**Monitoring report form for CDM project activity**
**(Version 06.0)**

| MONITORING REPORT | | |
|---|---|---|
| **Title of the project activity** | Canhanduba Landfill Project | |
| **UNFCCC reference number of the project activity** | 9943 | |
| **Version number of the PDD applicable to this monitoring report** | 5 | |
| **Version number of this monitoring report** | 1.0 | |
| **Completion date of this monitoring report** | 07/06/2018 | |
| **Monitoring period number** | #1 | |
| **Duration of this monitoring period** | 01/07/2014 – 14/07/2015 | |
| **Monitoring report number for this monitoring report** | Not applicable. | |
| **Project participants** | Itajaí Biogás e Energia S.A. | |
| **Host Party** | Brazil | |
| **Sectoral scopes** | 13 - Waste handling and disposal | |
| **Applied methodologies and standardized baselines** | ACM0001, version 13.0.0 - Flaring or use of landfill gas | |
| **Amount of GHG emission reductions or net anthropogenic GHG removals achieved by the project activity in this monitoring period** | Amount achieved before 1 January 2013 | Amount achieved from 1 January 2013 |
| | - | 32,978 $tCO_2e$ |
| **Amount of GHG emission reductions or net anthropogenic GHG removals estimated ex ante for this monitoring period in the PDD** | 66,642 $tCO_2e$ | |

# SECTION A. Description of project activity

## A.1. General description of project activity

>>

The CDM project activity “Canhanduba Landfill Project” is implemented at the Canhanduba landfill. During the considered monitoring period, the project activity promoted real, measurable and permanent abatement of greenhouse gas (GHG) emissions through collection of landfill gas (LFG) that is generated at this landfill and its destruction (by combustion in a high temperature enclosed flare) and its utilization as gaseous fuel in the project’s electricity generation infrastructure.

The Canhanduba landfill is located in the municipality of Itajaí, Santa Catarina State, in the South region of Brazil. The Canhanduba landfill was inaugurated in 2006 and has employed *state-of-the-art* waste landfilling technics and operation management. In the absence of the CDM project activity (that was commissioned in 2014), no efficient management of LFG would occur.

As part of the operation of the project activity during the considered monitoring period, LFG generated at the Canhanduba landfill was collected and converted into carbon dioxide ($CO_2$) through both combustion in a high temperature enclosed flare and through its utilization as gaseous fuel for electricity generation in the engine-generator sets of the project’s electricity generation infrastructure. The operation of the project activity thus mitigates emissions of the greenhouse gas (GHG) methane ($CH_4$) that would otherwise be directly emitted into the atmosphere in the absence of the project activity (baseline scenario). The project activity has also promoted carbon dioxide ($CO_2$) emission reductions due to displacement of electricity (under amount equivalent to the amount of electricity generated by the project’s electricity generation infrastructure) which would otherwise be generated by existing grid-connected power plants, including fossil-fuel fired power plants (and addition of new power generation units) within the National Electricity Grid of Brazil.

The amount and quality of collected LFG which is sent to the flare and to the electricity generation facility have been continuously measured, recorded and reported along the considered monitoring period. As also established in the project’s monitoring procedure valid for the 1st 7-year crediting period as per the PDD, the status/conditions of the high temperature enclosed flare and its compliance with operational requirements (as established by the flare equipment manufacturer) are also monitored.

During the considered monitoring period, the project activity operated under complete conformance with project design information and applicable monitoring requirements as made available in the latest and currently registered version of the PDD valid for 1st 7-year crediting period of the project activity (PDD version 5, dated 06/01/2014, herein after termed “PDD”).

## A.2. Location of project activity

>>

The Canhanduba landfill is located in the Estrada Geral de Canhanduba in the municipality of Itajaí Santa Catarina State, Brazil

The exact geographic coordinates of the project site (in decimal and in Degree, Minute, Second (DMS) formats) are as follows:

| Format | Latitude | Longitude |
|---|---|---|
| DMS | 26° 58' 31" S | 48° 42' 16" W |
| Decimal | -26.975407 | -48.704497 |

The following images show the location of the project activity.

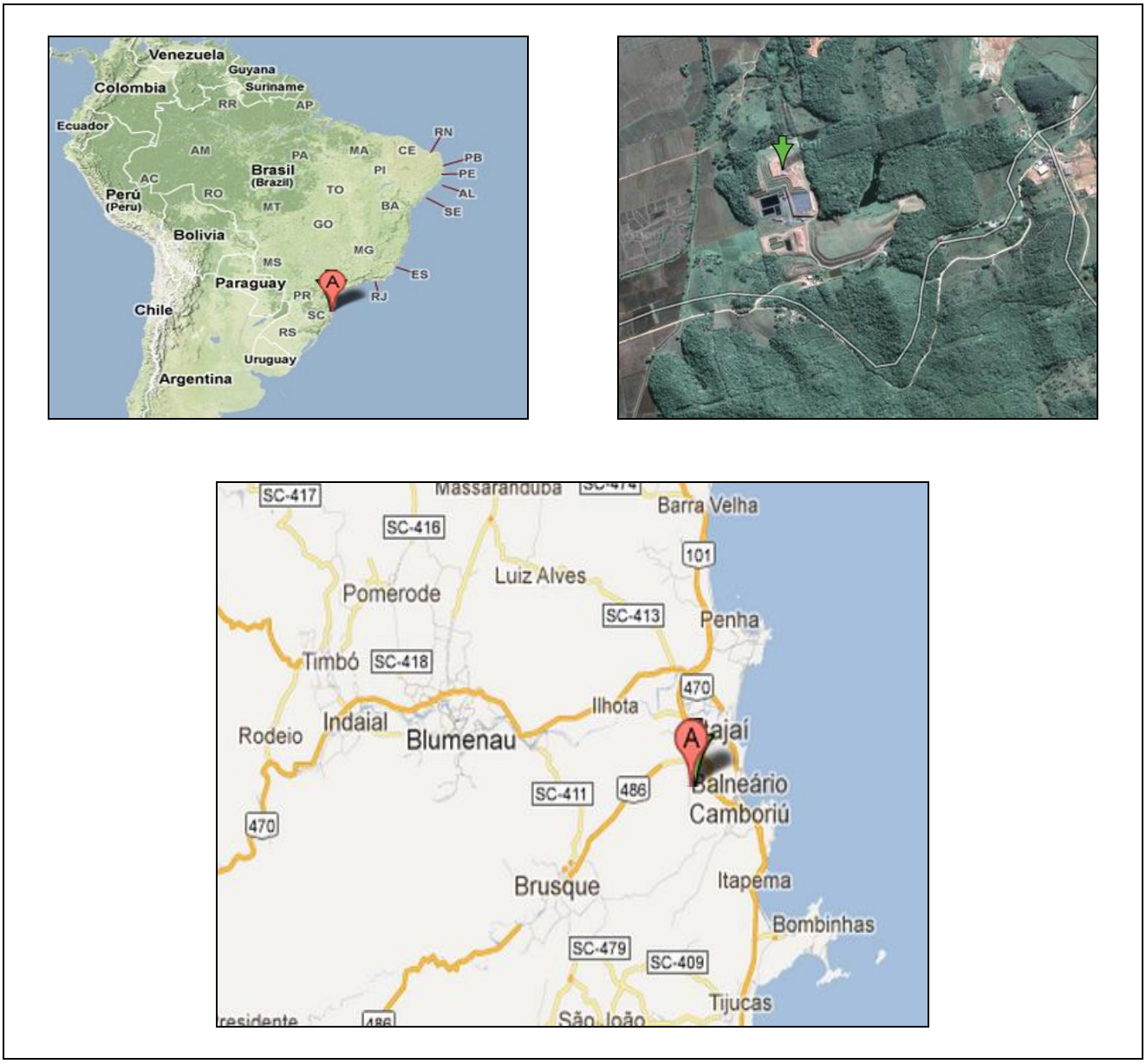


Figure 1 - Location of the project activity
(Above: Landfill location in the country on the left; satellite view of the landfill location on the right. Below: Santa Catarina State map showing location of the landfill).

## A.3. Parties and project participants

| Parties involved | Project participants | Indicate if the Party involved wishes to be considered as project participant (Yes/No) |
|---|---|---|
| Brazil (host) | Itajaí Biogás e Energia S.A. | No |

## A.4. Reference to applied methodologies and standardized baselines

>>

The project activity applies the following large-scale CDM baseline and monitoring methodology:

- ACM0001 - ”Flaring or use of landfill gas” (version 13.0.0). (http://cdm.unfccc.int/filestorage/E/Y/F/EYFHCV3K4J5P06DTQSG9WLMOBNUX2I/EB67_repan12_ACM0001_ver13.0.0.pdf?t=aWV8bmVmZHlhfDAbkn62RDZuyjHVzDOMoxMx)

For the considered monitoring period, as also established in the PDD, the following methodological tools are also applied[1]:

- "Tool to calculate baseline, project and/or leakage emissions from electricity consumption" (version 01) (http://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-05-v1.pdf).

  The application of this tool refers to the ex-post application of the latest version of the "Tool to calculate the emission factor for an electricity system" (version 04.0) (http://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-07-v4.0.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 02.0.0, EB 61) (http://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-08-v2.0.0.pdf);

### A.5. Crediting period type and duration

>>
1st 7-year renewable crediting period from 01/07/2014 to 30/06/2021.

## SECTION B. Implementation of project activity

### B.1. Description of implemented project activity

>>
During the considered monitoring period, the project activity encompassed the operation of the following equipment:

- LFG gas extraction system composed of vertical extraction wells,

- centrifugal blowers,

- LFG condensation traps (for separating undesirable liquids in the collected LFG (leachate and condensate)),

- One high temperature enclosed flare (designed and supplied by Biotecnogas S.r.l.). The flare has a declared maximum LFG flow operational capacity of 1,200 $m^3$/h,

- Electricity generation infrastructure using collected LFG as gaseous fuel comprising 1 engine-generator modular package sets (container based assembly) which includes an engine-generator set manufactured by Guascor, of model SFGM560 with individual nameplate installed capacity of 1.060 MW. The project's electricity generation infrastructure also encompasses the installation and operation of a LFG cooling unit (electrical LFG chilling).

Further details about monitoring instruments/equipment under operation during the considered monitoring period are included in Section D.2.

[1] The registered PDD also refer to the methodological tool "Emissions from solid waste disposal sites" (version 06.0.1, EB86). However, it is crucial to note that, as outlined in the PDD, applicable guidance of this methodological tools is only applied in the context of ex-ante estimation of emission reductions to be achieved by the project activity during the 1st 7-year crediting period. This methodological tool is thus not applied for the ex-post determination of emission reductions achieved by the project activity.

In general, during the considered monitoring period, the project activity was implemented and has operated under full conformance with the previously conceived project design (as described in the PDD).

During the considered monitoring period, the project activity faced events when it became temporarily out of operation due to different reasons (occurred temporarily interruption in the supply of grid-sourced electricity, occurred previously planned and unplanned equipment maintenance/repair events, occurred performance of regular calibration events, events of drainage of condensate from the project's LFG pipeline, identification of unexpected problems in the PLC panel, data communication problems, etc.).

Since the project's operation start in July 2014 until the end of the considered monitoring period, no backup captive off-grid electricity generator was ever used to meet the project's electricity demand during eventual interruptions of the supply of grid-sourced electricity to the project activity. While as per the PDD a backup captive off-grid electricity generator fuelled by Diesel would be installed as part of the project activity (for emergency purposes only), so far such generator has not been installed yet.

## B.2. Post-registration changes

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

>>
Not applicable for the considered. There are no temporary deviations from the registered monitoring plan and/or applied CDM baseline and monitoring methodology and/or applicable methodological tools encompassed by the considered monitoring period.

### B.2.2. Corrections

>>
Not applicable for the considered monitoring period. There are no Corrections (in information that do not affect the project design) encompassed by the considered monitoring period that are to be submitted with this Monitoring Report as part of the request for issuance (post-registration change – issuance track).

### B.2.3. 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.

### B.2.4. Inclusion of monitoring plan

>>
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.

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

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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 CDM baseline and monitoring methodology and/or applicable methodological tools encompassed by the considered monitoring period that are to be submitted with this Monitoring Report as part of the request for issuance (post-registration change – issuance track).

### B.2.6. Changes to project design

>>

Not applicable for the considered monitoring period. There are no permanent changes to the design of the project activity encompassed by the considered monitoring period that are to be submitted with this Monitoring Report as part of the request for issuance (post-registration change – issuance track).

## SECTION C. Description of monitoring system

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C.1. INSTRUMENTATION

Figure shows a schematic instrumentation diagram of the project's monitoring system as per the configuration available during the monitoring period.

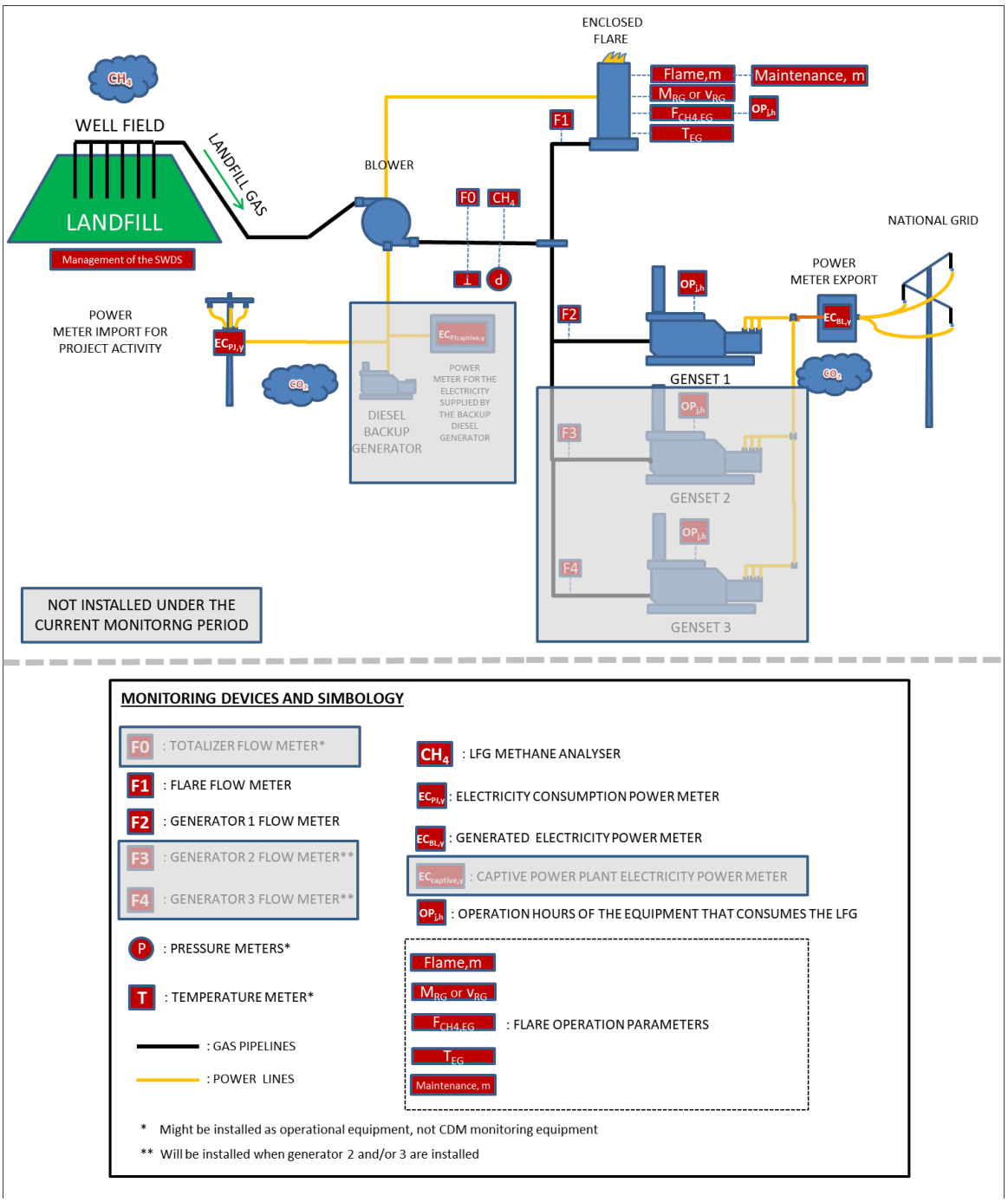


Figure 1: Schematic instrumentation diagram of the project's monitoring system valid for the considered monitoring period

*Project's LFG collection and destruction infrastructure (incl. the LFG flaring facility):*
As part of the project activity, the following monitoring instruments/equipment are installed along the main LFG distribution pipeline (in its final section) within the project's LFG destruction facility (between the installed centrifugal blowers and the enclosed flare):

- One differential pressure flow meter. This measurement unit measures the flow of LFG collected by the project activity which is sent to the installed flare for combustion.

- One LFG pressure sensor. This instrument measures LFG pressure in the section between the centrifugal blowers and the high temperature enclosed flare in the LFG collection pipeline.

- One LFG temperature sensor. This instrument measures the LFG temperature in the LFG collection pipeline in the section between the centrifugal blowers and the high temperature enclosed.

- One continuous $CH_4$ content gas analyzer unit. This equipment provides continuous measurement of methane fraction in collected LFG. While the project's LFG collection process ensures that most of the humidity of the collected LFG is removed by condensation (in available condensation removal traps) prior of having collected LFG passing through the installed LFG flow meters and the installed $CH_4$ content gas analyzer unit, flow of collected LFG being sent to the flare and $CH_4$ fraction of collected LFG can thus be regarded as measured under the same basis/conditions in terms of moisture.

- One thermocouple that measure the temperature in the exhaust gas of the flare ($T_{EG,m}$). Such measurements are considered in order to assure the operation of flare as per the operation conditions defined by the flare manufacturer. The thermocouple is located in the upper section of the installed flare and is only used to monitor the flare temperature from an operational point of view and in order to ensure that high flare combustion efficiency is achieved.

- One UV flame detector. For every minute that flame is detected in the flare, its operational status is considered as "On" and emission reductions are thus accounted for such given minute.

*Project's electricity generation infrastructure:*
As part of the project activity, the following instruments/equipment are installed as part of the project's electricity generation infrastructure:

- One flow meter of differential pressure type to measure flow of LFG which is sent to the engine-generator set of the project's electricity generation infrastructure.

- One pressure sensor to measure pressure of the LFG which is sent to the engine-generator set of the project's electricity generation infrastructure.

- One temperature sensor to measure temperature of the LFG which is sent to the engine-generator set of the project's electricity generation infrastructure.

- One digital bi-directional electricity meter to measure the amount of net electricity generated by the project's electricity generation infrastructure that is exported through the local electricity grid. The bi-directional electricity meter also measures the amount of grid-sourced electricity imported by the project activity (whenever the project's electricity generation infrastructure is not under operational status).

The electricity demand of the project activity has been entirely met by electricity generated by the project activity (whenever the project's electricity generation infrastructure is under operation). During time periods when the project's electricity generation infrastructure is not under operation (temporary interruptions), electricity demand of the project activity has been met by imports of grid electricity through the same dedicated transmission line which is used for exporting electricity generated by the project activity.

C.2. DATA ACQUISITION, STORAGE AND MANAGEMENT SYSTEM

As part of the monitoring process for the project activity, all continuous measurements of LFG related monitoring parameters (including measurements of temperature of exhaust gas of the flare and status of the flare) and also monitoring of operation status of the project's electricity generation infrastructure were recorded/reported every minute during the considered monitoring period in an

installed data acquisition unit and archiving solution (database) designed and configured by Biotecnogas S.r.l.[2]

As part of the operation of the project activity, monitoring data has been recorded by the utilized data acquisition and archiving infrastructure (database). Recorded LFG related monitoring data (+ measurement records for temperature of temperature of exhaust gas of the flare, status of the flare, and operational status of the installed engine-generator set consuming LFG) are regarded as "*raw data*" for processing emission reduction calculations valid for the considered monitoring period. As part of the implemented monitoring procedure for the project activity, such "*raw data*" is exported into MS-Excel spreadsheet format for generating the emission reduction calculation spreadsheets which are enclosed to this Monitoring Report.

The project's operational staff for both the LFG destruction and electricity generation infrastructure are trained for all related operation, maintenance and safety procedures. Related training certificates for operational staff were issued and are kept achieved. All relevant operational events (emergency, failures, maintenance, etc.) for both the LFG destruction and electricity generation infrastructure are registered in operation workbooks. All performed maintenance and/or repair events applicable for the critical pieces of equipment for both project components (flare, centrifugal blowers, $CH_4$ content gas analyzer unit, air compressor, engine-generator modular package sets, control systems, etc.) are also registered in the project's operation workbooks.

Records and documented evidences for performed calibration events in monitoring instruments/equipment are also registered in workbooks. The calibration certificates and registries for all performed calibration events are also kept in files. Calibration procedures are performed in accordance with applicable recommendation and requirements as established by equipment manufacturers and are also under conformance with applicable CDM requirements. The project's maintenance manual also includes related calibration procedures, requirements and instructions.

## C.3. MANAGERIAL RESPONSIBILITIES

Operation of the whole project activity under compliance with all applicable CDM requirements is the responsibility of the CDM Operational Manager of Itajaí Biogás e Energia S.A. The CDM Project Manager of Itajaí Biogás e Energia S.A. (who directly reports to the vice-president of the organization), is in charge of all validation and verification related activities (including development of PDD, Monitoring Reports and supporting documentation). The CDM Operational Manager is assisted/supported by hired technical consultants from the hired CDM technical consultancy/advisory service company UniCarbo – Energia e Biogás Ltda. The CDM Project Manager is responsible for ensuring the correct application of the monitoring plan.

Under an operational perspective, the CDM operations manager and CDM supervisor are in charge of performing all field monitoring activities and ensuring appropriate monitoring data logging and recording (always with assistance/support from by hired technical consultants from UniCarbo – Energia e Biogás Ltda.). They are also responsible for the performance of related calibration events as well as all applicable planned or unplanned maintenance and repair events.

[2] Biotecnogas S.r.l. is an Italy headquartered organization specialized in the design, installation and operation of biogas destruction and/or utilization infrastructure. Solutions developed by the organization includes the design, installation, configuration and training for related data acquisition and archiving solutions (database). Details about Biotecnogas S.r.l. products, services and expertise/experience are available online: http://www.biotecnogas.com

## SECTION D. Data and parameters

### D.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 06.0.1) |
| 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 13.0.0) |
| 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<br><br>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 02.0.0) |
| 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 02.0.0) |
| Value(s) applied | For considered gases *k* that are greenhouse gases (GHGs), the values below are applied for MMi.<br><br>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.*<br><br>ACM0001 (version 13.0.0) 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) and the difference to 100% is just considered as pure nitrogen. |
| Choice of data or measurement methods and procedures | - |

| Compound | Structure | Molecular mass (kg/kmol) |
|---|---|---|
| Nitrogen | $N_2$ | 28.01 |

| | |
|---|---|
| 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 02.0.0) |
| Value(s) applied | The following values of molecular mass are applicable for $CH_4$ (the only GHG which is considered):<br>Compound: Methane; Structure: $CH_4$; Molecular mass (kg/kmol): 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 02.0.0) |
| 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 02.0.0) |

| | |
|---|---|
| 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 02.0.0) |
| 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** | **$TDL_{grid,y}$** |
|---|---|
| Unit | - |
| Description | Average technical transmission and distribution losses for providing electricity to the grid |
| Source of data | Applicable default as per the methodological tool "Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation". |
| Value(s) applied | 20% |
| Choice of data or measurement methods and procedures | - |
| Purpose of data/parameter | Calculation of project emissions (due to the consumption of grid-sourced electricity by the project activity). |
| Additional comments | - |

| Data/Parameter | $w_{BM}$ |
|---|---|
| Unit | % |
| Description | Weighting of build margin emissions factor |
| Source of data | Applicable default value as per the "Tool to calculate the emission factor for an electricity system" (version 04.0) |
| Value(s) applied | 0.5 (50%) during the 1st 7-year crediting period |
| Choice of data or measurement methods and procedures | The applicable value valid for 1st crediting period as per the "Tool to calculate the emission factor for an electricity system" (version 4.0) is selected. |
| Purpose of data/parameter | Calculation of project emissions (due to the consumption of grid-sourced electricity by the project activity). |
| Additional comments | - |

| Data/Parameter | $w_{OM}$ |
|---|---|
| Unit | % |
| Description | Weighting of operating margin emissions factor |
| Source of data | Applicable default value as per the "Tool to calculate the emission factor for an electricity system" (version 04.0) |
| Value(s) applied | 0.5 (50%) during the 1st 7-year crediting period |
| Choice of data or measurement methods and procedures | The applicable value for the 1st crediting period as per the "Tool to calculate the emission factor for an electricity system" (version 4.0) is selected. |
| Purpose of data/parameter | Calculation of project emissions (due to the consumption of grid-sourced electricity by the project activity). |
| Additional comments | - |

| Data/Parameter | $SPEC_{flare}$ |
|---|---|
| Unit | °C (for temperature values)<br>$m^3/h$ (for LFG flow values)<br>Number of days (for maintenance schedule interval values) |
| Description | Manufacturer's flare specifications for temperature, flow rate and maintenance schedule interval. |

<table>
<tr><td>Source of data</td><td>Flare manufacturer[3]</td></tr>
<tr><td>Value(s) applied</td><td>The specifications of the installed flare are listed below:
<table>
<tr><th>$SPEC_{flare}$</th><th>Min.</th><th>Max.</th></tr>
<tr><td>Operational LFG flow (for continuous operation):</td><td>240 $Nm^3/h$</td><td>1,200 $Nm^3/h$</td></tr>
<tr><td>Required temperature of the exhaust gas of the flare (to ensure LFG destruction (combustion) under high $CH_4$ destruction efficiency):</td><td>850 $^oC$</td><td>1,000 $^oC$</td></tr>
<tr><td>Required minimum frequency for inspection and maintenance service (incl. inspection in the conditions of the flare isolation ceramics revetment material):</td><td colspan="2">Min. every year (min each 365 days)</td></tr>
</table></td></tr>
<tr><td>Choice of data<br>or measurement methods and procedures</td><td>As established by the methodological tool “Project emissions from flaring”, 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 $SPEC_{flare}$. During the 1st 7-year crediting period, ex-ante selected data will be compared against monitored data related to the operation of the flares, including:<br>a) Minimum and maximum monitoring records for data regarding inlet LFG flow rate, if necessary converted to flow rate at reference conditions or heat flux,<br>(b) Minimum and maximum monitoring records for data of temperature in the exhaust gas of each individual high temperature enclosed flare; and<br>(c) Duration in days of time periods between maintenance events for each individual high temperature enclosed flare.</td></tr>
<tr><td>Purpose of data/parameter</td><td>Calculation of baseline emissions[4].</td></tr>
<tr><td>Additional comments</td><td>All flare specification and operation details/requirements are based on information provided by the equipment manufacturer.</td></tr>
</table>

[3] The manufacturer of the flare is “Biotecnogas S.r.l.”, which is a flaring equipment manufacturer based in Brazil.

[4] As also highlighted in Section B.3, it is important to note that residual project emissions of $CH_4$ due to the combustion of LFG in the installed enclosed flare are considered in the context of the determination of baseline emissions (although ACM0001 (version 13.0.0) refers to the term “project emissions from flaring”.

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

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

- Efficiency of the LFG capture system that will be installed in the project activity ($\eta_{PJ}$)
- Default value for model correction factor to account for model uncertainties ($\varphi_{default}$)
- Oxidation factor (reflecting the amount of methane from the considered SWDS that is oxidized in the soil (or other material covering the waste)) (OX)
- Fraction of methane in the SWDS gas (volume fraction) (F)
- 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* ($W_j$)

As also outlined in the PDD, 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 project activity" ($F_{CH4,PJ,y}$) (in the context of ex-ante estimation of emission reductions to be achieved by the project activity during the 1st 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 project activity during the considered monitoring period. Relevant details for such not reported parameters are included in Section B.6.2 of the PDD.

Moreover, the ex-ante determined parameter "Rated capacity of the captive backup diesel generator fuel by diesel" ($PP_{CP,Diesel\text{-}generator}$), which is also included in the PDD, was also not used as no captive backup diesel generator was so far installed as part of the project activity.

## D.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 project activity, the management of the Canhanduba landfill is yearly compared against the previously conceived original construction and operational design for the Canhanduba 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 13.0.0), any change in the management of the Canhanduba landfill after the implementation of the project activity should be justified by referring to applicable technical or regulatory specifications. |
| Source of data | An initial technical evaluation was performed on 21/01/2015. This initial evaluation covers the period from 01/07/2014 (date when the project activity started to operate) to 21/01/2015 (issuance date of the declaration document for the performed evaluation).<br><br>As per the applicable monitoring procedure, a sequential technical evaluation was also performed on January 2016. The findings for such performed technical evaluation are reported in the declaration that is dated 21/01/2016.<br><br>As part of the performed evaluation, the current configuration and operational conditions of the Canhanduba landfill were compared against the previously conceived design and operational conditions of the landfill prior of the occurred implementation of the project activity on the basis of different sources and assessments including inter alia:<br><br>- The original design documents of the landfill (as described in the documentation required for all phases of the environmental licensing and operational permitting for the URBAM landfill);<br>- Applicable local or national regulations; |

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| Value(s) of monitored parameter | As outlined in the issued internal technical evaluation/declaration reports dated 21/01/2015 and 21/01/2016, the previously conceived original design of the Canhanduba landfill (dated prior to the implementation of the project activity) is confirmed not to being deliberately modified during the period from 01/07/2014 (date when the project activity started to operate) until the end of the considered monitoring period. Furthermore, no modification in the previously conceived original design of the Canhanduba landfill has occurred or was promoted during the period. The issued technical reports confirm that no practice to increase methane generation at the Canhanduba landfill have occurred or have been promoted (when compared to management and MSW landfilling practices prior to implementation of the project activity). 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.<br><br>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 Canhanduba 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.<br><br>In the particular case of the Canhanduba 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 Santa Catarina State (FATMA).<br><br>Currently, there is still no 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 Canhanduba landfill). |
| Monitoring equipment | Not applicable. No measuring equipment is used for monitoring management of the Canhanduba landfill. |
| Measuring/reading/recording frequency | Annual checking is performed. |
| 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 Itajaí Biogás e Energia S.A. in accordance with detailed working instructions that are included in the company's quality management and control (QA/QC) and environmental management system (EMS). |
| Purpose of data/parameter | Calculation of baseline emissions |

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|---|---|
| Additional comments | As required by ACM0001 (version 13.0.0), any change in the management of the landfill after the implementation of the project activity 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 PDD (in terms of operation and management conditions of the landfill from which LFG is combusted). |

| **Data/Parameter** | $\mathbf{V_{t,wb,j}}$ |
|---|---|
| Unit | $m^3$ wet gas/h |
| Description | Volumetric flow of LFG stream in time interval *t* on a wet basis for *j* (where *j* is the LFG delivery pipeline to each item of electricity generation and LFG delivery pipeline to the flare(s)). |
| Measured/calculated/ default | Continuously measured by two LFG flow meters (one flow meter for the high temperature enclosed flare and one flow meter for the engine-generator set of the electricity generation facility).<br>. |
| Source of data | Continuous measurements performed by two installed LFG flow meters are recorded in the project's acquisition system with an every-minute frequency. |
| Value(s) of monitored parameter | The emission reduction calculation spreadsheets (that are enclosed to this Monitoring Report) include all records of measurement data of LFG flow sent to the installed high temperature enclosed flare and LFG flow sent to the engine-generator set of the electricity generation infrastructure during the considered monitoring period. Measurement data is recorded and reported with an every-minute frequency.<br><br>While measurements are performed by two installed LFG flow meters (one flow meter for the high temperature enclosed flare and one flow meter for the engine-generator set of the electricity generation infrastructure), the monitoring parameter $V_{t,wb,j}$ is thus measured, recorded and reported on the basis of the following sub-parameters:<br><br>- $V_{t,wb,flare}$: Volumetric flow of LFG to the Flare<br>- $V_{t,wb,genset}$: Volumetric flow of LFG to the engine-generator set |

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| Monitoring equipment | Measurements of LFG flow sent to the flare are performed by a LFG flow meter that is installed in an independent section of the LFG pipeline located between the centrifugal blowers and the installed high temperature enclosed flare,<br><br>Measurements of LFG flow sent to the engine-generator set of the project's electricity generation infrastructure have been performed by a LFG flow meters which is installed in an independent section of the LFG pipeline close to the engine-generator modular package set. It is thus ensured that flow of LFG sent to the flare and flow of LFG sent to the engine-generator set of the electricity generation infrastructure are independently and continuously measured.<br><br>*Specifications and calibration details for the LFG flow meter used during the considered monitoring period for measuring the flow of LFG sent to the flare ($V_{t,wb,flare}$):*<br><br>• Manufacturer: ABB Automation Products GmbH<br>• Model: FS4000<br>• Accuracy: +/-0.5%<br>• Serial Number: 241836358/X001<br>• Calibration frequency (as specified by the monitoring methodology/tool and/or in the PDD): The registered PDD establishes the following:<br>"*Periodic calibration events will be performed in a frequency as per instrument specifications and/or instrument manufacturer's recommendations".*<br>• Calibration frequency (as per the application of the monitoring plan and recommendations from the equipment manufacturer): Calibration events are performed every 3 years<br>• Dates for performed calibration events valid for the considered monitoring period: 18/03/2013<br>• Validity of the performed calibration events: The calibration event dated 18/03/2013 is valid until 17/03/2016 (3 years).<br>• Entity/company responsible for performing the calibration events: ABB Automation Products GmbH<br><br>*Specifications and calibration details for the LFG flow meter used for measuring the flow of LFG sent to the engine-generator set of the project's electricity generation infrastructure ($V_{t,wb,genset}$):*<br><br>• Manufacturer: ABB Automation Products GmbH<br>• Model: FS4000<br>• Accuracy: +/-0.5%<br>• Serial Number: 241836358/X002<br>• Calibration frequency (as specified by the monitoring methodology/tool and/or in the PDD): The registered PDD establishes the following:<br>"*Periodic calibration events will be performed in a frequency as per instrument specifications and/or instrument manufacturer's recommendations".*<br>• Calibration frequency (as per the application of the monitoring plan and recommendations from the equipment manufacturer): Calibration events are performed every 3 years<br>• Dates for performed calibration events valid for the considered monitoring period: 18/03/2013<br>• Validity of the performed calibration events: The calibration event dated 18/03/2013 is valid until 17/03/2016 (3 years).<br>• Entity/company responsible for performing the calibration events: ABB Automation Products GmbH |
| Measuring/reading/recording | Continuous measurements are recorded and reported with an every-minute |

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|---|---|
| frequency | frequency. |
| Calculation method (if applicable) | Not applicable. |
| QA/QC procedures | Monitoring equipment/instruments are calibrated and maintained as per instrument specifications and/or recommendations of manufacturer.<br><br>Procedures related to collection/gathering, recording, storing and reporting of monitoring data for the project activity are performed at Itajaí Biogás e Energia S.A. in accordance with detailed working instructions that are included in the company's quality management and control (QA/QC) and environmental management system (EMS). |
| Purpose of data/parameter | Calculation of baseline emissions |
| Additional comments | While the installed flow meters do not automatically convert measurements in normal cubic meter per hour ($Nm^3/h$), measurements of LFG pressure and LFG temperature (monitoring parameters "Temperature of the LFG stream in time interval *t"* ($T_t$) and "Pressure of the LFG stream in time interval *t"* ($P_t$) respectively) are considered for converting measurements of $V_{t,wb,flare}$ and $V_{t,wb,genset}$ into normal cubic meter per hour ($Nm^3/h$) ($V_{t,wb,n,flare}$ and $V_{t,wb,n,genset}$) as outlined in the monthly emission reduction calculation spreadsheets enclosed to this Monitoring Report. |

| **Data/Parameter** | $\mathbf{v_{CH4,t,wb}}$ |
|---|---|
| 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 an installed $CH_4$ content gas analyzer. |
| Source of data | Measured as part of the operation of the project activity by applying appropriate monitoring instrument ($CH_4$ content gas analyser with continuous measurements being electronically recorded). |
| Value(s) of monitored parameter | The 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. |

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| Monitoring equipment | *Continuous $CH_4/O_2$ content gas analyzer unit:*<br><br>Specifications of the installed continuous $CH_4$ content gas analyzer are described below:<br>- Manufacturer: Siemens AG<br>- Model: Ultramat 23<br>- Accuracy: ±1%<br>- Serial number (S/N): N1D1212<br>- Calibration frequency and maintenance requirements[5]: Calibration events are performed every year<br>- Calibration events valid for the considered monitoring period: Calibration event dated 01/03/2013.<br>- Validity of the performed calibration events: The calibration event dated 01/03/2013 is valid until 28/02/2014 (1 years).<br>- Entity/company responsible for performing the calibration events: Siemens AG |
| Measuring/reading/recording frequency | Continuously measurements are recorded/reported every minute. |
| Calculation method (if applicable) | Not applicable. |
| QA/QC procedures | Monitoring equipment/instruments are calibrated and maintained as per instrument specifications and/or recommendations of their manufacturer.<br><br>Procedures related to collection/gathering, recording, storing and reporting of monitoring data for the project activity are performed at Itajaí Biogás e Energia S.A. in accordance with detailed working instructions that are included in the company's quality management and control (QA/QC) and environmental management system (EMS). |
| 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 | Continuously measured by two temperature sensors (one temperature sensor for the high temperature enclosed flare and one temperature sensor for the engine-generator set of the electricity generation facility).<br><br>Measurements are primarily recorded and reported in $^oC$. Recorded/reported data is converted into Kelvin and data is also reported in this unit, thus meeting the related monitoring requirement as per the PDD. |
| Source of data | Measured as part of the operation of the project activity by applying |

[5] The calibration frequencies adopted for the installed LFG flow meter, $CH_4$ content gas analyzer unit, LFG pressure sensor and LFG temperature sensor are all as per the recommendations of related equipment/instrument manufacturers. The PDD and ACM0001 (version 13.0.0) do not specify any frequency for the calibration of such equipment/instruments. Moreover, the PDD and ACM0001 (version 13.0.0) do not specify any accuracy or other specification requirement for such instruments/equipment either.

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|---|---|
| | appropriate monitoring instrument (temperature sensors with recordable electronic signal). |
| Value(s) of monitored parameter | The 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 | The emission reduction calculation spreadsheets (that are enclosed to this Monitoring Report) include all records of measurement data of temperature of LFG which is sent to the installed high temperature enclosed flare and temperature of LFG which is sent to the engine-generator set of the electricity generation infrastructure during the considered monitoring period. Measurement data is recorded and reported with an every-minute frequency.<br><br>While measurements are performed by two installed temperature sensors (one for the high temperature enclosed flare and one for the engine-generator set of the electricity generation infrastructure), the monitoring parameter $T_t$ is thus measured, recorded and reported on the basis of the following sub-parameters:<br><br>- $T_{t,flare}$: Temperature of LFG which is sent to the Flare<br>- $T_{t,genset}$: Temperature of LFG which is sent to the engine-generator set<br><br>*Specifications and calibration details for the temperature sensor used during the considered monitoring period for measuring temperature of LFG which is sent to the flare ($T_{t,flare}$):*<br><br>- Manufacturer:<br><br>*Specifications and calibration details for the temperature sensor used during the considered monitoring period for measuring temperature of LFG which is sent to the engine-generator set ($T_{t,genset}$):*<br><br>- Manufacturer: |
| Measuring/reading/recording frequency | Continuously measurements are recorded/reported every minute. |
| Calculation method (if applicable) | Not applicable. |
| QA/QC procedures | Monitoring equipment/instruments are calibrated and maintained as per instrument specifications and/or recommendations of their manufacturer.<br><br>Procedures related to collection/gathering, recording, storing and reporting of monitoring data for the project activity are performed at Itajaí Biogás e Energia S.A. in accordance with detailed working instructions that are included in the company's quality management and control (QA/QC) and environmental management system (EMS). |
| 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 two pressure sensors (one for the high temperature enclosed flare and one for the engine-generator set of the electricity generation facility).<br><br>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 PDD. |
| Source of data | Measured as part of the operation of the project activity by applying appropriate monitoring instrument (pressure sensors with recordable electronic signal). |
| Value(s) of monitored parameter | The 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 | The emission reduction calculation spreadsheets (that are enclosed to this Monitoring Report) include all records of measurement data of pressure of LFG which is sent to the installed high temperature enclosed flare and pressure of LFG which is sent to the engine-generator set of the electricity generation infrastructure during the considered monitoring period. Measurement data is recorded and reported with an every-minute frequency.<br><br>While measurements are performed by two installed pressure sensors (one for the high temperature enclosed flare and one for the engine-generator set of the electricity generation infrastructure), the monitoring parameter $P_t$ is thus measured, recorded and reported on the basis of the following sub-parameters:<br><br>- $P_{t,flare}$: Pressure of LFG which is sent to the Flare<br>- $P_{t,genset}$: Pressure of LFG which is sent to the engine-generator set<br><br>*Specifications and calibration details for the pressure sensor used during the considered monitoring period for measuring pressure of LFG which is sent to the flare ($P_{t,flare}$)::*<br><br>- Manufacturer:<br><br>*Specifications and calibration details for the pressure sensor used during the considered monitoring period for measuring pressure of LFG which is sent to the engine-generator set ($P_{t,genset}$):*<br><br>- Manufacturer: |
| Measuring/reading/recording frequency | Continuously measurements are recorded/reported every minute. |
| Calculation method (if applicable) | Not applicable. |
| QA/QC procedures | Monitoring equipment/instruments are calibrated and maintained as per instrument specifications and/or recommendations of manufacturer.<br><br>Procedures related to collection/gathering, recording, storing and reporting of monitoring data for the project activity are performed at Itajaí Biogás e Energia S.A. in accordance with detailed working instructions that are included in the company's quality management and control (QA/QC) and environmental management system (EMS). |

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

| **Data/Parameter** | **$EC_{PJ,y}$** |
|---|---|
| Unit | MWh |
| Description | Amount of grid electricity consumed by the project activity during the year *y* |
| Measured/calculated/ default | Measured as part of the operation of the project activity by applying appropriate electricity meter. |
| Source of data | Installed electricity meter. |
| Value(s) of monitored parameter | Monthly records of grid-sourced electricity consumption valid for the considered monitoring period: |

| **Month** | **Total amount of consumed grid electricity (MWh)** |
|---|---|
| Jul. 2014 | 0.774 |
| Aug. 2014 | 1.796 |
| Sep. 2014 | 1.755 |
| Oct. 2014 | 1.306 |
| Nov. 2014 | 0.863 |
| Dec. 2014 | 0.643 |
| Jan. 2015 | 1.362 |
| Feb. 2015 | 9.369 |
| Mar. 2015 | 2.300 |
| Apr. 2015 | 0.381 |
| May 2015 | 7.843 |
| Jun. 2015 | 2.483 |
| Jul. 2015 (from 01/07/2015 to 14/07/2015) | 0.559 |

| | |
|---|---|
| Monitoring equipment | *Specifications of the installed electricity meter*<br>- Manufacturer: |
| Measuring/reading/recording frequency | Continuous measurements performed by installed electricity meter are automatically transmitted, aggregated and recorded. |
| Calculation method (if applicable) | Not applicable. |
| QA/QC procedures | Monitoring equipment/instruments are calibrated and maintained as per instrument specifications and/or recommendations of manufacturer.<br><br>Procedures related to collection/gathering, recording, storing and reporting of monitoring data for the project activity are performed at Itajaí Biogás e Energia S.A. in accordance with detailed working instructions that are included in the company's quality management and control (QA/QC) and environmental management system (EMS). |

| | |
|---|---|
| Purpose of data/parameter | Calculation of project emissions (due to consumption of grid-sourced electricity by the project activity). |
| Additional comments | |

| | |
|---|---|
| **Data/Parameter** | **$EC_{BL,y}$** |
| Unit | MWh |
| Description | Amount of electricity generated using LFG by the project activity in year *y* |
| Measured/calculated/ default | Measured as part of the operation of the project activity by applying appropriate electricity meter. |
| Source of data | Installed electricity meter. |
| Value(s) of monitored parameter | Monthly records of electricity generated by the project activity valid for the considered monitoring period: |

| Month | Amount of electricity generated using LFG (MWh) |
|---|---|
| Jul. 2014 | 515.597 |
| Aug. 2014 | 439.786 |
| Sep. 2014 | 465.104 |
| Oct. 2014 | 537.611 |
| Nov. 2014 | 528.685 |
| Dec. 2014 | 634.769 |
| Jan. 2015 | 657.531 |
| Feb. 2015 | 217.194 |
| Mar. 2015 | 600.165 |
| Apr. 2015 | 677.685 |
| May 2015 | 380.969 |
| Jun. 2015 | 473.502 |
| Jul. 2015 (from 01/07/2015 to 14/07/2015) | 575.953 |

| | |
|---|---|
| Monitoring equipment | *Specifications of the installed electricity meter*<br>- Manufacturer: |
| Measuring/reading/recording frequency | Continuous measurements performed by installed electricity meter are automatically transmitted, aggregated and recorded. |
| 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 Itajaí Biogás e Energia S.A. in accordance with detailed working instructions that are included in the company's quality management and control (QA/QC) and environmental management system (EMS). |
| Purpose of data/parameter | Calculation of baseline emissions (due to the displacement of an equivalent amount of electricity generated by the project's electricity generation |

| | |
|---|---|
| | infrastructure which would otherwise be generated by existing grid-connected power plants (and addition of new power generation units) within the National Electricity Grid of Brazil). |
| Additional comments | Whenever the project's electricity generation infrastructure is under operation, all electricity demand of the project activity is met by electricity generated by the project activity. Thus, reported values for the monitoring parameter $EC_{BL,y}$ represent net amount of generated electricity that is exported through the National Electricity Grid of Brazil. |

| **Data/Parameter** | **$EF_{grid,OM,y}$ = $EF_{grid,OM-DD,y}$** |
|---|---|
| Unit | $tCO_2/MWh$ |
| Description | Operation margin $CO_2$ emission factor in year *y* = Dispatch data analysis operating margin $CO_2$ emission factor in year *y* |
| Measured/calculated/ default | Calculated (based on official monthly values as calculated and published by the DNA of Brazil). |
| Source of data | Selected average values of $EF_{grid,OM,y}$ = $EF_{grid,OM-DD,y}$ valid for years 2014 and 2015 are calculated by the DNA of Brazil and are made public available at the website of the DNA of Brazil:<br><br>General link: http://www.mctic.gov.br/mctic/opencms/ciencia/SEPED/clima/textogeral/emissao_despacho.html |
| Value(s) of monitored parameter | Average annual values of operation margin $CO_2$ emission factor for the National Electricity Grid of Brazil for the years of 2014 and 2015:<br>- 2014: 0.5837 $tCO_2/MWh$<br>- 2015: 0.5597 $tCO_2/MWh$ |
| Monitoring equipment | Not applicable |
| Measuring/reading/recording frequency | Values are updated annually. |
| Calculation method (if applicable) | Values applicable for the years of 2014 and 2015 were calculated by the DNA of Brazil as per applicable guidance of the calculation method "dispatch data analysis operating margin $CO_2$ emission factor" of the "Tool to calculate the emission factor for an electricity system". |
| QA/QC procedures | - |
| Purpose of data/parameter | Calculation of project emissions (due to consumption of grid-sourced electricity by the project activity) and baseline emissions (due to the displacement of an equivalent amount of electricity generated by the project's electricity generation infrastructure which would otherwise be generated by existing grid-connected power plants (and addition of new power generation units) within the National Electricity Grid of Brazil). |
| Additional comments | - |

| **Data/Parameter** | **$EF_{grid,BM,y}$** |
|---|---|
| Unit | $tCO_2/MWh$ |
| Description | Build margin $CO_2$ emission factor in year *y* |
| Measured/calculated/ default | Calculated (based on official monthly values as calculated and published by the DNA of Brazil). |
| Source of data | Selected average values of $EF_{grid,BM,y}$ valid for years 2014 and 2015 are calculated by the DNA of Brazil and are made public available at the website of the DNA of Brazil:<br><br>General link: http://www.mctic.gov.br/mctic/opencms/ciencia/SEPED/clima/textogeral/emissao_despacho.html |
| Value(s) of monitored parameter | Average annual values of build margin $CO_2$ emission factor for the National Electricity Grid of Brazil for the years of 2014 and 2015:<br>- 2014: 0.2963 $tCO_2/MWh$<br>- 2015: 0.2553 $tCO_2/MWh$ |
| Monitoring equipment | Not applicable |
| Measuring/reading/recording frequency | Values are updated annually. |
| Calculation method (if applicable) | Values applicable for the years of 2014 and 2015 were calculated by the DNA of Brazil as per applicable guidance of the calculation method “dispatch data analysis operating margin $CO_2$ emission factor” of the “Tool to calculate the emission factor for an electricity system”. |
| QA/QC procedures | - |
| Purpose of data/parameter | Calculation of project emissions (due to consumption of grid-sourced electricity by the project activity) and baseline emissions (due to the displacement of an equivalent amount of electricity generated by the project’s electricity generation infrastructure which would otherwise be generated by existing grid-connected power plants (and addition of new power generation units) within the National Electricity Grid of Brazil). |
| Additional comments | - |

| **Data/Parameter** | **$Op_{j,h}$** |
|---|---|
| Unit | - |
| Description | Operation of the equipment that consumes LFG |
| Measured/calculated/ default | For each equipment unit *j* using the LFG monitor that the plant is operating in hour h by the monitoring any one or more of the following three parameters: (a) Temperature. Determine the location for temperature measurements and minimum operational temperature based on manufacturer’s specifications of the burning equipment. Document and justify the location and minimum threshold in the PDD; |

| | |
|---|---|
| | (b) Flame. Flame detection system is used to ensure that the equipment is in operation;<br>(c) Products generated. Monitor the generation of steam for the case of boilers and air-heaters and glass for the case of glass melting furnances. This option is not applicable to brick kilns.<br><br>$Op_{j,h}$ = 0 when:<br>(a) One of more temperature measurements are missing or below the minimum threshold in hour h (instantaneous measurements are made at least every minute);<br>(b) Flame is not detected continuously in hour h (instantaneous measurements are made at least every minute);<br>(c) No products are generated in the hour h. Otherwise, $Op_{j,h}$ = 1 |
| Source of data | The electronic control system for each engine-generator set of the project's electricity generation infrastructure continuously monitor operational status of the set (engine-generator set running "on" or not-running "off"). |
| Value(s) of monitored parameter | Records for every-minute operational status of the set (engine-generator set running ("on") = 1 or not-running ("off") = 0) are made available in the emission reduction calculation spreadsheets valid for the considered monitoring period).<br>- |
| Monitoring equipment | Not applicable. |
| Measuring/reading/recording frequency | Values are reported on a minute basis. |
| 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 Companhia Riograndense de Valorização de Resíduos S/A and Biotérmica Energia S.A. in accordance with detailed working instructions that are included in the company's quality management and control (QA/QC) and environmental management system (EMS). |
| Purpose of data/parameter | Calculation baseline emissions (due to the displacement of an equivalent amount of electricity generated by the project's electricity generation infrastructure which would otherwise be generated by existing grid-connected power plants (and addition of new power generation units) within the National Electricity Grid of Brazil). |
| Additional comments | - |

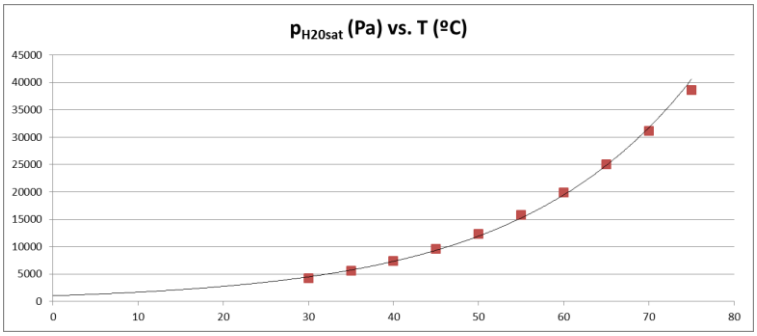
| **Data/Parameter** | $p_{H20,t,Sat}$ |
|---|---|
| Unit | Pa (depending on measurement instrument, measurement records in mbar will be converted and also reported in Pa) |
| Description | Saturation pressure of $H_2O$ at temperature $T_t$ in time interval *t* |
| Measured/calculated/ default | Default 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:<br>$p_{H2O,t,sat} = 1{,}031.3 * e^{(0.049 * Tt)}$, with a correlation coefficient of $R^2 = 0.998$.<br>Further details are presented below in "Calculation Method". |
| Monitoring equipment | Not applicable. |
| Measuring/reading/recording frequency | Not applicable |

| | |
|---|---|
| Calculation method (if applicable) | 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: |

| Temperature | $p_{H2O,t,Sat}$ |
|---|---|
| ºC | Pa |
| 30 | 4,246 |
| 35 | 5,628 |
| 40 | 7,384 |
| 45 | 9,593 |
| 50 | 12,349 |
| 55 | 15,758 |
| 60 | 19,940 |
| 65 | 25,030 |
| 70 | 31,190 |
| 75 | 38,580 |

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.

| | |
|---|---|
| QA/QC procedures | Not applicable. |
| Purpose of data/parameter | Calculation of baseline emissions. |
| Additional comments | It is important to note that $p_{H2O,t,Sat}$ is only used in the context of the determination of 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 (parameter $F_{CH4,RG,t}$). The calculations of every-minute values of $p_{H2O,t,Sat}$ for the 2 time periods during which the flare efficiency is measured is thus presented only in the flare efficiency calculation spreadsheet. |

| **Data/Parameter** | **$T_{EG,m}$** |
|---|---|
| Unit | $^{o}C$ |
| Description | Temperature in the exhaust gas of the enclosed flare 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 (thermocouple with recordable electronic signal). |
| Value(s) of monitored parameter | Values are reported in the emission reduction calculation spreadsheets (that are enclosed to this Monitoring Report). Measurement data is recorded and reported with an every-minute frequency. |
| Monitoring equipment | The specifications of the installed thermocouple are as follows;<br><br>- Manufacturer: |
| Measuring/reading/recording frequency | Continuous measurements are recorded/reported every minute. |
| Calculation method (if applicable) | - |
| QA/QC procedures | Monitoring equipment/instruments are calibrated and maintained as per instrument specifications and/or recommendations of manufacturer.<br><br>Procedures related to collection/gathering, recording, storing and reporting of monitoring data for the project activity are performed at Itajaí Biogás e Energia S.A. in accordance with detailed working instructions that are included in the company's quality management and control (QA/QC) and environmental management system (EMS). |
| Purpose of data/parameter | Calculation of baseline emissions. |
| Additional comments | - |

| **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 are reported in the emission reduction calculation spreadsheets (that are enclosed to this Monitoring Report). Measurement data is recorded and reported with an every-minute frequency. |

| | |
|---|---|
| Monitoring equipment | *Specifications and calibration details for the installed/utilized UV Flame detector:*<br>• Manufacturer: |
| Measuring/reading/recording frequency | Continuously measurements are recorded/reported every minute. |
| Calculation method (if applicable) | Not applicable |
| QA/QC procedures | Monitoring equipment/instruments are calibrated and maintained as per instrument specifications and/or recommendations of manufacturer.<br><br>Procedures related to collection/gathering, recording, storing and reporting of monitoring data for the project activity are performed at Itajaí Biogás e Energia S.A. in accordance with detailed working instructions that are included in the company's quality management and control (QA/QC) and environmental management system (EMS). |
| Purpose of data/parameter | Calculation of baseline emissions |
| Additional comments | - |

| **Data/Parameter** | **$Maintenance_y$** |
|---|---|
| Unit | Calendar dates |
| Description | Maintenance events completed in year *y* |
| Measured/calculated/ default | - |
| Source of data | Maintenance logs |

| | |
|---|---|
| Value(s) of monitored parameter | The following relevant maintenance events (inspection and maintenance services) are applicable for the installed high temperature enclosed flare during the considered monitoring period:<br><br>- 11/11/2014: General inspection/maintenance service on the Flare (incl. inspection of the condition of the flare isolation ceramics revetment material, checking of conditions of the LPG supply valve for pilot flame, checking of condition/function of the air inlet dumpers, checking of the conditions of the thermocouples, checking of the condition of the UV flame detector, checking of the condition of the flame arrester valve, checking of the conditions of the LFG injectors, checking of painting conditions).<br>- 22/04/2015: General inspection/maintenance service on the Flare (incl. inspection of the condition of the flare isolation ceramics revetment material, checking of conditions of the LPG supply valve for pilot flame, checking of condition/function of the air inlet dumpers, checking of the conditions of the thermocouples, checking of the condition of the UV flame detector, checking of the condition of the flame arrester valve, checking of the conditions of the LFG injectors, checking of painting conditions).<br><br>As per the applied maintenance practice for the project activity, general inspection/maintenance services on the flare are opportunely performed during planned or unplanned interruptions of operation of the flare within a time interval between 2 performed inspection/maintenance services events never higher than a year.<br><br>Performed maintenance and overhauling services in the flare are performed under by specialized technical service team under conformance with maintenance requirements for the flare (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 D.1. |
| Monitoring equipment | Not applicable. |
| Measuring/reading/recording frequency | Not applicable. |
| Calculation method (if applicable) | Not applicable. |
| QA/QC procedures | The maintenance event logs and documentation for the whole project activity are recorded as per requirement of the company's quality and control (QA/QC) and environmental management (EMS) system that is implemented for activities undertaken at the Canhanduba landfill. |
| Purpose of data/parameter | Calculation of baseline emissions |
| Additional comments | Monitoring of this parameter is required for the case of enclosed flare and the project participant selects Option B to determine flare efficiency.<br><br>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 ($SPEC_{flare}$). |

The following monitoring parameters (which are also included in the monitoring plan of the PDD) were not monitored as the methodological options for which they are applicable were not selected as the monitoring or calculation approaches for the determination of baseline emissions and/or project emissions achieved by the project activity during the considered monitoring period:

- Volumetric flow of LFG stream in time interval t on a dry basis for *j* (where *j* is the LFG delivery pipeline to each item of electricity generation and LFG delivery pipeline to the flare(s)) ($V_{t,db,j}$)
- 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 for *j* (where *j* is the LFG delivery pipeline to each item of electricity generation and LFG delivery pipeline to the flare(s)) ($M_{t,db,j}$)
- Quantity of electricity generated in captive diesel backup generator during the year *y* ($EC_{PJ,captive,y}$)
- Mass flow of methane in the exhaust gas of the flare on a dry basis at reference conditions in the time period *t* ($F_{CH4,EG,t}$)

### D.3. Implementation of sampling plan

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Not applicable.

## SECTION E. Calculation of emission reductions or net anthropogenic removals

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

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

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

Where:

| | |
|---|---|
| $BE_{CH4,y}$ | Baseline emissions of methane from the SWDS[6]. |
| $BE_{EC,y}$ | Baseline emissions associated with electricity generation in year *y* (in $tCO_2$/yr). |

*Determination of baseline emissions associated with electricity generation ($BE_{EC,y}$)*

Baseline emissions associated with electricity generation ($BE_{EC,y}$) is determined as follows:

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

Where:

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

$EC_{BL,y}$ Net amount of electricity generated using LFG in year y (in MWh). As per the applied monitoring procedure, monthly records of net electricity generated by the project activity (using collected LFG as gaseous fuel) for the considered monitoring period are summarized below:

| Month | Amount of electricity generated using LFG (kWh) |
|---|---|
| Jul. 2014 | 515.597 |
| Aug. 2014 | 439.786 |
| Sep. 2014 | 465.104 |
| Oct. 2014 | 537.611 |
| Nov. 2014 | 528.685 |
| Dec. 2014 | 634.769 |
| Jan. 2015 | 657.531 |
| Feb. 2015 | 217.194 |
| Mar. 2015 | 600.165 |
| Apr. 2015 | 677.685 |
| May 2015 | 380.969 |
| Jun. 2015 | 473.502 |
| Jul. 2015 (from 01/07/2015 to 14/07/2015) | 575.953 |

Additional monitoring details about the monitoring parameter $EC_{BL,y}$ are included in Section D.2.

$EF_{EL,grid,y}$ Emission factor for grid sourced electricity in year *y* (in $tCO_2/MWh$). $EF_{EL,grid,y}$ is determined as the combined margin emission factor ($EF_{grid,CM,y}$) that is calculated as the weighted average of the operating margin and build margin emission factors. To weight these two factors, the default values applicable to both for the 1st crediting period are applied. The combined margin emission factor is thus obtained as follows:

$$EF_{EL,grid,y} = EF_{grid,CM,y} = w_{OM} * EF_{grid,OM,y} + w_{BM} * EF_{grid,BM,y}$$

Where:

$w_{OM}$ Weighting of operating margin emissions factor. $w_{OM}$ is ex-ante selected as 0.5. Further details about the ex-ante selected parameter $w_{OM}$ are included in Section D.1 and in the PDD.

$w_{BM}$ Weighting of operating margin emissions factor. $w_{BM}$ is ex-ante selected as 0.5. Further details about the ex-ante selected parameter $w_{BM}$ are included in Section D.1 and in the PDD.

$EF_{grid,OM,y}$ Operating margin $CO_2$ emission factor in year *y* (in $tCO_2/MWh$). Selected values for the monitoring parameter $EF_{grid,OM,y} = EF_{grid,OM-DD,y}$ represent the official average annual values for years 2014 and 2015 (0.5837 $tCO_2/MWh$ and 0.5597 $tCO_2/MWh$, respectively) as calculated and published by the DNA of Brazil. Further details about the monitoring parameter $EF_{grid,OM}$ are included in Section D.2.

$EF_{grid,BM,y}$ Build margin $CO_2$ emission factor in year *y*. $EF_{grid,BM}$ is ex-ante determined as 0.2963 $tCO_2/MWh$. Selected values for

the monitoring parameter $EF_{grid,BM,y}$ represent the official average annual values for years 2014 and 2015 (0.2963 $tCO_2$/MWh and 0.2553 $tCO_2$/MWh, respectively) as calculated and published by the DNA of Brazil. Further details about the monitoring parameter $EF_{grid,OM}$ are included in Section D.2.

For the considered monitoring period, $EF_{EL,grid,y}$ is thus calculated as 0.440 $tCO_2$/MWh and 0.4075 for the years of 2014 and 2015, respectively.

$TDL_{grid,y}$ Average technical transmission and/or distribution losses for providing electricity to the grid and/or for grid sourced electricity consumed by the project activity. For the particular case of determination of $BE_{EC,y}$, $TDL_{,grid,y}$ is ex-ante determined as being 3% ($TDL_{grid,export,y}$).

Baseline emissions associated with electricity generation in year *y* ($BE_{EC,y}$) for the considered monitoring period are calculated and reported as 3,137 $tCO_2$. All related calculation are presented in an emission reduction calculation spreadsheet that is enclosed to the Monitoring Report.

*Determination of baseline emissions of methane from the SWDS ($BE_{CH4,y}$):*

Baseline emissions of methane from the SWDS ($BE_{CH4,y}$) are determined as follows:

$BE_{CH4,y}$ Baseline emissions of methane from the SWDS[7]. As established by both ACM0001 (version 13.0.0) and the PDD, 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 and utilization of collected LFG as gaseous fuel for electricity generation) by the project activity. As established by both ACM0001 (version 13.0.0) and the PDD, 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 13.0.0) 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:

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

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 D.1 and in the PDD.

$GWP_{CH4,y}$ 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 D.1 and in the PDD.

$F_{CH4,BL,y}$ Amount of methane in the LFG that would be flared in the baseline scenario (absence of project activity). As outlined in the PDD, for the

[7] SWDS = Solid Waste Disposal Site. For the case of the project activity, the SWDS is the URBAM landfill.

particular case of the project activity, while no LFG was combusted prior the implementation of the project activity, $F_{CH4,BL,y} = 0$.

$F_{CH4,PJ,y}$ 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:

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

Where:

$F_{CH4,EL,y}$ Amount of methane in the LFG which is used for electricity generation in year *y* (in $tCH_4/yr$). Details for the determination of every-minute values for $F_{CH4,EL,y}$ for each individual engine-generator during the the considered monitoring period are presented below (under "*Determination of every-minute values for the calculation parameters $F_{CH4,sent\_flare,y}$ and $F_{CH4,EL,y}$*").

$F_{CH4,flared,y}$ Amount of methane in the LFG flared by the project activity (in $tCH_4$) during the whole monitoring period. In accordance with calculation guidance included in the PDD and by following applicable guidance of the "Tool to determine the mass flow of a greenhouse gas in a gaseous stream", for each individual flare 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 $F_{CH4,sent\_flare,y}$ for each individual flare are presented below (under "*Determination of every-minute values for the calculation parameters $F_{CH4,sent\_flare,y}$ and $F_{CH4,EL,y}$*").

$PE_{flare,y}$ 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 parameters $F_{CH4,sent\_flare,y}$ and $F_{CH4,EL,y}$:*
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 the flare and to the electricity generation infrastructure)[8] is

[8] It is relevant to note that the PDD states the following regarding the calculation approach for values of $F_{CH4,sent\_flare,y}$ and $F_{CH4,EL,y}$:

the selected option for determination of values of $F_{CH4,sent\_flare,y}$ (applicable for flare) and independent values of $F_{CH4,EL,y,genset}$ (applicable for the engine-generator set of the electricity generation infrastructure).

*$F_{CH4,sent\_flare,y}$:*
By following calculation option C (that is one of the applicable calculation methods the PDD refers to), the mass flow of greenhouse gas *i* ($F_{i,t}$) (*i* = $CH_4$) for the installed flare during the whole considered monitoring period is determined as follows:

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

Where:

$V_{t,wb,n,flare}$ 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 $V_{t,wb,n.flare}$ are calculated and reported (in $Nm^3$ wet gas/h) in the 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, measurements of volumetric flow of the gaseous stream (LFG) sent to the flare are not processed and recorded in $Nm^3$ of wet gas/h (normal conditions), values of $V_{t,wb,n,flare}$ valid for each minute encompassed by monitoring period are thus calculated as follows:

$V_{t,wb,n,genset} = V_{t,wb,genset} * (T_n / T_{tgenset}) * (P_{tgenset} * P_n)$

Where:

$V_{t,wb,flare}$ Volumetric flow of the gaseous stream (LFG) to the flare in time interval *t* on a wet basis at actual conditions. Every-minute values of $V_{t,wb,flare}$ for the flare are reported (in $m^3$ wet gas/h) in the emission reduction calculation spreadsheets enclosed to the Monitoring Report. Further monitoring details about the monitoring parameter $V_{t,wb,flare}$ are included under details for the monitoring parameter $V_{t,wb,j}$ in Section D.2.

$T_{tflare}$ Temperature of the gaseous stream in time interval *t*. Every-minute values of $T_{tflare}$ for the flare are reported (in Kelvin) in the emission reduction calculation spreadsheets enclosed to the Monitoring Report. Further monitoring details about the parameter $T_{tflare}$ are included under details for the monitoring parameter $T_t$ in Section D.2.

$T_n$ 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 D.1 and in the PDD.

$P_{tflare}$ Pressure of the gaseous stream in time interval *t*. Every-minute values of $P_{tflare}$ for the flare are reported (in Pa) in the emission reduction calculation spreadsheets enclosed to the

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"*Applicable guidance of the "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" will be applied to determine $F_{CH4,sent\_flare,y}$ and $F_{CH4,EL,y}$ by using Option 2: Simplified calculation without measurement of the moisture content, and one of the options A, C or D. The selection of the determination option will depend on project conditions and equipment to be installed."*

Monitoring Report. Further monitoring details about the parameter $P_{tflare}$ are included under details for the monitoring parameter $P_t$ in Section D.2.

$P_n$ 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 D.1 and in the PDD.

$v_{CH4,t,wb}$ 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 emission reduction calculation spreadsheet 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 D.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 emission reduction calculation spreadsheet 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 D.1 and in the PDD.

$T_n$ 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 D.1 and in the PDD.

$MM_i$ 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 D.1 and in the PDD.

$R_u$ 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 D.1 and in the PDD.

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

*$F_{CH4,EL,}$:*
By following calculation option C (that is one of the applicable calculation methods the PDD refers to), the mass flow of greenhouse gas i ($F_{i,t}$) (i = $CH_4$) to the engine-generator set of the project's electricity generation infrastructure ($F_{CH4,EL,y,genset}$) is determined as follows:

$F_{CH4,EL,y,\ genset} = V_{t,wb,n,genset} * v_{CH4,t,wb} * \rho_{CH4,n}$

Where:

$V_{t,wb,n,genset}$ Volumetric flow of the gaseous stream (LFG) to the engine-generator set in time interval *t* on a wet basis at normal conditions. For the considered monitoring period, every-minute values of the calculation parameters $V_{t,wb,n.genset}$ are calculated and

reported (in $Nm^3$ wet gas/h) in the emission reduction calculation spreadsheets valid for the considered monitoring period (and enclosed to the Monitoring Report). While in the particular case of the project activity, during the considered monitoring period, measurements of volumetric flow of the gaseous stream (LFG) sent to the engine-generator set are not processed and recorded in $Nm^3$ of wet gas/h (normal conditions), values of $V_{t,wb,n,genset}$ valid for each minute encompassed by monitoring period are thus calculated as follows:

Under conformance with related provisions of the PDD, the following equation is used to convert the measured volumetric flow of LFG sent to the engine-generator sets from actual conditions to normal conditions of temperature and pressure:

$$V_{t,wb,n,genset} = V_{t,wb,genset} * (T_n / T_{tgenset}) * (P_{tgenset} * P_n)$$

Where:

$V_{t,wb,genset}$ Volumetric flow of the gaseous stream (LFG) to the engine-generator set in time interval *t* on a wet basis at actual conditions. Every-minute values of $V_{t,wb,genset}$ for the engine-generator set are reported (in $m^3$ wet gas/h) in the emission reduction calculation spreadsheets enclosed to the Monitoring Report. Further monitoring details about the parameter $V_{t,wb,genset}$ are included under details for the monitoring parameter $V_{t,wb,flare,j}$ in Section D.2.

$T_{tgenset}$ Temperature of the gaseous stream in time interval *t*. Every-minute values of $T_{tgenset}$ for the engine-generator set are reported (in Kelvin) in the emission reduction calculation spreadsheets enclosed to the Monitoring Report. Further monitoring details about the parameter $T_{tgenset-n}$ are included under details for the monitoring parameter $T_t$ in Section D.2.

$T_n$ 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 D.1 and in the PDD.

$P_{tgenset}$ Pressure of the gaseous stream in time interval *t*. Every-minute values of $P_{tgenset}$ for the engine-generator set are reported (in Pa) in the emission reduction calculation spreadsheets enclosed to the Monitoring Report. Further monitoring details about the parameter $P_{tgenset}$ are included under details for the monitoring parameter $P_t$ in Section D.2.

$P_n$ 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 D.1 and in the PDD.

All related calculation are presented in the emission reduction calculation spreadsheets that are enclosed to the Monitoring Report.

$v_{CH4,t,wb}$ Volumetric fraction of $CH_4$ in the gaseous stream in time interval *t* on a wet basis. Further monitoring details about the monitoring parameter $v_{CH4,t,wb}$ are included above and in Section D.2.

$\rho_{CH4,n}$ Density of $CH_4$ in the gaseous stream (LFG) at normal conditions. $\rho_{CH4,n}$ is calculated as 0.7156650 $kgCH_4$ / $m^3CH_4$ as reported in the emission reduction

calculation spreadsheet valid for the considered monitoring period. Details about the determination of $\rho_{CH4,n}$ are presented above.

*Determination of $PE_{flare,y}$:*

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

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

Where:

$F_{CH4,RG,m}$ Methane mass flow in the residual gas of the flare. For each minute *m* of the considered monitoring period, values for $F_{CH4,RG,m}$ are equal to every-minute reported measurement records of the calculation sub-parameter "Amount of methane in the LFG which is sent to the flare" ($F_{CH4,sent\_flare,y}$).

$\eta_{flare,m}$ Flare efficiency in minute m. For the considered monitoring period, $\eta_{flare,m}$ is determined by following applicable guidance as per Option A (Default value) of the methodological tool "Project emissions from flaring" from which the following related guidance of the PDD is applied:

> *"(…)*
>
> ***Option A: Default value***
>
> *The flare efficiency for the minute m ($\eta_{flare,m}$) is 90% when the following two conditions are met to demonstrate that the flare is operating:*
>
> *(1) The temperature of the flare ($T_{EG,m}$) and the flow rate of the residual gas to the flare ($F_{RG,m}$) is within the manufacturer's specification for the flare ($SPEC_{flare}$) in minute m;*
> *(2) The flame is detected in minute m ($Flame_m$).*
>
> *Otherwise $\eta_{flare,m}$ is 0%.*
>
> *(…)"*

*Meeting of applicable flare operational criteria/requirements:*

As per the applied monitoring procedure, compliance with operational and maintenance requirements for the flare, 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 $\eta_{flare,m}$ for the determination of $F_{CH4,PJ,y} = F_{CH4,flared,y}$ along the considered monitoring period. This is reflected in the 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 $\eta_{flare,m}$ for the determination of values of $F_{CH4,PJ,y} = F_{CH4,flared,y}$ along the considered monitoring period. This is also reflected in the emission reduction spreadsheet.

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 provided by the manufacturer's specifications for operating conditions as per the ex-ante determined parameter $SPEC_{flare}$ (min. and max. flow of LFG to the flare + min and max. temperature of exhaust gas of the flare + meeting of maintenance requirements) are also considered in the context of the application of determined values for $\eta_{flare,m}$ along the considered monitoring period. As outlined in the emission reduction spreadsheets, for each minute *m* within the considered monitoring period when the flare have combusted LFG by not operating in accordance with all the operational criteria/requirements 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 as part of the calculation values of $F_{CH4,PJ,y} = F_{CH4,flared,y}$ achieved by the project activity. The emission reduction calculation spreadsheets enclosed to the Monitoring Report includes the compliance/meeting of all the operational criteria/requirements as established by the ex-ante estimated parameter $SPEC_{flare}$ (in terms of LFG flow, temperature of exhaust gas or maintenance practice) during every single minute of the considered monitoring period.

For the considered monitoring period, the accumulated value for $F_{CH4,PJ,y} = F_{CH4,flared,y} + F_{CH4,EL,y}$ is calculated as 1,327 $tCH_4$.

For the considered monitoring period, baseline emissions of methane from the SWDS ($BE_{CH4,y}$) are calculated as 29,858 $tCO_2e$.

The summarized emission reduction calculation spreadsheets (that are enclosed to this Monitoring Report) summarizes the determination of $BE_y = BE_{CH4,y} + BE_{EC,y}$ for the considered monitoring period. For the considered monitoring period, $BE_y$ = 32,995 $tCO_2e$

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

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As outlined in the registered PDD, the operation of the project activity requires consumption of grid-sourced electricity. As also established in the PDD, 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 PDD, project emissions ($PE_y$) for the considered monitoring period are determined (in $tCO_2e$) as follows:

$PE_y = PE_{EC,grid,y}$[9]

Where:

$PE_{EC,grid,y}$ Project emissions due to the consumption of grid-sourced electricity by the project activity. $PE_{EC,grid,y}$ is calculated as per the "Tool to calculate baseline, project and/or leakage emissions from electricity consumption" as follows:

[9] It is important to note that the PDD also refers to project emissions from a backup captive off-grid electricity generator (fuelled by Diesel). However, while not backup electricity generator was so far installed as part of the project activity, such component is thus not considered for the calculations of project emissions.

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

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 D.1 and in the PDD.

$EC_{PJ,grid,y}$ Quantity of grid sourced electricity consumed by the project activity in year *y* (in MWh). As per the applied monitoring procedure, 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) |
|---|---|
| Jul. 2014 | 0.774 |
| Aug. 2014 | 1.796 |
| Sep. 2014 | 1.755 |
| Oct. 2014 | 1.306 |
| Nov. 2014 | 0.863 |
| Dec. 2014 | 0.643 |
| Jan. 2015 | 1.362 |
| Feb. 2015 | 9.369 |
| Mar. 2015 | 2.300 |
| Apr. 2015 | 0.381 |
| May 2015 | 7.843 |
| Jun. 2015 | 2.483 |
| Jul. 2015 (from 01/07/2015 to 14/07/2015) | 0.559 |

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

$EF_{EL,grid,y}$ Emission factor for grid sourced electricity in year *y* (in $tCO_2/MWh$). $EF_{EL,grid,y}$ is determined as the combined margin emission factor ($EF_{grid,CM,y}$) that is calculated as the weighted average of the operating margin and build margin emission factors. To weight these two factors, the default values applicable to both for the 1st crediting period are applied. The combined margin emission factor is thus obtained as follows:

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

Where:

$w_{OM}$ Weighting of operating margin emissions factor. $w_{OM}$ is ex-ante selected as 0.25. Further details about the ex-ante selected parameter $w_{OM}$ are included in Section D.1 and in the PDD.

$w_{BM}$ Weighting of operating margin emissions factor. $w_{BM}$ is ex-ante selected as 0.75. Further details about the ex-ante selected parameter $w_{BM}$ are included in Section D.1 and in the PDD.

$EF_{grid,OM,y}$ Operating margin $CO_2$ emission factor in year *y* (in $tCO_2/MWh$). Selected values for the monitoring parameter $EF_{grid,OM,y} = EF_{grid,OM\text{-}DD,y}$ represent the official average annual values for years 2014 and 2015

(0.5837 $tCO_2$/MWh and 0.5597 $tCO_2$/MWh, respectively) as calculated and published by the DNA of Brazil. Further details about the monitoring parameter $EF_{grid,OM}$ are included in Section D.2.

$EF_{grid,BM,y}$ Build margin $CO_2$ emission factor in year *y*. $EF_{grid,BM}$ is ex-ante determined as 0.2963 $tCO_2$/MWh. Selected values for the monitoring parameter $EF_{grid,BM,y}$ represent the official average annual values for years 2014 and 2015 (0.2963 $tCO_2$/MWh and 0.2553 $tCO_2$/MWh, respectively) as calculated and published by the DNA of Brazil. Further details about the monitoring parameter $EF_{grid,OM}$ are included in Section D.2.

For the considered monitoring period, $EF_{EL,grid,y}$ is thus calculated as 0.440 $tCO_2$/MWh and 0.4075 for the years of 2014 and 2015, respectively.

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 17 $tCO_2$ (rounded value).

The summarized emission reduction calculation spreadsheet (that is enclosed to this Monitoring Report) includes all calculations related to the determination of $PE_{EC,grid,y}$ for the considered monitoring period.

### E.3. Calculation of leakage emissions

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Not applicable.

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

| | Baseline GHG emissions or baseline net GHG removals (t $CO_2$e) | Project GHG emissions or actual net GHG removals (t $CO_2$e) | Leakage GHG emissions (t $CO_2$e) | GHG emission reductions or net anthropogenic GHG removals (t $CO_2$e) | | |
|---|---|---|---|---|---|---|
| | | | | Before 01/01/2013 | From 01/01/2013 | Total amount |
| **Total** | 32,995 | 17 | - | - | 32,987 | 32,978 |

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

| Amount achieved during this monitoring period (t $CO_2$e) | Amount estimated ex ante (t $CO_2$e) |
|---|---|
| 32,978 | 66,642[10] |

### E.6. Remarks on increase in achieved emission reductions

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Achieved emission reductions for the project activity are about ~51% lower than the calculated value of ex-ante estimation of emission reductions as per the PDD that is valid for the considered 379-day monitoring period within years 2014 and 2015. The following aspect justifies and explains the relative difference between such value for ex-ante estimation of emission reductions as per the

[10] The 66,642 $tCO_2$e value is calculated as the sum of the of the estimated total emission reductions for year 2014 to be achieved during the 184-day length considered monitoring period within year 2014 (31,211 $tCO_2$e) and the share of the estimated total emission reductions for year 2015 to be achieved during the 195-day length considered monitoring period within year 2015 (calculated as 66,320 $tCO_2$e * 195 / 365)

PDD (calculated as applicable for the considered monitoring period) and emission reductions actually achieved by the project activity during the considered monitoring period:

Aspect/condition which represents a decrease 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:

1) *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 Canhanduba landfill and collected by the project activity was derived by applying the First Order Decay (FOD) model as per the methodological tool "Emission from Solid Waste Disposal Sites" (version 06.0.1) in the context of the determination of ex-ante estimated emission reductions to be achieved during the 1st 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 overestimated the amount of LFG to be actually generated and collected by the project activity. In this particular context, it is crucial to note that, while the PDD assumes a LFG collection efficiency of 92.80% (ex-ante determined parameter "Efficiency of the LFG capture system that will be installed in the project activity" ($\eta_{PJ}$)) in the context of the ex-ante estimates of emission reductions, as outlined in Section A.1 and B.2, during the considered monitoring period there were relevant number of LFG collection wells and conventional LFG venting/combustion drains that were not connected to project activity, thus negatively affecting the collection efficiency of LFG generated in the site during the considered period. Besides of minor uncertainty aspects, this particular aspect represents a relevant negative impact over emission reductions achieved during the period (when compared to estimates in the PDD).

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## Document information

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

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