0.049 * Tt)}$

This equation represents the above data with a correlation coefficient of $R^2 = 0.998$.

Thus, by applying the above equation, $p_{H2O,t,sat}$ is determined as a function of the temperature.</td></tr>
<tr><td>QA/QC procedures</td><td>Procedures related to collection/gathering, recording, storing and reporting of monitoring data for the CPA are performed at Ciclus Ambiental in accordance with detailed working instructions.</td></tr>
<tr><td>Purpose of data/parameter</td><td>Calculation of baseline emissions.</td></tr>
</table>

Additional comments	It is important to note that $p_{H2O,t,Sat}$ is used in the context of the determination of the methane mass flow in the residual gas (in a dry basis) for each minute *m* which the flare efficiency is measured (parameter $F_{CH4,RG,t}$). The calculations of every-minute values of $p_{H2O,t,Sat}$ which the flare efficiency is measured is thus presented only in the enclosed calculation spreadsheets.

Data/Parameter	**$T_{EG,m}$**
Unit	^oC
Description	Temperature in the exhaust gas of the enclosed flares in minute *m*
Measured/calculated/ default	Continuously measured by a thermocouple installed in the upper section of the flare
Source of data	Measured as part of the operation of the project activity by applying appropriate monitoring instruments (thermocouples) (with recordable electronic signal). Continuously measurements are performed by 4 thermocouples (each thermocouple installed in the upper section of each one of the 4 high temperature enclosed flares).
Value(s) of monitored parameter	Values for each one of the installed 4 high temperature enclosed flares are reported in the monthly emission reduction calculation spreadsheets (that are enclosed to this Monitoring Report). Measurement data is recorded and reported with an every-minute frequency. While measurements are performed by 4 thermocouples (one thermocouple installed in the upper section of each individual installed flare), the monitoring parameter $T_{EG,m}$ is measured, recorded and reported on the basis of the following sub-parameters: -$T_{EG,m,flare-1}$: Temperature in the exhaust gas of Flare 1 -$T_{EG,m,flare-2}$: Temperature in the exhaust gas of Flare 2 -$T_{EG,m,flare-3}$: Temperature in the exhaust gas of Flare 3 -$T_{EG,m,flare-4}$: Temperature in the exhaust gas of Flare 4

<table>
<tr><td>Monitoring equipment</td><td>

<u>Specifications and calibration details for the installed/utilized thermocouples:</u>

Thermocouple used during the considered monitoring period for measuring $T_{EG,m,flare-1}$ (Flare 1):

<table>
<tr><th colspan="2">Type: ECIL Type S</th></tr>
<tr><td>Accuracy:</td><td>± 0.25%</td></tr>
<tr><td>Serial number:</td><td>2644/18</td></tr>
<tr><td>Calibration frequency:</td><td>12 months</td></tr>
<tr><td>Calibration Date:</td><td>14/03/2019</td></tr>
<tr><td>Validity:</td><td>13/03/2020</td></tr>
<tr><td>Operation Period:</td><td>05/10/2019 to 02/03/2020</td></tr>
</table>

Thermocouple used during the considered monitoring period for measuring $T_{EG,m,flare-2}$ (Flare 2):

<table>
<tr><th colspan="2">Type: ECIL Type S</th></tr>
<tr><td>Accuracy:</td><td>± 0.25%</td></tr>
<tr><td>Serial number:</td><td>11095/18</td></tr>
<tr><td>Calibration frequency:</td><td>12 months</td></tr>
<tr><td>Calibration Date:</td><td>21/12/2019</td></tr>
<tr><td>Validity:</td><td>20/12/2020</td></tr>
<tr><td>Operation Period:</td><td>05/10/2019 to 02/03/2020</td></tr>
</table>

Thermocouple used during the considered monitoring period for measuring $T_{EG,m,flare-3}$ (Flare 3):

<table>
<tr><th colspan="2">Type: ECIL Type S</th></tr>
<tr><td>Accuracy:</td><td>± 0.25%</td></tr>
<tr><td>Serial number:</td><td>2689/18</td></tr>
<tr><td>Calibration frequency:</td><td>12 months</td></tr>
<tr><td>Calibration Date:</td><td>16/04/2019</td></tr>
<tr><td>Validity:</td><td>15/04/2020</td></tr>
<tr><td>Operation Period:</td><td>05/10/2019 to 02/03/2020</td></tr>
</table>

Thermocouple used during the considered monitoring period for measuring $T_{EG,m,flare-4}$ (Flare 4):

<table>
<tr><th colspan="2">Type: ECIL Type S</th></tr>
<tr><td>Accuracy:</td><td>± 0.25%</td></tr>
<tr><td>Serial number:</td><td>11097/18</td></tr>
<tr><td>Calibration frequency:</td><td>12 months</td></tr>
<tr><td>Calibration Date:</td><td>24/09/2019</td></tr>
<tr><td>Validity:</td><td>23/09/2020</td></tr>
<tr><td>Operation Period:</td><td>05/10/2019 to 02/03/2020</td></tr>
</table>

</td></tr>
<tr><td>Measuring/reading/recording frequency</td><td>Continuous measurements are automatically recorded/reported every minute.</td></tr>
<tr><td>Calculation method (if applicable)</td><td>-</td></tr>
<tr><td>QA/QC procedures</td><td>Monitoring equipment/instruments are to be calibrated and maintained as per instrument specifications and/or recommendations of manufacturer.

Procedures related to collection/gathering, recording, storing and reporting of</td></tr>
</table>

	monitoring data for the CPA are performed at Ciclus Ambiental in accordance with detailed working instructions.
Purpose of data/parameter	Calculation of baseline emissions.
Additional comments	Measurements are required to determine if manufacturer's flare specifications for operating temperature are met.

Data/Parameter	**$Flame_m$**
Unit	Flame status "*on*" or flame status "*off*"
Description	Flame detection of flare in the minute *m*
Measured/calculated/ default	Continuously measured by Ultra violet (UV) flame detector
Source of data	Whenever flame is detected in the flare, flame status "*on*" or "1" value is attributed. Whenever no flame is detected in the flare, flame status "*off*" or "0" is attributed.
Value(s) of monitored parameter	Values for each one of the installed 4 high temperature enclosed flares are reported in the monthly emission reduction calculation spreadsheets (that is enclosed to this Monitoring Report). Measurement data is recorded and reported with an every-minute frequency. While measurements are performed by 4 UV flame detectors (one UV flame detector installed in each individual installed flare), the monitoring parameter $Flame_m$ is thus measured, recorded and reported on the basis of the following sub-parameters: -$Flame_{m,flare-1}$: Flame detection in Flare 1 -$Flame_{m,flare-2}$: Flame detection in Flare 2 -$Flame_{m,flare-3}$: Flame detection in Flare 3 -$Flame_{m,flare-4}$: Flame detection in Flare 4
Monitoring equipment	*4 UV flame detectors (one UV flame detector installed in each individual installed flare:* *Specifications of the installed/utilized UV Flame detectors:* - Manufacturer: Krom Schröder - Model: UVS10 - Calibration frequency: No calibration event is required as the equipment has a self-checking function.
Measuring/reading/recording frequency	Continuously measurements are recorded/reported every minute.
Calculation method (if applicable)	Not applicable
QA/QC procedures	Monitoring equipment/instruments are to be calibrated and maintained as per instrument specifications and/or recommendations of their manufacturer. Procedures related to collection/gathering, recording, storing and reporting of monitoring data for the CPA are performed at Ciclus Ambiental in accordance with detailed working instructions.

Purpose of data/parameter	Calculation of baseline emissions
Additional comments	-

Data/Parameter	**Maintenance$_y$**
Unit	Calendar dates
Description	Maintenance events completed in year *y* as monitored by the project participants.
Measured/calculated/ default	-
Source of data	Maintenance logs
Value(s) of monitored parameter	The following previously performed relevant maintenance events (inspection and maintenance services) are applicable for the flares during the considered monitoring period: -16/07/2019 and 13/01/2020: General inspection/maintenance service on Flares 1, 2, 3 and 4 (incl. inspection of the condition of the flares isolation ceramics revetment material, checking of conditions of the LPG supply valve for pilot flames, checking of condition/function of the air inlet dumpers, checking of the conditions of the thermocouples, checking of the condition of the UV flame detectors, checking of the condition of the flame arrester valves, checking of the conditions of the LFG injectors, checking of painting conditions). As per the applied maintenance practice for the project activity, general inspection/maintenance services on the flares are opportunely performed during planned or unplanned interruptions of operation of the flares within a time interval between 2 performed inspection/maintenance services events never higher than 6 months. The expected lifetime for the isolation ceramics revetment material for all flares is of at least 10 years (as established under details valid for the ex-ante determined parameter “Manufacturer’s flare specifications for temperature, flow rate and maintenance schedule interval” ($SPEC_{flare}$)). Flare 1, Flare 2, Flare 3 and Flare 4 are under conformance with the required interval for replacement of their isolation ceramics revetment material (as defined under the details for the ex-ante parameter $SPEC_{flare}$) Performed maintenance and overhauling services in the flare are performed under by specialized technical service team under conformance with maintenance requirements for the flares (as established by equipment manufacturer) and as required by the ex-ante determined parameter $SPEC_{flare}$. Further details about the parameter $SPEC_{flare}$ are included in Section E.1.
Monitoring equipment	Not applicable.
Measuring/reading/recording frequency	Not applicable.
Calculation method (if applicable)	Not applicable.

QA/QC procedures	Procedures related to collection/gathering, recording, storing and reporting of monitoring data for the CPA are performed at Ciclus Ambiental in accordance with detailed working instructions.
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	These dates are required so that they can be compared to the maintenance schedule to check that maintenance events were completed within the minimum time between maintenance events specified by the manufacturer ($SPEC_{flare}$).

Data/Parameter	**$v_{CH4,RG,m}$**
Unit	-
Description	Volumetric fraction of component i in the residual gas on a dry basis in the minute m where i = CH_4, CO, CO_2, O_2, H_2, H_2S, NH_4, N_2
Measured/calculated/ default	Continuously measured by an gas analyser
Source of data	Measured as part of the operation of the CPA by applying appropriate monitoring instruments (gas analyser).
Value(s) of monitored parameter	While measurements are performed by installed 4 LFG flow meter sets (one set for each individual installed flare), the monitoring parameter $M_{RG,m}$ is thus measured, recorded and reported on the basis of the following sub-parameters: - $v_{CH4,RG,m,flare-1}$: Volumetric fraction of CH_4 in the residual gas on a dry basis in the minute *m* on Flare 1 - $v_{CH4,RG,m,flare-2}$: Volumetric fraction of CH_4 in the residual gas on a dry basis in the minute *m* on Flare 2 - $v_{CH4,RG,m,flare-3}$: Volumetric fraction of CH_4 in the residual gas on a dry basis in the minute *m* on Flare 3 - $v_{CH4,RG,m,flare-4}$: Volumetric fraction of CH_4 in the residual gas on a dry basis in the minute *m* on Flare 4 The monthly emission reduction calculation spreadsheets (that are enclosed to this Monitoring Report) include measurement data for $v_{CH4,RG,m}$ are recorded and reported with an every-minute frequency.

Monitoring equipment

Specifications and calibration details for the continuous CH_4 content gas analyzer unit used during the considered monitoring period for measuring the Volumetric fraction of CH_4 in the residual gas in the collected LFG:

Gas analyser used for measuring $v_{CH4,RG,m,flare-1}$ during the considered monitoring period (Flare 1):

-Manufacturer: NUK
-Model: GAE
-Accuracy: ±1%
-Serial Number: A1903
-Calibration frequency (as per the application of the monitoring plan and recommendations from the equipment manufacturer): No external calibration required according to manufacturer. Every two weeks calibrations performed on site by the plant operators;
- Dates and validity of performed calibration event(s) valid for the considered monitoring period:

Date of Performed Calibration Event	Validity of Performed Calibration Event
03/10/2019	17/10/2019
10/10/2019	24/10/2019
17/10/2019	31/10/2019
24/10/2019	07/11/2019
31/10/2019	14/11/2019
07/11/2019	21/11/2019
14/11/2019	28/11/2019
22/11/2019	06/12/2019
28/11/2019	12/12/2019
05/12/2019	19/12/2019
12/12/2019	26/12/2019
19/12/2019	02/01/2020
26/12/2019	09/01/2020
02/01/2020	16/01/2020
09/01/2020	23/01/2020
16/01/2020	30/01/2020
23/01/2020	06/02/2020
30/01/2020	13/02/2020
06/02/2020	20/02/2020
13/02/2020	27/02/2020
20/02/2020	05/03/2020
27/02/2020	12/03/2020

Gas analyser used for measuring $v_{CH4,RG,m,flare-2}$ during the considered monitoring period (Flare 2):

-Manufacturer: NUK
-Model: GAE
-Accuracy: ±1%
-Serial Number: A2055
-Calibration frequency (as per the application of the monitoring plan and recommendations from the equipment manufacturer): No external calibration required according to manufacturer. Every two weeks calibrations performed on site by the plant operators;
-Dates and validity of performed calibration event(s) valid for the considered monitoring period:

Date of Performed Calibration Event	Validity of Performed Calibration Event
03/10/2019	17/10/2019
10/10/2019	24/10/2019
17/10/2019	31/10/2019
24/10/2019	07/11/2019
31/10/2019	14/11/2019

	07/11/2019 – 21/11/2019 14/11/2019 – 28/11/2019 22/11/2019 – 06/12/2019 28/11/2019 – 12/12/2019 05/12/2019 – 19/12/2019 12/12/2019 – 26/12/2019 19/12/2019 – 02/01/2020 26/12/2019 – 09/01/2020 02/01/2020 – 16/01/2020 09/01/2020 – 23/01/2020 16/01/2020 – 30/01/2020 23/01/2020 – 06/02/2020 30/01/2020 – 13/02/2020 06/02/2020 – 20/02/2020 13/02/2020 – 27/02/2020 20/02/2020 – 05/03/2020 27/02/2020 – 12/03/2020 *Gas analyser used for measuring $v_{CH4,RG,m,flare-3}$ during the considered monitoring period (Flare 3):* -Manufacturer: Siemens -Model: Ultramat 23 -Accuracy: ±1% -Serial Number: N1F3921 -Calibration frequency (as per the application of the monitoring plan and recommendations from the equipment manufacturer): Calibration events are to be performed every year -Dates and validity of performed calibration event(s) valid for the considered monitoring period: •Calibration event for the continuous CH_4 gas analyzer unit performed on 27/06/2019 by Isocell Soluções em Analítica (as indicated in the Calibration Certificate Number 161.0/2019). The performed calibration event is valid until 26/06/2020. *Gas analyser used for measuring $v_{CH4,RG,m,flare-4}$ during the considered monitoring period (Flare 4):* -Manufacturer: Siemens -Model: Ultramat 23 -Accuracy: ±1% -Serial Number: N1HN918 -Calibration frequency (as per the application of the monitoring plan and recommendations from the equipment manufacturer): Calibration events are to be performed every year -Dates and validity of performed calibration event(s) valid for the considered monitoring period: •Calibration event for the continuous CH_4 gas analyzer unit performed on 27/08/2019 by Fazit (as indicated in the Calibration Certificate Number 4900B-19). The performed calibration event is valid until 26/08/2020. The calibration events were performed by using certified span gas cylinder with a known CH_4 composition (as outlined in the Calibration Certificate).
Measuring/reading/recording frequency	Continuously measurements are recorded/reported every minute.
Calculation method (if applicable)	Not applicable
QA/QC procedures	Monitoring equipment/instruments are to be calibrated and maintained as per instrument specifications and/or recommendations of their manufacturer.

	Procedures related to collection/gathering, recording, storing and reporting of monitoring data for the CPA are performed at Ciclus in accordance with detailed working instructions.
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	-

Data/Parameter	**$M_{RG,m}$**
Unit	kg
Description	Mass flow of the residual gas on a dry basis at reference conditions in the minute *m*
Measured/calculated/ default	Continuously measured by a flow meter
Source of data	Measured as part of the operation of the CPA by applying appropriate monitoring instruments (flow meter).
Value(s) of monitored parameter	While measurements are performed by installed 4 LFG flow meter sets (one set for each individual installed flare), the monitoring parameter $M_{RG,m}$ is thus measured, recorded and reported on the basis of the following sub-parameters: - $M_{RG,m,flare-1}$: Mass flow of the residual gas on a dry basis at reference conditions in the minute *m* - $M_{RG,m,flare-2}$: Mass flow of the residual gas on a dry basis at reference conditions in the minute *m* - $M_{RG,m,flare-3}$: Mass flow of the residual gas on a dry basis at reference conditions in the minute *m* - $M_{RG,m,flare-4}$: Mass flow of the residual gas on a dry basis at reference conditions in the minute *m* The monthly emission reduction calculation spreadsheets (that are enclosed to this Monitoring Report) report all records of measurement data of LFG flow sent to the installed high temperature enclosed flares during the considered monitoring period. Measurement data is recorded and reported with an every-minute frequency.

Monitoring equipment	*Specifications and calibration details for the LFG flow meters used during the considered monitoring period for measuring the Mass flow of the residual gas ($M_{RG,m,flare-1}$, $M_{RG,m,flare-2}$, $M_{RG,m,flare-3}$ and $M_{RG,m,flare-4}$):* *Specifications and calibration details for the installed flow meter used for measuring $M_{RG,m,flare-1}$ (Flare 1):* -Manufacturer: Endress + Hauser -Model: Deltabar S -Accuracy: ±0.696% -Serial Number: H901DB0109D -Calibration frequency (as per the application of the monitoring plan and recommendations from the equipment manufacturer): Calibration events are to be performed every year. -Date(s) and validity of performed calibration event(s) valid for the considered monitoring period: •Calibration event performed on 17/07/2019 by CTJ (as indicated in the Calibration Certificate Number P-4772/19). The performed calibration event is valid until 16/07/2020. *Specifications and calibration details for the installed flow meter used for measuring $M_{RG,m,flare-2}$ (Flare 2):* -Manufacturer: Endress + Hauser -Model: Deltabar S -Accuracy: ±0.696% -Serial Number: F804240109D -Calibration frequency (as per the application of the monitoring plan and recommendations from the equipment manufacturer): Calibration events are to be performed every year. -Date(s) and validity of performed calibration event(s) valid for the considered monitoring period: •Calibration event performed on 17/07/2019 by CTJ (as indicated in the Calibration Certificate Number P-4770/19). The performed calibration event is valid until 16/07/2020. *Specifications and calibration details for the installed flow meter used for measuring $M_{RG,m,flare-3}$ (Flare 3):* -Manufacturer: ABB S.p.A. -Model: 266DSH -Accuracy: ±0.075% -Serial Number: 3K646615009427 -Calibration frequency (as per the application of the monitoring plan and recommendations from the equipment manufacturer): Calibration events are to be performed every year. -Date(s) and validity of performed calibration event(s) valid for the considered monitoring period: •Calibration event performed on 17/07/2019 by CTJ (as indicated in the Calibration Certificate Number P-4774/19). The performed calibration event is valid until 16/07/2020. *Specifications and calibration details for the installed flow meter used for measuring $M_{RG,m,flare-4}$ (Flare 4):* -Manufacturer: ABB S.p.A. -Model: 266DSH -Accuracy: ±0.075% -Serial Number: 3K646616045657 -Calibration frequency (as per the application of the monitoring plan and

	recommendations from the equipment manufacturer): Calibration events are to be performed every year. -Date(s) and validity of performed calibration event(s) valid for the considered monitoring period: •Calibration event performed on 17/07/2019 by CTJ (as indicated in the Calibration Certificate Number P-4786/19). The performed calibration event is valid until 16/07/2020.
Measuring/reading/recording frequency	Continuously measurements are recorded/reported every minute.
Calculation method (if applicable)	Not applicable
QA/QC procedures	Monitoring equipment/instruments are to be calibrated and maintained as per instrument specifications and/or recommendations of their manufacturer. Procedures related to collection/gathering, recording, storing and reporting of monitoring data for the CPA are performed at Ciclus in accordance with detailed working instructions.
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	-

Data/Parameter	**$v_{O2,EG,m}$**
Unit	-
Description	Volumetric fraction of O_2 in the exhaust gas on a dry basis at reference conditions in the minute *m*
Measured/calculated/ default	Continuously measured by a gas analyser
Source of data	Measured as part of the operation of the CPA by applying appropriate monitoring instruments (gas analyser).
Value(s) of monitored parameter	The monthly emission reduction calculation spreadsheets (that are enclosed to this Monitoring Report) include measurement data for $v_{O2,EG,m}$ for each one of the 4 installed high temperature enclosed flares that are recorded and reported with an every-minute frequency. While measurements are performed by 4 gas analysers (one gas analyser installed in each individual installed flare), the monitoring parameter $v_{O2,EG,m}$ is thus measured, recorded and reported on the basis of the following sub-parameters: -$V_{O2,EG,m,flare-1}$: Volumetric fraction of O_2 in the exhaust gas on a dry basis in the minute m in Flare 1; -$V_{O2,EG,m,flare-2}$: Volumetric fraction of O_2 in the exhaust gas on a dry basis in the minute m in Flare 2; -$V_{O2,EG,m,flare-3}$: Volumetric fraction of O_2 in the exhaust gas on a dry basis in the minute m in Flare 3; -$V_{O2,EG,m,flare-4}$: Volumetric fraction of O_2 in the exhaust gas on a dry basis in the minute m in Flare 4;

Monitoring equipment

Gas analyser used for measuring $V_{O2,EG,m,flare-1}$ *during the considered monitoring period (Flare 1):*

-Manufacturer: NUK
-Model: GAE
-Accuracy: ±1%
-Serial Number: A2055
-Calibration frequency (as per the application of the monitoring plan and recommendations from the equipment manufacturer): No external calibration required according to manufacturer. Every two weeks calibrations performed on site by the plant operators;
-Dates and validity of performed calibration event(s) valid for the considered monitoring period:

Date of Performed Calibration Event	Validity of Performed Calibration Event
03/10/2019	17/10/2019
10/10/2019	24/10/2019
17/10/2019	31/10/2019
24/10/2019	07/11/2019
31/10/2019	14/11/2019
07/11/2019	21/11/2019
14/11/2019	28/11/2019
22/11/2019	06/12/2019
28/11/2019	12/12/2019
05/12/2019	19/12/2019
12/12/2019	26/12/2019
19/12/2019	02/01/2020
26/12/2019	09/01/2020
02/01/2020	16/01/2020
09/01/2020	23/01/2020
16/01/2020	30/01/2020
23/01/2020	06/02/2020
30/01/2020	13/02/2020
06/02/2020	20/02/2020
13/02/2020	27/02/2020
20/02/2020	05/03/2020
27/02/2020	12/03/2020

Gas analyser used for measuring $V_{O2,EG,m,flare-2}$ *during the considered monitoring period (Flare 2):*

-Manufacturer: NUK
-Model: GAE
-Accuracy: ±1%
-Serial Number: A1903
-Calibration frequency (as per the application of the monitoring plan and recommendations from the equipment manufacturer): No external calibration required according to manufacturer. Every two weeks calibrations performed on site by the plant operators;
-Dates and validity of performed calibration event(s) valid for the considered monitoring period:

Date of Performed Calibration Event	Validity of Performed Calibration Event
03/10/2019	17/10/2019
10/10/2019	24/10/2019
17/10/2019	31/10/2019
24/10/2019	07/11/2019
31/10/2019	14/11/2019
07/11/2019	21/11/2019
14/11/2019	28/11/2019
22/11/2019	06/12/2019
28/11/2019	12/12/2019

	05/12/2019 – 19/12/2019 12/12/2019 – 26/12/2019 19/12/2019 – 02/01/2020 26/12/2019 – 09/01/2020 02/01/2020 – 16/01/2020 09/01/2020 – 23/01/2020 16/01/2020 – 30/01/2020 23/01/2020 – 06/02/2020 30/01/2020 – 13/02/2020 06/02/2020 – 20/02/2020 13/02/2020 – 27/02/2020 20/02/2020 – 05/03/2020 27/02/2020 – 12/03/2020 *Gas analyser used for measuring* $V_{O2,EG,m,flare-3}$ *during the considered monitoring period (Flare 3):* -Manufacturer: Siemens -Model: Ultramat 23 -Accuracy: ±1% Serial Number: N1F3921 -Calibration frequency (as per the application of the monitoring plan and recommendations from the equipment manufacturer): Calibration events are to be performed every year -Dates and validity of performed calibration event(s) valid for the considered monitoring period: •Calibration event for the continuous CH_4 gas analyzer unit performed on 27/06/2019 by Isocell Soluções em Analítica (as indicated in the Calibration Certificate Number 161.0/2019). The performed calibration event is valid until 26/06/2020. *Gas analyser used for measuring* $V_{O2,EG,m,flare-4}$ *during the considered monitoring period (Flare 4):* -Manufacturer: Siemens -Model: Ultramat 23 -Accuracy: ±1% -Serial Number: N1HN918 -Calibration frequency (as per the application of the monitoring plan and recommendations from the equipment manufacturer): Calibration events are to be performed every year -Dates and validity of performed calibration event(s) valid for the considered monitoring period: •Calibration event for the continuous CH_4 gas analyzer unit performed on 27/08/2019 by Fazit (as indicated in the Calibration Certificate Number 4900B-19). The performed calibration event is valid until 26/08/2020.
Measuring/reading/recording frequency	Continuously measurements are recorded/reported every minute.
Calculation method (if applicable)	Not applicable
QA/QC procedures	Monitoring equipment/instruments are to be calibrated and maintained as per instrument specifications and/or recommendations of their manufacturer. Procedures related to collection/gathering, recording, storing and reporting of monitoring data for the CPA are performed at Ciclus in accordance with detailed working instructions.
Purpose of data/parameter	Calculation of baseline emissions

Additional comments	-

Data/Parameter	**$fc_{CH4,EG,m}$**
Unit	mg/m^3
Description	Concentration of methane in the exhaust gas of the flare on a dry basis at reference conditions in the minute *m*
Measured/calculated/ default	Continuously measured by a gas analyser
Source of data	Measured as part of the operation of the CPA by applying appropriate monitoring instruments (gas analyser).
Value(s) of monitored parameter	The monthly emission reduction calculation spreadsheets (that are enclosed to this Monitoring Report) include measurement data for $fc_{CH4,EG,m}$ for each one of the 4 installed high temperature enclosed flares that are recorded and reported with an every-minute frequency. While measurements are performed by 4 gas analysers (one gas analyser installed in each individual installed flare), the monitoring parameter $fc_{CH4,EG,m}$ is thus measured, recorded and reported on the basis of the following sub-parameters: -$fc_{CH4,EG,m,flare-1}$: Concentration of methane in the exhaust gas of the flare on a dry basis at reference conditions in the minute *m* on Flare 1; -$fc_{CH4,EG,m,flare-2}$: Concentration of methane in the exhaust gas of the flare on a dry basis at reference conditions in the minute *m* on Flare 2; -$fc_{CH4,EG,m,flare-3}$: Concentration of methane in the exhaust gas of the flare on a dry basis at reference conditions in the minute *m* on Flare 3; -$fc_{CH4,EG,m,flare-4}$: Concentration of methane in the exhaust gas of the flare on a dry basis at reference conditions in the minute *m* on Flare 4;

Monitoring equipment

Specifications and calibration details for gas analyzer unit used during the considered monitoring period for measuring the concentration of methane in the exhaust gas of the flare on a dry basis at reference conditions in the minute m:

Gas analyser used for measuring $fc_{CH4,EG,m,flare-1}$ during the considered monitoring period (Flare 1):

-Manufacturer: NUK
-Model: GAE
-Accuracy: ±1%
-Serial Number: A1903
-Calibration frequency (as per the application of the monitoring plan and recommendations from the equipment manufacturer): No external calibration required according to manufacturer. Every two weeks calibrations performed on site by the plant operators;
-Dates and validity of performed calibration event(s) valid for the considered monitoring period:

Date of Performed Calibration Event	Validity of Performed Calibration Event
03/10/2019	17/10/2019
10/10/2019	24/10/2019
17/10/2019	31/10/2019
24/10/2019	07/11/2019
31/10/2019	14/11/2019
07/11/2019	21/11/2019
14/11/2019	28/11/2019
22/11/2019	06/12/2019
28/11/2019	12/12/2019
05/12/2019	19/12/2019
12/12/2019	26/12/2019
19/12/2019	02/01/2020
26/12/2019	09/01/2020
02/01/2020	16/01/2020
09/01/2020	23/01/2020
16/01/2020	30/01/2020
23/01/2020	06/02/2020
30/01/2020	13/02/2020
06/02/2020	20/02/2020
13/02/2020	27/02/2020
20/02/2020	05/03/2020
27/02/2020	12/03/2020

Gas analyser used for measuring $fc_{CH4,EG,m,flare-2}$ during the considered monitoring period (Flare 2):

-Manufacturer: NUK
-Model: GAE
-Accuracy: ±1%
-Serial Number: A2055
-Calibration frequency (as per the application of the monitoring plan and recommendations from the equipment manufacturer): No external calibration required according to manufacturer. Every two weeks calibrations performed on site by the plant operators;
-Dates and validity of performed calibration event(s) valid for the considered monitoring period:

Date of Performed Calibration Event	Validity of Performed Calibration Event
03/10/2019	17/10/2019
10/10/2019	24/10/2019
17/10/2019	31/10/2019
24/10/2019	07/11/2019
31/10/2019	14/11/2019

	07/11/2019 – 21/11/2019 14/11/2019 – 28/11/2019 22/11/2019 – 06/12/2019 28/11/2019 – 12/12/2019 05/12/2019 – 19/12/2019 12/12/2019 – 26/12/2019 19/12/2019 – 02/01/2020 26/12/2019 – 09/01/2020 02/01/2020 – 16/01/2020 09/01/2020 – 23/01/2020 16/01/2020 – 30/01/2020 23/01/2020 – 06/02/2020 30/01/2020 – 13/02/2020 06/02/2020 – 20/02/2020 13/02/2020 – 27/02/2020 20/02/2020 – 05/03/2020 27/02/2020 – 12/03/2020 *Gas analyser used for measuring $fc_{CH4,EG,m,flare-3}$ during the considered monitoring period (Flare 3):* -Manufacturer: Siemens -Model: Ultramat 23 -Accuracy: ±1% -Serial Number: N1F3921 -Calibration frequency (as per the application of the monitoring plan and recommendations from the equipment manufacturer): Calibration events are to be performed every year -Dates and validity of performed calibration event(s) valid for the considered monitoring period: •Calibration event for the continuous CH_4 gas analyzer unit performed on 27/06/2019 by Isocell Soluções em Analítica (as indicated in the Calibration Certificate Number 161.0/2019). The performed calibration event is valid until 26/06/2020. *Gas analyser used for measuring $fc_{CH4,EG,m,flare-4}$ during the considered monitoring period (Flare 4):* -Manufacturer: Siemens -Model: Ultramat 23 -Accuracy: ±1% -Serial Number: N1HN918 -Calibration frequency (as per the application of the monitoring plan and recommendations from the equipment manufacturer): Calibration events are to be performed every year -Dates and validity of performed calibration event(s) valid for the considered monitoring period: •Calibration event for the continuous CH_4 gas analyzer unit performed on 27/08/2019 by Fazit (as indicated in the Calibration Certificate Number 4900B-19). The performed calibration event is valid until 26/08/2020. The calibration events were performed by using certified span gas cylinder with a known CH_4 composition (as outlined in the Calibration Certificate).
Measuring/reading/recording frequency	Continuously measurements are recorded/reported every minute.
Calculation method (if applicable)	Not applicable

QA/QC procedures	Monitoring equipment/instruments are to be calibrated and maintained as per instrument specifications and/or recommendations of their manufacturer. Procedures related to collection/gathering, recording, storing and reporting of monitoring data for the CPA are performed at Ciclus in accordance with detailed working instructions.
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	-

Data/Parameter	**$TDL_{grid,y}$**
Unit	%
Description	Average technical transmission and distribution losses for providing electricity to the grid and/or for grid sourced electricity consumed by CPA-1 Santa Rosa in year *y*
Measured/calculated/ default	Default
Source of data	Default value as per the methodological tool "Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation" (version 03.0)
Value(s) of monitored parameter	20
Monitoring equipment	-
Measuring/reading/recording frequency	Default value
Calculation method (if applicable)	Not applicable
QA/QC procedures	Not applicable
Purpose of data/parameter	Calculation of project emisisons
Additional comments	-

Data/Parameter	**Status of biogas destruction device**
Unit	-
Description	Operational status of biogas destruction devices
Measured/calculated/ default	Every-minute records of the status of the flare are reported based on the flame status of the flare (parameter $Flame_m$).
Source of data	Available every-minute records of the status of Flare 1, Flare 2, Flare 3 and Flare 4 are reported based on the flame status of both flares (monitoring parameter $Flame_m$)

Value(s) of monitored parameter	See details in the applicable monitoring details table for the parameter $Flame_{m.}$.
Monitoring equipment	Specification details for the UV flame detectors used in Flare 1, Flare 2, Flare 3 and Flare 4 during the considered monitoring period are presented in the applicable monitoring details table for the parameter $Flame_{m}$ (with related measurements being recorded and reported on the basis of the sub-parameters $Flame_{m,flare-1}$, $Flame_{m,flare-2}$, $Flame_{m,flare-3}$ and $Flame_{m,flare-4}$)
Measuring/reading/recording frequency	Continuous measurements will be recorded and reported with an every minute frequency. See details in the applicable monitoring details table for the parameter $Flame_{m.}$.
Calculation method (if applicable)	Not applicable
QA/QC procedures	See details in the applicable monitoring details table for the parameter $Flame_{m.}$.
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	-

Data/Parameter	**$FC_{i,y}$**
Unit	m^3
Description	Quantity of diesel consumed by the CPA in year *y*
Measured/calculated/ Default	Measured
Source of data	Monitored values of $FC_{i,y}$ are based on measurements performed by a volume meter.
Value(s) of monitored parameter	As per the adopted monitoring procedure, the total amount of diesel consumed by the project activity during the considered monitoring period is represented below: Available monthly records of grid-sourced electricity consumption valid for the considered monitoring period:

Month	**Total amount of diesel consumed by the project activity (m^3)**
Oct./2019 (from 05/10 to 31/10/2019)	0.160
Nov./2019	0.682
Dec./2019	0.308
Jan./2020	0
Feb./2020	1.995
Mar./2020 (from 01/03 to 02/03/2020)	1.193

Monitoring equipment	*Specifications and calibration details for the installed volume meter for measurements of $FC_{i,y}$:* -Manufacturer: Lupus -Model: 2100-MPBS -Capacity: 1 to 20L -Accuracy: ±1L -Serial Number: 1663 -Calibration frequency (as specified by the monitoring methodology/tool): The monitoring plan of the CPA-DD and ACM0001 (version 19.0) do not specify any calibration frequency requirements for the weight scales. As per the CPA-DD, all equipment must be calibrated periodically. As per the "Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion", meters should be installed, maintained and calibrated according to equipment manufacturer instructions and be in line with national standards, or, if these are not available, international standards (e.g. IEC, ISO). -Date of valid calibration: 12/08/2019 (Calibration Certificate 108/2019). -Entity/company responsible for the performed calibration events: JRP Calibração e Serviços. -Validity of the performed calibration events: The calibration event dated 12/08/2019 is valid until 11/08/2020 (1 year).
Measuring/reading/recording frequency	Values are recorded on a monthly basis.
Calculation method (if applicable)	Not applicable.
QA/QC procedures	Monitoring equipment/instruments are to be calibrated and maintained as per instrument specifications and/or recommendations of their manufacturer. Procedures related to collection/gathering, recording, storing and reporting of monitoring data for the CPA are performed at Ciclus in accordance with detailed working instructions.
Purpose of data/parameter	Calculation of project emissions (due to consumption of diesel by the project activity).
Additional comments	-

Data/Parameter	**$NCV_{i,y}$**
Unit	GJ/ton diesel
Description	Net calorific value of the fuel diesel
Measured/calculated/ Default	Default value is selected.

Source of data	National default value as per the Brazilian National Energetic Balance Report for year 2020 (Balanço Energético Nacional (BEN) – 2020) / Table VIII.9 – Specific Mass and Heating Values (Higher Heating Value). This official document was published by the public entity Empresas de Pesquisas Energéticas (EPE). While create and established in accordance with the Federal Law 10.847 of 15/03/2004, the EPE is a governmental entity that undertakes energy planning related investigation and research services. The BEN-2020 report is available online: https://www.epe.gov.br/pt/publicacoes-dados-abertos/publicacoes/balanco-energetico-nacional-2020 Reported value in kcal/kg is converted into GJ/ton.
Value(s) of monitored parameter	49.1
Monitoring equipment	Not applicable.
Measuring/reading/recording frequency	In accordance with the CPA-DD, as national default value is considered, an every year monitoring frequency is thus applied.
Calculation method (if applicable)	Not applicable.
QA/QC procedures	Procedures related to collection/gathering, recording, storing and reporting of monitoring data for the project activity are performed at Essencis Soluções Ambientais S.A. in accordance with detailed working instructions that are included in the company's ISO 9001 and 14001 certified quality management and control (QA/QC) and environmental management system (EMS).
Purpose of data/parameter	Calculation of project emissions (due to consumption of diesel by the project activity).
Additional comments	-

Data/Parameter	**$EF_{CO2,i,y}$**
Unit	tCO_2/GJ diesel
Description	CO_2 emission factor of fuel diesel in year *y*
Measured/calculated/ Default	Default value is selected.
Source of data	Value is selected as per 2006 IPCC Guidelines on National GHG Inventories (applicable value at upper limit of uncertainty at 95% confidence interval as provided in Table 1.4 of Chapter 1 of Vol. 2 (Energy)).
Value(s) of monitored parameter	0.0656
Monitoring equipment	Not applicable.
Measuring/reading/recording frequency	In accordance with the CPA-DD, as IPCC default value is considered, an every year monitoring frequency is thus applied.
Calculation method (if applicable)	Not applicable.

QA/QC procedures	Procedures related to collection/gathering, recording, storing and reporting of monitoring data for the project activity are performed in accordance with detailed working instructions that are included in the company's ISO 9001 and 14001 certified quality management and control (QA/QC) and environmental management system (EMS).
Purpose of data/parameter	Calculation of project emissions (due to consumption of diesel by the project activity)
Additional comments	-

The following monitoring parameters (which are also included in the monitoring plan of the CPA-DD) were not monitored as the methodological options for which they are applicable/valid were not selected as the monitoring or calculation approaches for the determination of baseline emissions achieved by the project activity during the considered monitoring period:
-Volumetric flow of LFG stream in time interval *t* on a dry basis ($V_{t,db}$)
-Volumetric fraction of CH_4 in the collected LFG in time interval *t* on a dry basis ($V_{CH4,t,db}$)
-Mass flow of the LFG stream in time interval *t* on dry basis ($M_{t,db}$)
-

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

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Under conformance with provisions and calculation approaches of the registered CPA-DD, Baseline emissions (BE_y) for the considered monitoring period are determined (in tCO_2e) as follows:

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

Where:

$BE_{CH4,y}$ Baseline emissions of methane from the SWDS[6]. As established by both ACM0001 (version 19.0) and the CPA-DD, the determination of $BE_{CH4,y}$ is based on the amount of methane that is actually captured and combusted (through destruction of collected LFG in the flare) by the project activity. As established by both ACM0001 (version 19.0) and the CPA-DD, the amount of methane that, in the absence of the project activity (baseline scenario), would be otherwise captured and destroyed in the landfill (by the pre-project previously existent conventional LFG destruction system) is also taken into account. In addition, the effect of methane oxidation (that, as per ACM0001 (version 19.0) is assumed as existing in the baseline and not in the project scenario) is also taken into account. $BE_{CH4,y}$ is thus determined as follows:

[6] SWDS = Solid Waste Disposal Site. For the case of the project activity, the SWDS is the CTR Santa Rosa landfill.

$BE_{CH4,y} = ((1 – OX_{top\_layer}) * F_{CH4,PJ,y} – F_{CH4,BL,y}) * GWP_{CH4}$

Where:

OX_{top_layer} Fraction of methane in the LFG that would be oxidized in the top layer of the SWDS in the baseline scenario. OX_{top_layer} is ex-ante determined as 10%. Further details about the selection of the value for OX_{top_layer} is included in Section E.1 and in the CPA-DD.

$GWP_{CH4,y}$ Global warming potential of CH_4. GWP_{CH4} is ex-ante determined as 25. Further details about the selection of the value for GWP_{CH4} is included in Section E.1 and in the CPA-DD.

$F_{CH4,BL,y}$ Amount of methane in the LFG that would be flared in the baseline scenario (absence of project activity). As outlined in Section B.4.1 of the CPA-DD, as per ACM0001 (version 19.0), it is assumed that there was no existing LFG capture system at the CTR Santa Rosa landfill prior to the implementation of CPA-1 Santa Rosa, thus $F_{CH4,BL,y}$ is calculated as follows:

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

For the considered monitoring period, the accumulated value for $F_{CH4,BL,y}$ is calculated and reported as 0 tCH_4. All related calculation are presented in the monthly emission reduction calculation spreadsheets that are enclosed to the Monitoring Report.

$F_{CH4,PJ,y}$ Amount of methane in the LFG which is flared and/or used in the project activity. In the particular case of the project activity, $F_{CH4,PJ,y}$ is determined as follows:

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

Where:

$F_{CH4,flared,y}$ Amount of methane in the LFG which is destroyed by flaring (in tCH_4). In accordance with calculation guidance included in the CPA-DD and by following applicable guidance of the “Tool to determine the mass flow of a greenhouse gas in a gaseous stream”, every-minute values for $F_{CH4,flared,y}$ are determined as the difference between the amount of methane supplied to the flare and residual methane emissions from combustion of LFG in the flare, as follows:

$F_{CH4,flared,y} = F_{CH4,sent\_flare,y} – (PE_{flare,y} / GWP_{CH4})$

Where:

$F_{CH4,sent\_flare,y}$ Amount of methane in the LFG which is sent to the flare. Details for the determination of every-minute values for $F_{CH4,sent\_flare,y}$ are presented below (under “*Determination of every-minute values for the calculation parameter $F_{CH4,sent\_flare,y}$*”).

$PE_{flare,y}$ Project emissions from flaring of the residual gas stream. Details for the

determination of every-minute values for $PE_{flare,y}$ for each individual flare are presented below (under "*Determination of $PE_{flare,y}$*").

Determination of every-minute values for the calculation parameter $F_{CH4,sent\_flare,y}$:
For the considered monitoring period, Option C of the "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" (where the gaseous stream the tool shall be applied to is the stream of collected LFG that is sent to each the flare) is the selected option for determination of values of $F_{CH4,sent\_flare,y}$.

By following calculation option C (that is one of the applicable calculation methods the CPA-DD refers to), the mass flow of greenhouse gas *i* for the installed flares ($F_{i,t}$, where *i* = CH_4) during the whole considered monitoring period (by taking into account the share of period for which related monitoring records are available) is determined as follows:

$F_{CH4,t,flare-n} = F_{CH4,t,flare-n} = V_{t,wb,n,flare-n} * v_{CH4,t,wb} * \rho_{CH4,n}$

Where:

$V_{t,wb,n,flare-n}$ Volumetric flow of the gaseous stream (LFG) to the flare in time interval *t* on a wet basis at normal conditions. For the considered monitoring period, every-minute values of the calculation parameter $V_{t,wb,n,flare-n}$ for each flare (sub-parameters $V_{t,wb,n,flare-1}$ and $V_{t,wb,n,flare-2}$, $Vt_{,wb,n,flare-3}$ and $V_{t,wb,n,flare-4}$) are directly measured and automatically reported (in Nm^3 wet gas/h) in the monthly emission reduction calculation spreadsheets valid for the considered monitoring period (and enclosed to this Monitoring Report). While in the particular case of the project activity, during the considered monitoring period, the determination of volumetric flow of the gaseous stream (LFG) is already processed and reported in Nm^3 of wet gas/h (normal conditions), the following assumption is thus valid:

- $V_{t,wb,n,flare-1}$ is equivalent to $V_{t,wb,flare-1}$
- $V_{t,wb,n,flare-2}$ is equivalent to $V_{t,wb,flare-2}$
- $V_{t,wb,n,flare-3}$ is equivalent to $V_{t,wb,flare-3}$
- $V_{t,wb,n,flare-4}$ is equivalent to $V_{t,wb,flare-4}$

Where:

$V_{t,wb,flare-1}$ Volumetric flow of the gaseous stream (LFG) sent to Flare 1 in time interval *t* on a wet basis (in actual conditions).

$V_{t,wb,flare-2}$ Volumetric flow of the gaseous stream (LFG) sent to Flare 2 in time interval *t* on a wet basis (in actual conditions).

$V_{t,wb,flare-3}$ Volumetric flow of the gaseous stream (LFG) sent to Flare 3 in time interval *t* on a wet basis (in actual conditions).

$V_{t,wb,flare-4}$ Volumetric flow of the gaseous stream (LFG) sent to Flare 4 in time interval *t* on a wet basis (in actual conditions).

Note: in accordance with the CPA-DD, since measurements of LFG flow sent to each one of the flares are automatically processed and recorded in normalized cubic meters, monitoring of "Pressure of the LFG stream in time interval t" (P_t) and

"Temperature of the LFG stream in time interval *t*" (T_t) are thus not required for the determination of $V_{t,wb,n,flare-1}$ and $V_{t,wb,n,flare-2}$, $Vt_{,wb,n,flare-3}$ and $V_{t,wb,n,flare-4}$. Further monitoring details about the monitoring parameter $V_{t,wb}$ are included in Section E.2.

$v_{CH4,t,wb}$ Volumetric fraction of CH_4 in the gaseous stream in time interval *t* on a wet basis. As per the applied monitoring procedure, every-minute values of the monitoring parameter $v_{CH4,t,wb}$ (in m^3 of CH_4 / m^3 of wet LFG) are reported in the monthly emission reduction calculation spreadsheets valid for the considered monitoring period (and enclosed to this Monitoring Report). Further monitoring details about the monitoring parameter $v_{CH4,t,wb}$ are included in Section E.2.

$\rho_{CH4,n}$ Density of CH_4 in the gaseous stream (LFG) at normal conditions. For the considered monitoring period, value of $\rho_{CH4,n}$ (in kg of CH_4 / m^3 of CH_4) is calculated and reported in the monthly emission reduction calculation spreadsheets valid for the considered monitoring period (and enclosed to this Monitoring Report) as follows:

$\rho_{CH4,n} = (P_n * MM_i) / (R_u * T_n)$

Where:

P_n Absolute pressure at normal conditions. P_n is ex-ante determined as 101,325 Pa. Further details about the ex-ante determined parameter P_n are included in Section E.1 and in the CPA-DD.

T_n Temperature at normal conditions. T_n is ex-ante determined as 273.15 Kelvin. Further details about the ex-ante determined parameter T_n are included in Section E.1 and in the CPA-DD.

MM_i Molecular mass of greenhouse gas *i* (*i* = CH_4). MM_i (*i* = CH_4) is ex-ante determined as 16.04 kg/mol. Further details about the ex-ante determined parameter MM_i (*i* = CH_4) are presented in Section E.1 and in the CPA-DD.

R_u Universal ideal gases constant. R_u is ex-ante determined as 8,314 $Pa.m^3$ /kmol.K. Further details about the ex-ante determined parameter R_u are presented in Section E.1 and in the CPA-DD.

$\rho_{CH4,n}$ is calculated as 0.7156650 kgCH_4 / m^3CH_4 as reported in the monthly emission reduction calculation spreadsheets valid for the considered monitoring period.

Determination of $PE_{flare,y}$:

$PE_{flare,y}$ is determined for the installed flares ($PE_{flare,y,flare-1}$, $PE_{flare,y,flare-2}$, $PE_{flare,y,flare-3}$ and $PE_{flare,y,flare-4}$) by following the applicable stepwise guidance of the methodological tool "Project emissions from flaring" (version 03.0). Every minute values for $PE_{flare,y,flare-1}$, $PE_{flare,y,flare-2}$, $PE_{flare,y,flare-3}$ and $PE_{flare,y,flare-4}$ are determined as a function of every-minute records of mass flow of methane sent to the flare in question as well as based on calculated values for flare efficiency ($\eta_{flare,m} = \eta_{flare,calc,y}$) for each one of the flares as follows:

$$PE_{flare,y} = GWP_{CH4} * \sum_{m=1}^{525,600} F_{CH4,RG,m} * (1 - \eta_{flare,m}) * 10^{-3}$$

Where:

$F_{CH4,RG,m}$ Mass flow of methane in the residual gas in the minute *m*. For each minute *m* of the considered monitoring period and for each individual flare (Flare 1, Flare 2, Flare 3

and Flare 4), values for $F_{CH4,RG,m}$ are equal to every-minute reported measurement records of the calculation parameter "Amount of methane in the LFG which is sent to the flare" ($F_{CH4,sent\_flare,y}$) that is valid to each individual flare (calculation sub-parameter $F_{CH4,sent\_flare,flare-1}$,$F_{CH4,sent\_flare,flare-2}$, $F_{CH4,sent\_flare,flare-3}$ and $F_{CH4,sent\_flare,flare-4}$).

$\eta_{flare,m}$ Flare efficiency in minute *m*. For the considered monitoring period, $\eta_{flare,m}$ is calculated based on performed measurements of methane in exhaust gas of the flare by following applicable guidance as per Option B.2 (Every minute measured flare efficiency) of the methodological tool "Project emissions from flaring (version 03.0)" from which the following related guidance of the registered CPA-DD is applied:

> "(…)
> *Option B: Measured flare efficiency:*
> *For each one of the high temperature enclosed flares which are part of the project activity, the flare efficiency in the minute m is determined as a value which is calculated based on performed related measurements ($\eta_{flare,m} = \eta_{flare,calc,m}$) when the following two conditions are simultaneously met (in order to demonstrate that the flare is operating):*
> *(1) The temperature of the exhaust gas of the flare (monitoring parameter $T_{EG.m}$) and the flow rate LFG to the flare (monitoring parameter $F_{CH4,RG,m}$) is within the manufacturer's specification for the flare ($SPEC_{flare}$) in minute m*
> *(2)Flame is detected in the flare in minute m (monitoring parameter $Flame_m$).*
>
> *Otherwise $\eta_{flare,m}$ is set as 0%.*
> *(…)"*

In applying Option B, the project participants chose to determine $\eta_{flare,calc,m}$ for Flare 1, Flare 2, Flare 3 and Flare 4 by applying guidance of Option B.2.

In order to calculate the flare efficiency value for Flare 1, Flare 2, Flare 3 and Flare 4 ($\eta_{flare,calc,m,flare-1}$, $\eta_{flare,calc,m,flare-2}$, $\eta_{flare,calc,m,flare-3}$ and $\eta_{flare,calc,m,flare-4}$) for the monitoring parameter "Mass flow of methane in the exhaust gas of the flare on a dry basis at reference conditions in the time period t" ($F_{CH4,EG,t}$)) are considered as per the following calculation formula[7]:

Option B.2: The flare efficiency is measured in each minute:
For each individual flare, the calculated flare efficiency $\eta_{flare,calc,m}$ for low-heigh flares is determined as follows:

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

Where:

$F_{CH4,EG,m}$ Mass flow of methane in the exhaust gas of the flare on a dry basis at reference conditions in the time period *t*. As established by the registered CPA-DD, for the considered monitoring period, $F_{CH4,EG,m}$ was measured for each individual flare on a minute basis

[7] As per the provisions of the Methodological tool "Project emissions from flaring", for enclosed flares that are defined as low height flares (which is the case of the flares installed in the Project Activity), the flare efficiency shall be adjusted, as a conservative approach, by subtracting 0.1 from the efficiency as determined in Options A or B.

$F_{CH4,RG,m}$ Mass flow of methane in the residual gas on a dry basis at reference conditions in the time period *t.* Details for the determination of every-minute values for $F_{CH4,RG,m}$ for each individual flare are presented below.

Determination of $F_{CH4,EG,m}$:

As per the applicable guidance of the methodological tool "Project emissions from flaring (version 03.0)" and also as per the registered CPA-DD, the methane mass flow in the residual gas (in a dry basis) for each minute *m* shall be calculated by following the applicable guidance of the "Tool to determine the mass flow of a greenhouse gas in a gaseous stream (version 03.0)". Values for the parameter $F_{CH4,EG,m}$ valid for each flare (calculation sub-parameters $F_{CH4,EG,m,flare-3}$ and $F_{CH4,EG,m,flare-4}$) are thus calculated as follows:

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

Where:

$F_{CH4,EG,m}$ = Mass flow of methane in the exhaust gas of the flare on a dry basis at reference conditions in the minute m (kg);

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

$V_{EG,m}$ = Volumetric flow of the exhaust gas of the flare on a dry basis at reference conditions in minute m (m^3); As per applicable guidance of the methodological tool "Project emissions from flaring (version 03.0)" is calculated as follows:

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

Where:

$Q_{EG,m}$ = Volume of the exhaust gas on a dry basis at reference conditions per kilogram of residual gas on a dry basis at reference conditions in minute m (m^3 exhaust gas/kg residual gas);

$M_{RG,m}$ = Mass flow of the residual gas on a dry basis at reference conditions in the minute m (kg). As per applicable guidance of the methodological tool "Project emissions from flaring (version 02.0.0)", $M_{RG,m}$ is calculated as follows:

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

Where:

$M_{RG,m}$ = Mass flow of the residual gas on a dry basis at reference conditions in the minute m (kg);

$V_{RG,m}$ = Volumetric flow of the residual gas on a dry basis at reference conditions in the minute m (m^3)

$\rho_{RG,ref,m}$ = Density of the residual gas at reference conditions in minute m (kg/m^3);

And:

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

Where:

$\rho_{RG,ref,m}$ = Density of the residual gas at reference conditions in minute m (kg/m^3);

$P_{ref,m}$ = Atmospheric pressure at reference conditions (Pa); this parameter is ex-ante determined as 101,325. Further details about the ex-ante determined values for $P_{ref,m}$ are included in Section E.1 and in the registered CPA-DD.

R_u = Universal ideal gas constant (Pa.m^3 /kmol.K); which is ex-ante determined as 8,314. Further details about the ex-ante determined values for R_u are included in Section E.1 and in the registered CPA-DD.

T_{ref} = Temperature at reference conditions (K). this parameter is ex-ante determined as 273.15. Further details about the ex-ante determined values for T_{ref} are included in Section E.1 and in the registered CPA-DD.

$MM_{RG,m}$ = Molecular mass of the residual gas in minute m (kg/kmol); The molecular mass of CH_4 and N_2 are ex-ante determined as 16.04 and 28.01, respectively. Further details about the ex-ante determined values for MM_k are included in Section E.1 and in the registered CPA-DD. As per applicable guidance of the methodological tool “Project emissions from flaring version (02.0.0)” is calculated as follows:

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

Where:

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

$V_{i,RG,m}$ = Volumetric fraction of component i in the residual gas on a dry

basis at reference conditions in the hour h;

MM_i = Molecular mass of residual gas component i (i = CH_4 and N_2) which are ex-ante determined as 16.04 and 28.01, respectively. Further details about the ex-ante determined values for MM_i are included in Section E.1 and in the registered CPA-DD (kg/kmol);

ACM0001 (version 19.0) does not include any restriction to such simplification. Thus, only the volumetric fraction of gases that are greenhouse gases and are considered in related calculations (CH_4 in the particular case of the project activity) should be measured and the difference to 100% is just considered as pure nitrogen.

As per applicable guidance of the methodological tool "Project emissions from flaring (version 03.0)" the next step is to determine the volume of the exhaust gas on a dry basis at reference conditions per kilogram of residual gas ($Q_{EG,m}$) which is calculated as follows:

$$Q_{EG,m} = Q_{CO2,EG,m} + Q_{O2,EG,m} + Q_{N2,EG,m}$$

Where:

$Q_{EG,m}$ = Volume of the exhaust gas on a dry basis per kg of residual gas on a dry basis at reference conditions in the minute m (m^3 /kg residual gas);

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

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

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

With:

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

Where:

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

$n_{O2,EG,m}$ = O_2 (moles) in the exhaust gas per kg of residual gas flared on a dry basis at reference conditions in minute m (kmol/kg residual gas);

VM_{ref} = Volume of one mole of any ideal gas at reference temperature and pressure (m^3/kmol); this constant is ex-ante determined as per applicable methodological tool "Project emissions from flaring version 02.0.0)" as 22.4;

And:

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

Where:

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

VM_{ref} = Volume of one mole of any ideal gas at reference temperature and pressure (m^3 /kmol); this constant is ex-ante determined as per applicable methodological tool "Project emissions from flaring version 03.0)" as 22.4;

$MF_{N,RG,m}$ = Mass fraction of nitrogen in the residual gas in the minute m;

AM_N = Atomic mass of nitrogen (kg/kmol); this constant is ex-ante determined as per applicable methodological tool "Project emissions from flaring version 02.0.0)" as 14.01;

$v_{O2,air}$ = Volumetric fraction of O_2 in air; this constant is ex-ante determined as per applicable methodological tool "Project emissions from flaring version 03.0)" as 0.21;

$F_{O2,RG,m}$ = Stochiometric quantity of moles of O_2 required for a complete oxidation of one kg residual gas in minute m (kmol/kg residual gas);

$n_{O2,EG,m}$ = O_2 (moles) in the exhaust gas per kg of residual gas flared on a dry basis at reference conditions in minute m (kmol/kg residual gas).

And:

$$Q_{CO2,EG,m} = \frac{MF_{C,RG,m}}{AM_C} \times VM_{ref}$$

Where:

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

$M_{FC,RG,m}$ = Mass fraction of carbon in the residual gas in the minute m;

AM_C = Atomic mass of carbon (kg/kmol); this constant is ex-ante determined as per applicable methodological tool "Project emissions from flaring version 03.0)" as 12.00;

VM_{ref} = Volume of one mole of any ideal gas at reference temperature and pressure (m^3 /kmol); this constant is ex-ante determined as per applicable methodological tool "Project emissions from flaring version 03.0)" as 22.4.

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

Where:

$n_{O2,EG,m}$ = O_2 (moles) in the exhaust gas per kg of residual gas flared on a dry basis at reference conditions in minute m (kmol/kg residual gas);

$v_{O2,EG,m}$ = Volumetric fraction of O_2 in the exhaust gas on a dry basis at reference conditions in the minute m;

$v_{O2,air}$ = Volumetric fraction of O2 in the air; this constant is ex-ante determined as per applicable methodological tool "Project emissions from flaring version 03.0)" as 0.21;

$MF_{C,RG,m}$ = Mass fraction of carbon in the residual gas in the minute m;

AM_C = Atomic mass of carbon (kg/kmol); this constant is ex-ante determined as per applicable methodological tool

"Project emissions from flaring version 03.0)" as 12.00;

$M_{FN,RG,m}$ = Mass fraction of nitrogen in the residual gas in the minute m;

AM_N = Atomic mass of nitrogen (kg/kmol); this constant is ex-ante determined as per applicable methodological tool "Project emissions from flaring version 03.0)" as 14.01;

$F_{O2,RG,m}$ = Stochiometric quantity of moles of O_2 required for a complete oxidation of one kg residual gas in minute m (kmol/kg residual gas). As per applicable guidance of the methodological tool "Project emissions from flaring version (03.0)" is calculated as follows:

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

Where:

$F_{O2,RG,m}$ = Stochiometric quantity of moles of O2 required for a complete oxidation of one kg residual gas in minute m (kmol/kg residual gas);

$MF_{C,RG,m}$ = Mass fraction of carbon in the residual gas in the minute m;

AM_C = Atomic mass of carbon (kg/kmol); this constant is ex-ante determined as per applicable methodological tool "Project emissions from flaring version 03.0)" as 12.00;

$MF_{H,RG,m}$ = Mass fraction of hydrogen in the residual gas in the minute m;

AM_H = Atomic mass of hydrogen (kg/kmol); this constant is ex-ante determined as per applicable methodological tool "Project emissions from flaring version 03.0)" as 1.01;

$M_{FO,RG,m}$ = Mass fraction of oxygen in the residual gas in the minute m;

AM_O = Atomic mass of oxygen (kg/kmol); this constant is ex-ante determined as per applicable methodological tool "Project emissions from flaring version 03.0)" as 16.00;

As per applicable guidance of the methodological tool "Project emissions from flaring (version 03.0)" the next step is to determine the mass fractions of carbon, hydrogen, oxygen and nitrogen in the residual gas ($MF_{j,RG,m}$), but in the considered monitoring period option B was chose to calculate, as a simplification measure the volumetric fraction of methane and consider the difference to 100% as being nitrogen. This is calculated as follows:

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

Where:

$M_{Fj,RG,m}$ = Mass fraction of element j in the residual gas in the minute m;

$v_{i,RG,m}$ = Volumetric fraction of component i in the residual gas on a dry basis in the minute m;

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

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

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

i = Option (b) is selected then I = CH_4 and N_2.

$F_{CH4,RG,t}$ Mass flow of methane in the residual gas on a dry basis at reference conditions in the time period *t.* Details for the determination of every-minute values for $F_{CH4,RG,t}$ are presented below.

Determination of $F_{CH4,RG,t}$:

As per the applicable guidance of the methodological tool "Project emissions from flaring" and also as per the CPA-DD, for each flare, the methane mass flow in the residual gas (in a dry basis) for each minute *m* of the two time periods in year *y* during which the flare efficiency is measured shall be calculated by following the applicable guidance of the "Tool to determine the mass flow of a greenhouse gas in a gaseous stream". Values for the parameter $F_{CH4,RG,t}$ valid for for Flare 3 and Flare 4 (calculation sub-parameters $F_{CH4,RG,t,flare-3}$ and $F_{CH4,RG,t,flare-4}$) are thus calculated as follows:

$$F_{CH4,RG,t,flare-n} = V_{t,db,n,flare-n} * v_{CH4,t,db} * \rho_{CH4,n}$$

Where:

$\rho_{CH4,n}$ Density of greenhouse gas *i* (*i* = CH_4) in the gaseous stream (LFG) at normal conditions. Further details for the determination of $\rho_{CH4,n}$ are presented above under the sub-section "*Determination of every-minute values for the calculation parameter $F_{CH4,sent\_flare,y}$*".

$v_{CH4,t,db}$ Volumetric fraction of greenhouse gas *i* (*i* = CH_4) in the gaseous stream in a time interval *t* on a dry basis. The following is stated in footnote 3 of the methodological tool "Tool to determine the mass flow of a greenhouse gas in a gaseous stream":

> "*(…) Flow measurement on a dry basis is not feasible at reasonable costs for a wet gaseous stream, so there will be no difference in the readings for volumetric fraction in wet basis analyzers and dry basis analyzers (…).*"

Thus, every-minute values of $v_{CH4,t,db}$ are regarded as equal to every-minute values of the monitoring parameter $v_{CH4,t,wb}$ (for which further details are presented above under the sub-section "*Determination of every-minute values for the calculation parameter $F_{CH4,sent\_flare,y}$*").

$V_{t,db,n,flare-n}$ Volumetric flow of the gaseous stream (LFG) in time interval *t* on a dry basis which is sent to the flare n (n = 1, 2, 3 and 4). As per Option B of the applicable methodological "Tool to determine the mass flow of a greenhouse gas in a gaseous

stream", the volumetric flow of the gaseous stream on a dry basis for Flare 1, Flare 2, Flare 3 and Flare 4 (calculation sub-parameters $V_{t,db,n,flare-1}$, $V_{t,db,n,flare-2}$, $V_{t,db,n,flare-3}$ and $V_{t,db,n,flare-4}$) is determined by converting the measured volumetric flow from wet basis to dry basis as follows:

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

Where:

$V_{t,wb,n}$ Volumetric flow of the gaseous stream (LFG) in time interval *t* on a wet basis at normal conditions. Further details of $V_{t,wb,n,flare-n}$ are presented above under the sub-section "*Determination of every-minute values for the calculation parameter* $F_{CH4,sent\_flare,y}$"

$v_{H2O,t,db}$ Volumetric fraction of H_2O in the gaseous stream in time interval *t* on a dry basis. As per applicable guidance of the methodological "Tool to determine the mass flow of a greenhouse gas in a gaseous stream", $v_{H2O,t,db}$ is calculated as follows:

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

Where:

MM_{H2O} Molecular mass of H_2O. MM_{H2O} is ex-ante determined as 18.0152 kg/kmol.
Further details about the ex-ante determined parameter MM_{H2O} are included in Section E.1 and in the CPA-DD.

$MM_{t,db}$ Molecular mass of the gaseous stream in time interval *t* on a dry basis.
As per applicable guidance of the methodological "Tool to determine the mass flow of a greenhouse gas in a gaseous stream", $MM_{t,db}$ is calculated as follows:

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

Where:

k All gases, except H_2O, contained in the gaseous stream (e.g. N_2, CO_2, O_2, CO, H_2, CH_4, N_2O, NO, NO_2, SO_2, SF_6 and PFCs). See simplification below.

$V_{k,t,db}$ Volumetric fraction of gas *k* in the gaseous stream in time interval *t* on a dry basis. Applicable

guidance of the methodological "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" states the following:

> "*(…) The determination of the molecular mass of the gaseous stream ($MM_{t,db}$) requires measuring the volumetric fraction of all gases (k) in the gaseous stream. However, as a simplification, the volumetric fraction of only the gases k that are greenhouse gases and are considered in the emission reduction calculation in the underlying methodology must be monitored and the difference to 100% may be considered as pure nitrogen."*

ACM0001 (version 19.0) does not include any restriction to such simplification. Thus, only the volumetric fraction of gases that are greenhouse gases and are considered in related calculations (CH_4 in the particular case of the project activity) should be measured and the difference to 100% is just considered as pure nitrogen. Further details for the determination of the volumetric fraction of CH_4 in the gaseous stream ($V_{k,t,db}$ = $v_{CH4,t,db}$) are presented above under the calculation parameter $v_{CH4,t,db}$.

MM_k Molecular mass of gas *k* (*k* = CH_4 and N_2). The molecular mass of CH_4 and N_2 are ex-ante determined as 16.04 and 28.01, respectively. Further details about the ex-ante determined values for MM_k are included in Section E.1 and in the CPA-DD.

$m_{H2O,t,db}$ Absolute humidity in the gaseous stream in time interval *t* n a dry basis. As per Option 2 of the methodological "Tool to determine the mass flow of a greenhouse gas in a gaseous stream", by conservatively assuming that the gaseous stream is saturated

($m_{H2O,t,db} = m_{H2O,t,db,Sat}$), $m_{H2O,t,db}$ is calculated as follows [8]:

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

Where:

MM_{H2O}	Molecular mass of H_2O. MM_{H2O} is ex-ante determined as 18.0152. Further details about the ex-ante determined values for MM_{H2O} are included in Section E.1 and in the CPA-DD.
P_t	Absolute pressure of the gaseous stream in time interval *t*. Further monitoring details for P_t are included in Section E.2.
$MM_{t,db}$	Molecular mass of the gaseous stream in a time interval *t* on a dry basis. Further details for the determination of $MM_{t,db}$ are presented above.
$p_{H2O,t,Sat}$	Saturation pressure of H_2O at temperature T in time *t*. Further monitoring details about the monitoring parameter

[8] It is important to note that the simplified approach for the calculation of the absolute humidity of the gaseous stream ($m_{H2O,t,db}$) as presented in Option 2 of the methodological "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" shall be applied by assuming the gaseous stream is dry or saturated depending on which is the conservative situation. Footnote 4 of the "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" explicitly states the following:

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

In this particular case, $m_{H2O,t,db}$ is calculated for the determination of the mass flow of methane in the residual gas on a dry basis during the time period t ($F_{CH4,RG,t}$). While $F_{CH4,RG,t}$ is used for the determination of the parameter $PE_{flare,y}$ (project emissions from flaring the residual gas), the assumption that the gaseous stream is dry (conservatively applicable for calculating project emissions) would not be conservative in this case as an overestimation of the amount of methane in the residual gas would actually increase the calculated efficiency of the flare, thus resulting in a reduction of $PE_{flare,y}$ and consequent increment of emission reductions during the considered monitoring period.

$p_{H2O,t,Sat}$ are included in Section E.2.

In summary, for the considered monitoring period, the values of $\eta_{flare,m} = \eta_{flare,calc,m}$ are presented in the enclosed monthly calculation spreadsheets.

Furthermore, while Flare 1, Flare 2, Flare 3 and Flare 4 are regarded as a low height flares, the determined value of flare efficiency for this particular flare is adjusted, as a conservative approach, by subtracting 10 percentile points as established by the methodological tool "Project emissions from flaring" (version 03.0). Thus, in applying Option B.2, for every minute *m* within the considered monitoring, the flare efficiency in the minute m ($\eta_{flare,m}$) was adjusted, as a conservative approach, by subtracting 10 percentile points from the efficiency.

As per the applied monitoring procedure, compliance with operational and maintenance requirements for the flares, as established by the *ex-ante* determined parameter "Manufacturer's flare specifications for temperature, flow rate and maintenance schedule interval" ($SPEC_{flare}$), is also considered for the determination and application of the values of $\eta_{flare,m} = \eta_{flare,calc,m}$ as part of the determination of the value of $F_{CH4,PJ,y} = F_{CH4,flared,y}$ valid for the considered monitoring period.

This is reflected in the monthly emission reduction spreadsheets. Data records for the monitoring parameter "Flame detection of flare in the minute m" ($Flame_m$) are also considered for the determination and application of the values of $\eta_{flare,calc,m}$ as part of the determination of the value of $F_{CH4,PJ,y} = F_{CH4,flared,y}$ valid for the considered monitoring period. This is also reflected in the set of monthly emission reduction spreadsheets.

For each installed flare, the time the flare has operated is determined by monitoring the flame combustion status/condition by using an UV flame detector (of which status signal (flame status "*ON*" or "*OFF*") is continuously recorded and reported). Moreover, the monitoring requirements related to operational requirements/conditions for the flare (as established in the specifications for operational conditions defined by the flares' designer and manufacturer as per the ex-ante determined parameter $SPEC_{flare}$ (min. and max. flow of LFG to the flares + temperature of exhaust gas of the flares + meeting of maintenance requirements)) are also considered in the context of the application of determined values for $\eta_{flare,calc,m}$ along the considered monitoring period. As outlined in the set of monthly emission reduction spreadsheets, for each minute *m* within the considered monitoring period whenever a particular flare has combusted LFG by not operating in accordance with the operational criteria (as established by the ex-ante estimated parameter $SPEC_{flare}$ (in terms of LFG flow, temperature of exhaust gas or maintenance practice)), no destruction of methane is accounted for the flare in question as part of the calculation of the value of $F_{CH4,PJ,y} = F_{CH4,flared,y}$ valid for the considered monitoring period.

For the considered monitoring period, the accumulated value for $F_{CH4,PJ,y} = F_{CH4,flared,y}$ is calculated as 9,327 tCH_4.

For the considered monitoring period, baseline emissions of methane from the SWDS ($BE_{CH4,y}$) are calculated as 209,858 tCO_2e.

The summarized emission reduction calculation spreadsheet (that is enclosed to this Monitoring Report) summarizes the determination of $BE_y = BE_{CH4,y}$ for the considered monitoring period. For the considered monitoring period, BE_y = 209,858 tCO_2e.

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

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As outlined in the registered CPA-DD, the operation of the project activity requires consumption of grid-sourced electricity. As also established in the CPA-DD, project emissions due to consumption of this energy carrier are determined by following the applicable guidance of the "Tool to calculated baseline, project and/or leakage emissions from electricity consumption".

Under conformance with provisions and calculation approaches of the registered CPA-DD, project emissions (PE_y) for the considered monitoring period are determined (in tCO_2e) by taking into account the share of period for which related monitoring records are available as follows:

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

Where:

$PE_{EC,grid,y}$ Project emissions due to the consumption of grid-sourced electricity by the project activity.

Project emissions due to the consumption of grid-sourced electricity by the project activity ($PE_{EC,grid,y}$):

Project emissions due to the consumption of grid-sourced electricity by the project activity ($PE_{EC,grid,y}$) are calculated as per the "Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation" (version 02) as follows:

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

Where:

$TDL_{grid,y}$ Average technical transmission and distribution losses for grid sourced electricity consumed by the project activity in year *y.* $TDL_{grid,y}$ is ex-ante selected as 20%. Further details about the ex-ante determined parameter $TDL_{grid,y}$ are included in Section E.1 and in the CPA-DD.

$EC_{PJ,grid,y}$ Quantity of grid sourced electricity consumed by the project activity in year *y* (in MWh). As per the applied monitoring procedure, available monthly records of grid-sourced electricity consumption valid for the considered monitoring period are summarized below:

Month	Amount of grid-sourced electricity consumed by the project activity (MWh)
Oct./2019 (from 05/10 to 31/12/2019)	196.690
Nov./2019	213.021
Dec./2019	228.134
Jan./2020	176.728
Feb./2020	203.853
Mar./2020 (from 01/03 to 02/03/2020)	8.607

Additional monitoring details about the monitoring parameter $EC_{PJ,grid,y}$ are included in Section E.2.

$EF_{EL,grid,y}$ Emission factor for grid sourced electricity in year *y* (in tCO_2/MWh). $EF_{EL,grid,y}$ is directly determined as the conservative default value of the methodological tool "Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation" (version 03.0) applicable for grid-sourced electricity consumed by CPA-1 Santa Rosa through the electricity grid to which the CPA is connected to. 1.3 tCO2/MWh value is ex-ante selected as the applicable value for EFEL,grid,PJ,y in the particular case of determination of baseline emissions associated with generation of electricity by the CPA when using Option A.2.

For the considered monitoring period, project emissions due to the consumption of grid-sourced electricity by the project activity ($PE_{EC,grid,y}$) are thus calculated as 1,602 tCO_2 (rounded value).

Project emissions from consumption of fossil fuels due to the CPA (for purpose other than electricity generation and/or transportation of LFG) ($PE_{FC,y}$):

$PE_{FC,y} = PE_{i,y}$

Where:

Project emissions due to the consumption of diesel ($PE_{FC,y}$), which is calculated as follows:

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

$FC_{i,y}$ Quantity of diesel consumed (m^3 of diesel), values are summarized below:

Month	Quantity of diesel consumed (m^3)
Oct./2019 (from 05/10 to 31/12/2019)	0.160
Nov./2019	0.682
Dec./2019	0.308
Jan./2020	0
Feb./2020	1.995
Mar./2020 (from 01/03 to 02/03/2020)	1.193

$COEF_{i,y}$ CO_2 emission coefficient for diesel. As established in the CPA-DD, $COEF_{i,y}$ is determined by following applicable guidance of Option B of the methodological tool "Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion" (version 03) as follows:

$COEF_{i,y} = NCV_{i,y} * EF_{CO2,i,y}$

Where:

$NCV_{i,y}$ Net calorific value of the fuel diesel (in GJ/ton diesel)

$EF_{CO2,i,y}$	CO_2emission factor of fuel diesel (in energy basis). As per the applied monitoring procedure, $EF_{CO2,i,y}$ is determined as 0.0656 tCO_2/GJ. Further details about the determination of the monitoring parameter $EF_{CO2,i,y}$ are included in Section E.2.
$NCV_{i,y}$	Net calorific value of the fuel diesel. As per the applied monitoring procedure, $NCV_{i,y}$ is determined as 49.1 GJ/ton for the considered monitoring period. Further details about the monitoring parameter $NCV_{i,y}$ are included in Section E.2

Thus, $COEF_{i,y}$ = 0.0656 tCO_2/GJ * 49.1 GJ/ton = 3.2 tCO_2/ton

In summary, $PE_{i,y}$ is calculated as follows:

$PE_{i,y}$ = 4.338 m^3 diesel * 3.23 tCO_2/ton diesel = 14 tCO_2 (rounded value).

Project emissions due to the consumption of diesel are thus determined as 14 tCO_2 (rounded value).

Total project emissions (PE_y) for the considered monitoring period are calculated as 1,616 tCO_2 (rounded value).

F.3. Calculation of leakage emissions

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Not applicable.

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 - 0001	209,858	1,616	0	0	208,242	0	208,242
Total	209,858	1,616	0	0	208,242	0	208,242

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 - 0001	208,242	415,554

Total	208,242	415,554

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

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The 415,554 tCO2e value is calculated as the sum of (a) 241,629 tCO_2 as the ex-ante estimation of emission reductions valid for year 2019 which is equivalent to 87 days, consequently, the start of the 2nd crediting period; and (b) 1,043,552 * 62 / 366 as the share of the ex-ante estimation valid for year 2020 which is equivalent to 62 days, where 1,043,552 is the ex-ante estimation for year 2020, and 62 is the number of days encompassed by the monitoring period. The value of ex-ante estimation of emission reductions as per the CPA-DD that is valid/equivalent for the considered monitoring period is calculated as 415,554 tCO_2e.

F.6. Remarks on increase in achieved emission reductions

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Achieved emission reductions by the project activity during the considered monitoring period are about ~50% lower than the calculated equivalent value of ex-ante estimation of emission reductions valid for the same period as per the PDD. The following aspect(s) justify and explain the relative difference between the value for ex-ante estimation of emission reductions as per the PDD (calculated as valid/equivalent for the considered monitoring period) and emission reductions actually achieved by the project activity during the considered monitoring period:

Aspect/condition which represents an increase factor of reported emission reductions for the considered monitoring period when compared against the ex-ante estimation of emission reduction for the same period in the PDD:

- *Uncertainties associated with the application of First Order Decay (FOD) multi-phased model for estimating the emission reductions in the PDD:*
  As outlined in the PDD, like other similar CDM project activities encompassing LFG collection and destruction/utilization, the amount of methane to be generated by decomposition of MSW disposed at the CTR Santa Rosa landfill and collected by the project activity was derived by applying the First Order Decay (FOD) model as per the methodological tool "Emissions from Solid Waste Disposal Sites" (version 08.0) in the context of the determination of ex-ante estimated emission reductions to be achieved during the 2nd 7-year renewable crediting period. By taking in account all potential uncertainties associated with the application of such multi-phased decay model, it is reasonable to assume that, in the particular case of the project activity during the considered monitoring period, the application of this model somehow superestimated the amount of LFG to be actually generated and collected by the project activity.

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

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Not applicable.

Document information

Version	*Date*	*Description*
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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