# Project design document form
## (Version 11.0)

| BASIC INFORMATION | |
|---|---|
| **Title of the project activity** | Caieiras landfill gas emission reduction |
| **Scale of the project activity** | ☒ Large-scale<br>☐ Small-scale |
| **Version number of the PDD** | 11.0 |
| **Completion date of the PDD** | 15/06/2020 |
| **Project participants** | Essencis Soluções Ambientais S.A.<br>Nordic Environment Finance Corporation |
| **Host Party** | Brazil |
| **Applied methodologies and standardized baselines** | ACM0001 - “Flaring or use of landfill gas” (version 19.0) |
| **Sectoral scopes** | Sectoral Scope:<br>13 - Waste handling and disposal |
| **Estimated amount of annual average GHG emission reductions** | 1,555,637 $tCO_2e$ |

# SECTION A. Description of project activity

## A.1. Purpose and general description of project activity

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*Summarized description of the project activity:*

The registered CDM project activity "Caieiras landfill gas emission reduction" promotes methane destruction through collection and combustion of landfill gas (LFG) at the UVS - Caieiras landfill[1]. As per its actual project design configuration, combustion of collected LFG occurs in the following methane destruction devices:

- Set of high temperature enclosed flares
- Set of internal combustion gas engines (which since July/2016 represents, at the same time, (i) additional/alternative methane destruction devices for the project activity and (ii) the major components for a grid-connected electricity generation infrastructure fuelled by LFG and under operation within the geographical limits of the UVS – Caieiras landfill also since July/2016)[2].

LFG (which is rich in methane ($CH_4$) has been historically generated at the UVS - Caieiras landfill as a result of anaerobic decomposition of municipal solid waste (MSW) disposed in this solid waste disposal site (SWDS).

By promoting effective and efficient collection and combustion of LFG at the UVS - Caieiras landfill, the project activity thus promotes real and measureable greenhouse gas (GHG) emission reductions through destruction of methane in the project's methane destruction devices. It is assumed that, in the absence of the project activity, methane would otherwise be directly emitted into the atmosphere.

It is relevant to note that, due to the reasons and aspects further explained in Section A.3, the project activity does not encompass electricity generation (using LFG as renewable energy source) as an additional GHG abatement measure. Due to that, no emission reductions associated to generation of electricity since July/2016 in the grid-connected electricity generation infrastructure fuelled by LFG (for which the set of internal combustion gas engines represents the major components) will be accounted as part of the operation of the project activity during its 3rd and last

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[1] The designation of the landfill hosting the project activity was changed in early 2017 from "CTR Caieiras landfill" to "UVS - Caieiras landfill", where UVS stands for "*Unidade de Valorização Sustentável*" in Portuguese language (contextually translated into English language as *"unit for sustainable valuation (of solid waste)"*). Such occurred change in the designation of the landfill was promoted by the project participant and project owner Essencis Soluções Ambientais S.A. as part of the operationalization of the company's commercial, marketing and sustainability strategy. As outlined in previous versions of the PDDs valid for both the 1st and 2nd 7-year crediting periods of the project activity, the landfill hosting the project activity was previously named/designated as "CTR Caieiras landfill", where CTR Caieiras is an abbreviation (in Portuguese language) for "Centro de Tratamento de Resíduos Caieiras" (which is translated in English language as Caieiras Waste Treatment Center). The occurred change in the designation of the landfill does not represent any change in its design and/or operation.

[2] As summarized in both Section A.3 and Appendix 7, methane destruction through combustion of LFG (rich in methane) also occurring in a set of internal combustion gas engines (since July/2016) represents previously assessed and approved post-registration permanent changes in the project design. Meeting of electricity demand of the project activity with electricity generated by a backup captive off-grid electricity generator (fuelled by diesel) (under occasions of interruption of supply of grid-sourced electricity to the project activity) represents other previously assessed and approved permanent post-registration change in the project design.

*Non-inclusion of electricity generation as additional GHG abatement measure of the project activity under its revised design configuration (and consequently non-accounting of emission reductions associated to generation of electricity):*

Section A.3 also highlights in Box 2.c the previously decided non-inclusion of electricity generation as additional GHG abatement measure of the project activity (and consequently non-accounting of emission reductions associated to generation of electricity by the grid-connected electricity generation infrastructure fuelled by LFG and located within the geographical limits of the UVS – Caieiras landfill). Thus, emission reductions due to displacement of a more-GHG-intensive service are not eligible and not claimable under the project activity. Methane destruction thus is still representing the only GHG abatement measure of the project activity (under its revised design configuration).

7-year crediting period. The only type of GHG mitigation action encompassed by the CDM project activity “Caieiras landfill gas emission reduction” is destruction of methane emissions. No emission reductions due to displacement of a more-GHG-intensive service (due to generation of electricity using collected LFG as fuel) are thus eligible or claimable for the project activity.

The UVS - Caieiras landfill was built in year 2002. This landfill has been operated by the host country project participant and project owner Essencis Soluções Ambientais S.A. since its commissioning date in September 2002. The UVS - Caieiras landfill is located in the municipality of Caieiras, in São Paulo State, Brazil.

As a summary, the project design (under its actual design configuration) thus encompasses the following:

(i) Forced capturing/collection of LFG at the UVS - Caieiras landfill

(ii) Methane destruction through combustion of collected LFG in high temperature enclosed flares[3]

(iii) Methane destruction through combustion of collected LFG in a set of internal combustion gas engines (which since July/2016 represents, at the same time, (i) additional/alternative methane destruction devices for the project activity and (ii) major components of a grid-connected electricity generation infrastructure fuelled by LFG and located within the limits of the UVS-Caieiras landfill)[4].

(iv) Monitoring of quantity and quality of collected LFG which is sent for combustion in the high temperature enclosed flares and/or in the set of internal combustion gas engines (on an individual basis) as well as monitoring of conditions/status of occurrence of LFG combustion in each one of these methane destruction devices in order to both determine combustion efficiency for the flares (in terms methane destruction) and monitoring the operational status/conditions of equipment that consumes LFG (methane destruction devices) as required by applied CDM baseline and monitoring methodologies and applicable methodological tools[5].

(v) Monitoring of consumption of grid-sourced electricity by the project activity, electricity sourced by the backup captive off-grid electricity generator (fuelled by diesel)[6] and fossil fuel (LPG) consumed by the project activity

Equipment and infrastructure installed and/or monitored as part of the project activity (under its revised design configuration) thus encompasses the following:

- a LFG collection network comprising a constantly growing number of vertical LFG collection wells (with eventual implementation of horizontal LFG collection trenches being also

[3] As outlined in Section A.3, the project’s description in terms of LFG flaring infrastructure currently encompasses the installation and operation of 4 high temperature enclosed flares, of which specifications are also detailed in Section A.3 and B.6.2 (ex-ante determined parameter $SPEC_{flare}$). The number of operational flares may however temporarily or permanently change along the 3rd and last 7-year crediting period of the project acticity as a response to change in the quantity of collected LFG available to be combusted by flaring (as part of the operation of the project activity).

[4] Under normal operational conditions, the largest share of LFG collected as part of the operation of the project activity is expected to combusted in the set of internal combustion gas engines (which represents, at the same time, (i) alternative methane destruction devices for the project activity and (ii) the major components for a grid-connected electricity generation infrastructure located within the geographical limits of the UVS – Caieiras landfill). However, under events of temporary planned or unplanned interruption of operation of these set of engines, all collected LFG may be sent for combustion in the set of high temperature enclosed flares.

[5] Monitoring of the operational status/conditions of the set of internal combustion gas engines that consume collected LFG may be made inter-alia through monitoring of the amount electricity generated by the electricity generation infrastructure (of which the set of engines represents major components) on an individual or aggregated basis.

[6] As further explained in Section B.6.1, four methodological options are considered for the determination of project emissions due to the consumption of electricity supplied by the project’s backup captive off-grid electricity generator fuelled by diesel. As per these options, quantity of electricity generated and/or consumption of diesel and/or nameplate installed capacity of equipment and/or operational time of power generation equipment will be considered.

considered[7]);

- a LFG flaring station (currently comprising 4 high temperature enclosed flares[8] and all required monitoring and control systems);

- a set of internal combustion gas engines (which since July/2016 represents, at the same time, (i) additional/alternative methane destruction devices for the project activity and (ii) major components of a grid-connected electricity generation infrastructure fuelled by LFG and located within the limits of the UVS-Caieiras landfill). Such electricity generation infrastructure comprises container-based modular engine-generator packages + ancillary equipment and systems (with phased/gradual implementation in terms of combined nameplate installed capacity[9]) of which operation has started in July/2016 (under its implementation phase 1 encompassing 29.4 MW of combined nameplate installed capacity) and with forecasted final total combined nameplate installed capacity of 37.8 MW (under its final configuration of which starting of operations is currently expected to occur in year 2022);
- a backup captive off-grid electricity generator (fuelled by diesel). Such backup electricity generation source is expected to be used only under temporary circumstances of interruption of the supply of grid-sourced electricity to the project activity which would temporarily not allow the project's electricity demand cannot be met by imports of grid-sourced electricity due to[10] [11].

*Summarized description of the baseline scenario under the 3rd and last 7-year crediting period:*
For the 3rd and last 7-year crediting period of the project activity, the baseline scenario for LFG management at the UVS - Caieiras landfill (in terms of emissions of methane at the UVS - Caieiras landfill) remains being the same as the scenario existing prior to the implementation of the project activity at this landfill:

- LFG generated at the UVS - Caieiras landfill (with high content of methane) being freely directly emitted into the atmosphere without any treatment, collection, continuous combustion or control through the surfaces of the landfill (with small fraction being destroyed through combustion in conventional passive LFG venting/combustion drains in

[7] In April/2020, there was no horizontal LFG collection well/trench yet implemented as part of the project activity.

[8] In April/2020 there were 4 high temperature enclosed flares installed as part of the project activity of which only 2 have been under continuous operations. The number of operational high temperature enclosed flares may permanently or temporarily change during the 3rd and last 7-year crediting period of the project activity. In case of occurrence of permanent change of the number of installed flares, this will be opportunely addressed as per applicable guidance for addressing post-registration changes in the project design. Specification details for the currently installed high temperature enclosed flares are included in Section A.3.

[9] As per the recently revised and currently valid implementation schedule for the set of internal combustion gas engines (described in Section A.3), a total of additional 6 container-based modular engine-generator packages (+ all required ancillary equipment/devices) are expected to be become under operational status (starting operating) in years 2022 (6 years after the occurred commissioning and starting of operations of its 1st implementation phase occurred in July/2016 and encompassing the currently installed 21 modular engine-generator packages). Gradual/phased implementation of additional internal combustion gas engines is expected to occur in line with per forecasted expected increase in the amount of LFG to be collected as part of the project activity and addressing of potential LFG qualitative/quantitative risks, if applicable (i.e. eventual high content of contaminants in collected LFG and difficulties for performing related required LFG treatment/cleansing (removal of contaminants in collected LFG (i.e. furans and siloxanes), thus avoiding damages in such engines). Further details about the currently forecasted implementation schedule for the additional internal combustion gas engines are included in Section A.3.

[10] Specification details for the backup captive electricity generator (fuelled by diesel) are also included in Section A.3.

[11] As further explained in Sections B.6.1, B.7.1 and B.7.3, the project activity does not encompass electricity generation as an additional GHG abatement/mitigation measure. Thus, consumption by the project activity of electricity generated by the grid-connected electricity generation infrastructure fuelled by LFG located within the geographical limits of the UVS – Caieiras landfill (of which the set of internal combustion gas engines represents the major components) will always be accounted as consumption of grid-sourced electricity (with related project emissions being determined ex-post).

order to address safety and/or odor concerns[12]).

- Under the baseline scenario, it is still being assumed that in the absence of the project activity, only a minor fraction of generated LFG would be combusted in such conventional passive LFG venting/combustion drains.

*GHG emission reductions to be achieved by the project activity during its 3rd and last 7-year crediting period:*
By promoting permanent and real destruction of methane, the project activity is expected to promote total combined GHG emission reductions of 10,889,458 $tCO_2e$ during its 3rd and last 7-year crediting period. This value is equivalent to average annual GHG emission reductions of 1,555,637 $tCO_2e$/year.

*Environmental and climate change positive aspects of the project activity:*
While methane is a powerful greenhouse gas (GHG), the pre-project situation of emission of LFG into the atmosphere thus contributes to global warming. Collection and combustion of LFG promote real and permanent abatement of GHG emissions at the UVS - Caieiras landfill.
Besides climate change mitigation, the project activity provides other important local environmental benefits: LFG contains trace amounts of volatile organic compounds, which are regarded as local air pollutants. Capturing of LFG using an active forced collection system and its combustion thus also promote reduction of emission of local pollutants.

As officially acknowledged in the Letter of Approval (LoA) for the project activity that was issued by the Designated National Authority (DNA) of Brazil, the project activity contributes towards Sustainable Development in Brazil.

*Other contribution of the project activity towards Sustainable Development locally and in the whole country Brazil:*
The project also provides the following additional important local environmental and social benefits:
- Destruction of other air pollutants, such as hydrogen sulphide, that is present in trace quantities in LFG;
- Improved LFG management at the UVS - Caieiras landfill promotes reduction of risks of occurrence of fire and explosion at the landfill as well as reduction of odor;
- Potential of promotion of local job opportunities

*Non-representing of CPA excluded from a previously registered PoA:*
While registered under the CDM since 09/03/2006, the project activity does not represent a Component Project Activity (CPA) that has been excluded from a previously registered CDM Programme of Activities (CDM-PoA) as a result of erroneous inclusion of CPAs.

## A.2. Location of project activity

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The project activity is located in the Municipality of Caieiras, State of São Paulo within the South-Eastern Region of the Federal Republic of Brazil.

Physical/Geographical location of the project activity:

The project activity is implemented within the limits of the UVS - Caieiras landfill. The UVS - Caieiras landfill is located on the extreme Northeast of Caieiras municipality, on the Metropolitan Area of São Paulo (RMSP). The site has a total area of 3,500,000 m² (of which 1,620,000 m² area covered with forest will remain being preserved forming a Transaction Area as required by municipal legislation). Part of the landfill area is located within the limits of Franco da Rocha

[12] The baseline condition/situation involving destruction of small share of LFG in the pre-project conventional and passive LFG venting/combustion drains (including its continuation the 3rd and last 7-year crediting period) for address safety and odour concerns is further explained in Section B.6.1.

municipality. This area has not been used for waste disposal purposes and it has also been preserved as required by applicable legislation. The site access is through Bandeirantes Highway, km 33.

The project geographical coordinates are as follows:

- Latitude: 23º 20' 36" S or -23.343232
- Longitude: 46º 46' 11" W or -46.769788

The following pictures show the location of the project activity (which is implemented at the UVS - Caieiras landfill) within the limits Brazil, State of São Paulo and municipality of Caieiras:

**Map 1 - Location of the city of Caieiras within Brazil and São Paulo State**

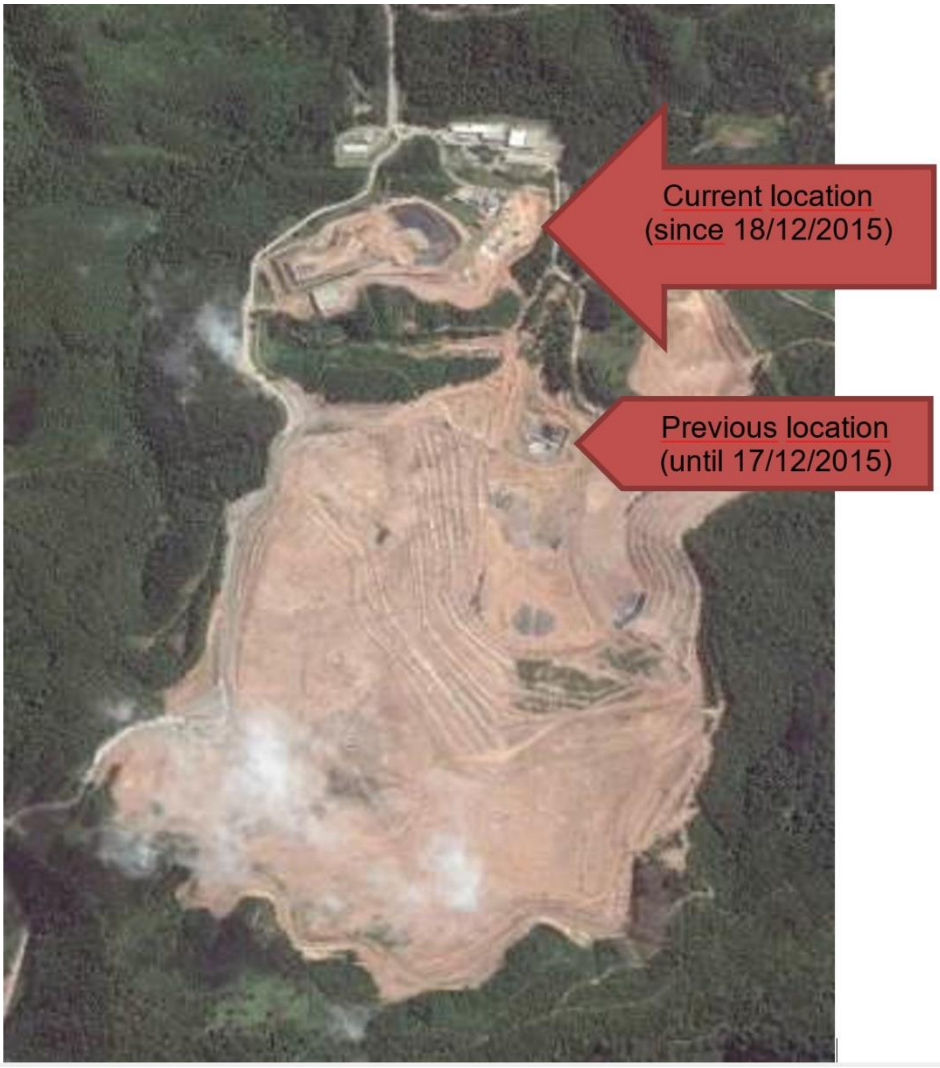


**Figure 1 - Aerial view of the location of the UVS - Caieiras landfill**

(as visible in May/2013 by using Google Earth PC application)

(The arrows highlight the location of the project's LFG flaring station (high temperature enclosed flares) as per its previous (until 17/12/2015) and current location (since 18/12/2015)).

**Figure 2 – Zoom Aerial view of the previous location of the project activity's LFG flaring infrastructure within the UVS - Caieiras landfill**

**(previous configuration under operation until 17/12/2015)**

(as visible in May/2013 by using Google Earth PC application)

(The arrow highlights the former location of the existent high temperature enclosed flares in May/2013[13])

[13] The project participant Essencis Soluções Ambientais S.A. highlights that the location of the high temperature enclosed flares and other project equipment was gradually changed during the initial phase of the currently expired 2nd 7-year crediting period due to the previously conceived management plan for the UVS - Caieiras landfill. The area within the UVS - Caieiras landfill where the project's LFG destruction unit was previously located was converted into a MSW disposal area.

**Figure 3 – Aerial and zoom aerial views of the current location of the project activity within the UVS - Caieiras landfill (current project location (since 18/12/2015))**[14]

(as visible in May/2018 by using Google Earth PC application)

[14] The project participant Essencis Soluções Ambientais highlights that the location of the high temperature enclosed flares and other project equipment was gradually changed during the initial phase of the currently expired 2nd 7-year crediting period due to the previously conceived management plan for the UVS - Caieiras landfill. The area within the UVS - Caierias landfill where the project's LFG destruction unit was previously located is converted into a MSW disposal area.

### A.3. Technologies/measures

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*Pre-project situation at the UVS - Caieiras landfill:*

Municipal Solid Waste (MSW) disposal at the UVS - Caieiras landfill started in September 2002. At the time of occurred project initial design conceptualization + CDM consideration (period encompassing years 2004 and 2005)[15], it was expected that an average daily MSW disposal rate of about 4,000 ton of MSW per day would not be exceeded at the landfill. However, this MSW disposal rate stream forecast was actually significantly exceed (and are expected to remain exceeding such earlier forecasts) due to the following reasons and operational aspects valid for the UVS - Caieiras landfill:

- From March/2007 onwards, other landfills (which at that time were also used for disposal of MSW generated in the large city of São Paulo and surrounding cities) faced the following relevant operational problems:
  - Initially, the Bandeirantes landfill (which was a public owned landfill) was finally closed on March/2007 after reaching its final and total MSW disposal capacity. As a result of that, all MSW streams which were used to be disposed in the Bandeirantes landfill at that time thus started to also being disposed in the UVS - Caieiras landfill. This decision of the administrative authorities of São Paulo region resulted in increase of the average daily MSW disposal rate at the UVS - Caieiras landfill[16].

  - Later in August/2007, an unfortunate and unexpected severe accident event happened in the São João landfill (other public owned landfill also serving the city of São Paulo and surrounding cities): slide of significant amount of disposed MSW. As a consequence of this severe accident, MSW disposal activities occurring at that time in that landfill were interrupted (with later permanent closure of the landfill being approved). Due to that, significant part of the daily MSW disposal stream that used to occur at this landfill were directed to the UVS - Caieiras landfill, thus further increasing the daily average MSW disposal rate in the UVS - Caieiras landfill

  While the permanent interruptions of MSW disposal activities at the Bandeirantes and São João landfills + closure of these landfills were decisions made by the environmental authority for the São Paulo State[17], the later decision of having an incremental amount of MSW being regularly disposed at the UVS - Caieiras landfill was a decision made by the administrative authorities of the municipality of São Paulo. As a direct result of the events summarized above, in year 2007 there was an accounted increment in the annual amount of waste disposed at the UVS - Caieiras landfill of about 149% (when compared to the previous year).

  For year 2008, the increment in the annual amount of waste disposed at the landfill is accounted as being about 37% when compared to the previous year.

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[15] As previously indicated in the latest version of the registered PDD valid for the currently expired 1st 7-year crediting period of the project activity, the time period encompassing years 2004 and 2005 is when the initial conceptualization of the general design of the project activity occurred. This period is also when CDM consideration occurred. All data, information and details applicable, valid and/or available in the context such initial project design conceptualization and CDM consideration period are referred in this revised version of the PDD with the reference "*at the time of occurred project design initial conceptualization + CDM consideration*" and thus refer to information dated, valid and/or available at the period encompassing years 2004 and 2005. The following definition of "CDM consideration as per applicable CDM rules (i.e. CDM Project Standard for Project Activities) is relevant:

> The time of "occurred CDM consideration" refers to the time within the investment decision-making process for implementing the project when ***"CDM benefits were considered necessary in the decision to undertake the project" (i.e. "(…) benefits of the CDM were a decisive factor in the decision to proceed with the project)."***

[16] 7,500 ton of MSW per day were the amount of MSW daily disposed at the Bandeirantes landfill at the time of its closure in year 2007. Waste stream formally disposed in this landfill started to be also disposed in the UVS - Caieiras landfill at that time, thus increasing its daily MSW disposal rate.

[17] The competente environmental authority in São Paulo State is Companhia de Tecnologia de Saneamento Ambiental – (CETESB).

The occurred heavily increment in the amount of MSW actually disposed in the UVS - Caieiras landfill (which has obviously resulted in a significant increase in the amount of LFG being generated at this landfill and significant increase in the amount of LFG collected and destroyed by the CDM project activity "Caieiras landfill gas emission reduction" from the end of year 2007 onwards) was a direct consequence of decisions made by third party entities. With more LFG being collected and destroyed, baseline emissions and emission reductions achieved by the project activity also increased accordingly. This is correct since in the absence of the project, incremental amount of LFG (rich in methane) would be emitted into the atmosphere at the landfill. It is also important to note that in the absence of the CDM project activity (baseline scenario), the occurred significant increment of MSW disposal rate at UVS - Caieiras landfill would happen anyway. Thus, baseline emissions are demonstrated not to be artificially or voluntarily "inflated" by the project participants[18].

The pre-project situation (situation prior to the implementation of the project activity) represents the non-existence of appropriate equipment and practice dedicated to promote effective LFG collection and destruction at the landfill site.

As part of the previously performed CDM validation for the project (in year 2005), the pre-project situation was demonstrated to represent the baseline scenario for the project activity with conventional and to some extent rudimentary conventional passive LFG venting/combustion drains being used in the landfill's MSW disposal area to allow sporadic passive combustion of LFG[19] (in order to avoid significant accumulation of LFG in the inner section of the landfill and thus reducing the risk of fire and explosions (safety concerns) and also address odor concerns).

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[18] The previously occurred significant increase in daily MSW disposal at the UVS - Caieiras landfill was successfully previously addressed in a revised version of the PDD valid for the currently expired 1st crediting period of the project activity and it was validated by a Designated Operational Entity (DOE) in the context of a submission of request of approval of post-registration changes (as part of the 5th periodic verification for the project activity - monitoring period from 01/10/2010 to 31/08/2011) which was approved by the CDM-EB with ref. PRC-0171-001. Information related to such submission (incl. related documents) is available online:

PRC-0171-001: https://cdm.unfccc.int/PRCContainer/DB/prcp844165620/view

The revised version of the PDD which addresses such corrections (which does not affect the project design) (PDD version 4, dated 10/01/2013) was effectively previously approved by the CDM-EB on 27/05/2013.

[19] As further explained and justified in Section B.6.1, the pre-project conventional LFG venting/combustion drains (which are assumed to be the only LFG management infrastructure to be used along the baseline scenario) are of somehow rudimentary design and, in most of the cases, such drains do not allow continuous combustion of LFG as these rudimentary LFG management solutions are not conceived/designed for ensuring continuous or efficient combustion of LFG. LFG has never been continuously combusted in the pre-project passive LFG venting/combustion drains available prior to the implementation of the project activity due to the following reasons/aspects:

- Design aspects and operational conditions of the conventional LFG venting/combustion drains (such as the diameter of the LFG venting drains, average pressure of LFG in the drains, influence of wind and other climate aspects (e.g. rains)),
- Typical operational conditions at the UVS - Caieiras landfill prior to the implementation of the project activity (where no working staff has ever been required to attempt ensuring continuous combustion of LFG in the drains and/or monitor the conditions/status of such drains (e.g. regular checking whether the drains are alight));
- There are still no applicable legal/regulatory requirements to collected and destroy or utilize methane in the UVS - Caieiras landfill.
- In the absence of the project activity (baseline scenario), as the operator of the UVS - Caieiras landfill, Essencis Soluções Ambientais S.A. would not have any real incentive or obligation to convert the existing LFG venting/combustion drains into a more appropriate LFG flaring system/solution as such conversion would represent additional costs. Moreover, in the absence of the project activity (baseline scenario), as the operator of the UVS - Caieiras landfill, Essencis Soluções Ambientais S.A. would not have any obligation to promote combustion of LFG in a set of internal combustion gas engines either.

Thus, in the absence of the proposed CDM project activity, it is assumed that continuous combustion of LFG in the pre-project/baseline drains (including additional drains that would be otherwise installed instead of the project's LFG collection wells) would not be a practice under the baseline scenario (including during the time period encompassed by the 3rd and last 7-year crediting period for the currently registered CDM project activity). The practice in the baseline scenario is assumed as being both venting and combustion of LFG under uncontrolled and non-systematic manner in the existent conventional LFG venting/combustion drains.

For the time period encompassing the 3rd and last 7-year crediting period of the currently registered CDM project activity, it is assumed that in the baseline scenario (absence of the proposed project activity), proper infrastructure for promoting effective and more efficient LFG collection and destruction would still being inexistent at the UVS - Caieiras landfill site during the whole period.

Currently (April/2020) there are still no legal municipal, state or national requirements in the municipality of Caieiras, São Paulo State nor in Brazil (respectively) that establish any requirement or guidance in terms of LFG management in new or existing landfills or waste dumpsites[20].

The baseline scenario for emissions of methane ($CH_4$) at the UVS - Caieiras landfill remains being the continuation of the pre-project practice (only a minor share of generated LFG being collected and destroyed by pre-project conventional passive LFG venting/combustion drains at the landfill (and additional drains that would otherwise the installed along the baseline scenario)). The baseline scenario for emissions of methane in the landfill site is therefore identical to the scenario existing prior to the implementation of the project activity (pre-project scenario) and remains unchanged for its 3rd and last 7-year crediting period.

The previously conceived overall design, operation and management plan of the UVS - Caieiras landfill has not compromised or changed as a result of the gradual/phased implementation of the project activity. The previously conceived overall design, operation and management plan of the UVS - Caieiras landfill is not expected to change during the time period to be encompassed by the 3rd and last 7-year crediting period of the project activity either.

While no practice to increase methane generation has ever occurred prior to the implementation of the project activity, none of such practice (to increase methane generation) has ever occurred after the implementation of the project activity either. Furthermore, none of such practices are expected to occur during the time period to be encompassed by the 3rd and last 7-year crediting period of the project activity either. As required by the applied baseline and monitoring methodology ACM0001 (version 19.0), the occurrence or planning of any change in the management of the UVS - Caieiras landfill during the time period to be encompassed by the 3rd and last 7-year crediting period of the project activity will be reported and will be justified by referring to applicable technical or regulatory specifications.

*Technology and measures encompassed by the project design:*
Employed technology encompasses deep improvements of LFG management at the UVS - Caieiras landfill through the installation and operation of an active LFG collection system composed by a LFG collection wells and LFG transportation pipeline network + methane destruction through combustion of collected LFG in high temperature enclosed flares and in set of internal combustion gas engines (which since July/2016 represents, at the same time, (i) additional/alternative methane destruction devices for the project activity and (ii) major components of a grid-connected electricity generation infrastructure fuelled by LFG and located within the limits of the UVS-Caieiras landfill).

Such measures allow methane contained in the LFG to be destroyed, thus avoiding emissions of methane into the atmosphere and, due to that, promoting real and permanent GHG emission reductions.

The project system is to be equipped with all needed monitoring system to ensure that all required measurements and monitoring are performed as established by ACM0001 (version 19.0) and applicable methodological tools. Such measurements include continuous monitoring of LFG flow to the flares and to the internal combustion gas engines, continuous monitoring of methane content in collected LFG, continuous monitoring of operational conditions/status of all elements combusting

[20] Further explanations regarding the expected continuation of the non-obligation of destroying/utilizing LFG (in order to meet legal or regulatory requirements) (also during the time period to be covered by the 3rd and last 7-year crediting period) are presented included in Section B.6.1.

LFG (methane destruction devices), etc.). In summary, the project technology is environmentally safe and sound.

*Destruction of methane in LFG flaring infrastructure:*

The project activity's design and construction encompasses the following characteristics/technology to promote controlled combustion of collected LFG through flaring:

- Safe and low emission combustion of LFG guaranteed by the utilization of high temperature enclosed flares that allow controlled and efficient combustion of LFG;
- Use of best practice safety devices for the flares (such as flame detectors and slam shut valve);
- Continuous measurement of temperature of the exhaust gas of each individual flares (with continuous monitoring of the flare status (with every minute recording of the status signal of flame detectors) being available during the 3rd and last 7-year crediting period).

The expected operational lifetime for the project's LFG collection and flaring infrastructure is at least 20 years. However, related equipment and infrastructure lifetime may even exceed 20 years if required service and maintenance is performed correctly and in case the project activity is always operated as per recommendation and requirements set by manufacturers of included equipment/instruments. No major and further technology or equipment replacement is expected to occur during the 3rd and last 7-year crediting period when compared to the currently existing project's configuration[21]. While the project's LFG collection and flaring infrastructure started its continuous operations (as part of its 1st crediting period) in February/2007[22], thus the remaining operational lifetime for related equipment potentially exceeds 8 years in April/2020.

While ACM0001 (version 19.0) requires ex-post monitoring whether equipment combusting LFG operates under compliance with operational requirements and/or recommendations as set by equipment manufacturer, the main operational characteristics and specifications of high temperature enclosed flares[23] [24] are defined as follows:

[21] The project participant Essencis Soluções Ambientais S.A. acknowledges however that due to malfunction or repair need or even due to the need of meeting calibration requirements, project equipment and/or monitoring instruments may be temporarily or permanently replaced. Furthermore, in order to accommodate projected increment in the amount of LFG to be collected and destroyed by the project activity, additional equipment may be installed during its 3rd and last 7-year crediting period (e.g. additional high temperature flare(s), additional centrifugal blowers, etc.).

[22] The starting of regular and continuous operation of the project activity in February/2007 is reported and assessed in the documentation for the previously performed 1st verification for the project activity (Monitoring Report and Verification Report). These documents are available on-line:

http://cdm.unfccc.int/Projects/DB/DNV-CUK1134509951.62/iProcess/SGS-UKL1195228146.42/view

[23] The currently installed four high temperature enclosed flares are the only equipment combusting LFG installed as part of the project activity of which compliance with specifications should be monitored as per ACM0001 (version 19.0) and applicable methodological tools. Thus, specifications and characteristic of these equipment are thus reported in this Section. The specifications of other ancillary equipment for the project's LFG collection and destruction infrastructure (e.g. centrifugal blowers, valves, flow meters, gas analyzer, etc.) are not presented in the PDD. However, specifications of all equipment and instrument are expected to be regularly reported in the Monitoring Reports to be issued along the 3rd and last 7-year crediting period of the project activity. This is in accordance with applicable guidelines for completing the PDD form and also in accordance with applicable methodological and monitoring requirements as set by ACM0001 (version 19.0) and applicable methodological tools.

[24] The project participant Essencis Soluções Ambientais S.A. acknowledges that additional high temperature enclosed flares may be installed during the 3rd and last 7-year crediting period of the project activity in order to fully accommodate projected increase in the amount of LFG to be collected by the project activity. This is in accordance to the project design conceptualization (which considers gradual installation of additional flares and other equipment (e.g. centrifugal blowers) within the project lifetime in order to address forecasted increase in LFG collection by the project activity).

| LFG combustion flaring equipment | Characteristics/specifications |
|---|---|
| Flare 1<br>Flare 2<br>Flare 3[25] | Manufacturer: BTS - Termodinâmica de Sistemas Ltda.<br>Model: n/a<br>Order Number: 10.196/05 (Flare 1), 10.287/08 (Flare 2), 10.408/11 (Flare 3)<br>Serial Number (S/N): n/a<br>Number of injectors: 5<br>(with new re-designed injectors being installed on 08/06/2015)<br><br>Min. LFG flaring capacity (for continuous operation): 650 $Nm^3/h$<br>Max. LFG flaring capacity (for continuous operation):<br><br>*Flare 2 and Flare 3:*<br>- 7,500 $Nm^3/h$ (since 08/06/2015 09:00 AM, after installation of new and larger LFG injectors)[26]<br><br>*Flare 1:*<br>- 7,500 $Nm^3/h$ (since 08/06/2015 02:00 PM, after installation of new and larger LFG injectors |

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In case of installation of additional flare(s) be indeed confirmed/occurred, information made available in different Sections of this PDD (which outline specifications and/or operational requirements and conditions for the flares) will be updated accordingly by applying applicable CDM procedure for addressing post-registration changes (e.g. correction in information that does not affect the project design). This PDD does not include detailed specifications and maintenance requirements for other equipment which are part of the project activity (e.g. centrifugal blowers, $CH_4$ content gas analyzer unit, LFG pressure and temperature sensors, thermocouples (for measuring temperature of the exhaust gas of the flares), etc.). While, differently than the case of the high temperature enclosed flares, compliance of maintenance requirements and specifications for such additional equipment of the project's LFG collection and flaring infrastructure are not required to be monitored through dedicated monitoring parameters, it is important to note that such equipment (i.e. centrifugal blowers, thermocouples, flow meters) may be changed during the 2nd crediting period (due to malfunction, maintenance schedules, calibration events, etc.). The non-inclusion of specification and maintenance details of such additional equipment in the PDD is in accordance with applicable CDM rules and requirements (incl. requirements of ACM0001 (version 19.0) and applicable guidelines for completing the PDD for a CDM project activity). Details about such additional ancillary equipment (incl. monitoring instruments/equipment) will be made available in the Monitoring Reports for regular monitoring periods for the project activity.

[25] It is relevant to note that Flare 1, Flare 2 and Flare 3 are of identical design and nameplate LFG flaring capacities.

[26] As further explained below in Section A.3 (under "*Box 2.a - Performed service intervention in each one of the installed 4 high temperature enclosed flares on 08/06/2015 for addressing detected undesirable and abnormal intermittent/sporadic vibration + noise problems in the flares (resulting in higher nameplate LFG flaring capacity for each flare)*"), a service intervention was performed in each one of the installed 4 high temperature enclosed flares on 08/06/2015 aiming to address/solve previously detected undesirable and abnormal intermittent/sporadic vibration + noise problems in the installed flares. The performed service intervention included redesign of the LFG burner unit in each flare (through the replacement of the previously existent 5 LFG injectors in the burner unit by 5 new and larger injectors (with higher firing capacity)) + related inspection + testing services. The performed service intervention successfully addressed the previously detected vibration + noise problems in the flares. By making use of slightly larger LFG injectors in the burner unit of the flares, the performed service intervention also resulted in slight increase of the nameplate maximum LFG flaring capacity for each one of the installed flares (as recommended/defined by the flares designer and manufacturer). These changes in the specification of the flares after the performance of the service intervention were confirmed by the flare manufacturer/designer BTS - Termodinâmica de Sistemas Ltda. as follows:

- the recommended minimum flow of LFG to be sent to each flare flaring for combustion (under continuous operation of the flare) remains being 650 $Nm^3/h$ after the performed service intervention as confirmed by BTS - Termodinâmica de Sistemas Ltda.
- as also confirmed by BTS - Termodinâmica de Sistemas Ltda., the recommended maximum flow of LFG to be sent to each flare flaring for combustion (under continuous operation of the flare) was slightly increased to 7,500 $Nm^3/h$ (instead of the previously valid 6,500 $Nm^3/h$ value) after the performed service as being

The flares specification change resulted from the performed service intervention is acknowledged by the manufacturer/designer of the flares as not promoting any adverse impact over the overall functioning of the flares. The occurred service intervention in the flares is addressed as a permanent post-registration change in the project design (since the specifications of the flares are slightly modified).

| | |
|---|---|
| | Min. $CH_4$ destruction efficiency: 99.5%<br>Required min. temperature of the exhaust gas of the flare (to ensure LFG destruction under high $CH_4$ destruction efficiency): 500 $^oC$<br>Required max. temperature of the exhaust gas of the flare (to ensure LFG destruction under high $CH_4$ destruction efficiency): 1,200 $^oC$<br>Required frequency for inspection service (incl. inspection in the conditions of the flare's isolation ceramics revetment material): every 6 months<br>Required replacement for the flare 4" isolation ceramics revetment material: after 10 years of regular and appropriate operation. |
| Flare 4 | Manufacturer: BTS - Termodinâmica de Sistemas Ltda.<br>Model: n/a<br>Order Number: S 10.041/00<br>Serial Number (S/N): n/a<br>Number of injectors: 5<br>(with new re-designed injectors being installed on 08/06/2015)<br><br>Min. LFG flaring capacity (for continuous operation): 650 $Nm^3/h$<br>Max. LFG flaring capacity (for continuous operation):<br>- 7,500 $Nm^3/h$ (since 08/06/2015 02:00 PM, after installation of new and larger LFG injectors<br><br>Min. $CH_4$ destruction efficiency: 99.5%<br>Required min. temperature of the exhaust gas of the flare (to ensure LFG destruction under high $CH_4$ destruction efficiency): 500 $^oC$<br>Required max. temperature of the exhaust gas of the flare (to ensure LFG destruction under high $CH_4$ destruction efficiency): 1,200 $^oC$<br>Required frequency for inspection service (incl. inspection in the conditions of the flare's isolation ceramics revetment material): every 6 months<br>Required replacement for the flare isolation ceramics revetment material: after 10 years of regular and appropriate operation. |

Source: Equipment technical declarations made available by BTS - Termodinâmica de Sistemas Ltda. (dated April/2013 / May/2016) [27].

The pictures below outline the main equipment/infrastructure of the project's LFG collection and flaring infrastructure (as per the project implementation/configuration available in May/2013 (prior of the occurred gradual moving of the project's LFG flaring infrastructure) and in May/2016 (after the occurred moving of the project's LFG flaring infrastructure to its current location)[28]).

[27] Upon request of Essencis Soluções Ambientais S.A., BTS - Termodinâmica de Sistemas Ltda. issued a technical declaration dated 04/05/2016 including details of the performed service intervention in each one of the flare on 08/06/2015 (that aimed to address previously detected abnormal noise and vibrations in the flares) and declaring/confirming *inter alia* the following:

(i) confirmation that, as a resulted of performed service, the nameplate maximum LFG flow for each one of the flares was changed from 6,500 $Nm^3/h$ to 7,500 $Nm^3/h$

(ii) confirmation that overall functioning of the flares (incl. expected methane destruction efficiency when flares are appropriately operated) is not negatively affected by the performed service intervention.

[28] The project participant Essencis Soluções Ambientais S.A. highlights that although the applied technology is expected to remain unchanged, the current project configuration may change in the future with the installation of additional equipment (e.g. additional centrifugal blower(s) and/or additional high temperature enclosed flare(s)) in order to accommodate forecasted increase in the amount of LFG collected by the project activity. Furthermore, as outlined in Box. 3 below, as per the previously made plan/forecast of Essencis Soluções Ambientais S.A. for MSW disposal at the UVS - Caieiras landfill, the area where the project's LFG flaring infrastructure was previously located will be used for disposal of MSW. Due to that, the whole project's LFG flaring infrastructure (incl. the installed flares, centrifugal blowers, safety system/equipment and monitoring equipment/instruments) was moved to another area/region within the UVS - Caieiras landfill.

In Section B.3, a schematic flow diagram that summarizes the project boundary and delineates the project activity (equipment, parameters to be monitored, and GHGs included in the project boundary) complements information about the project's main equipment/infrastructure.

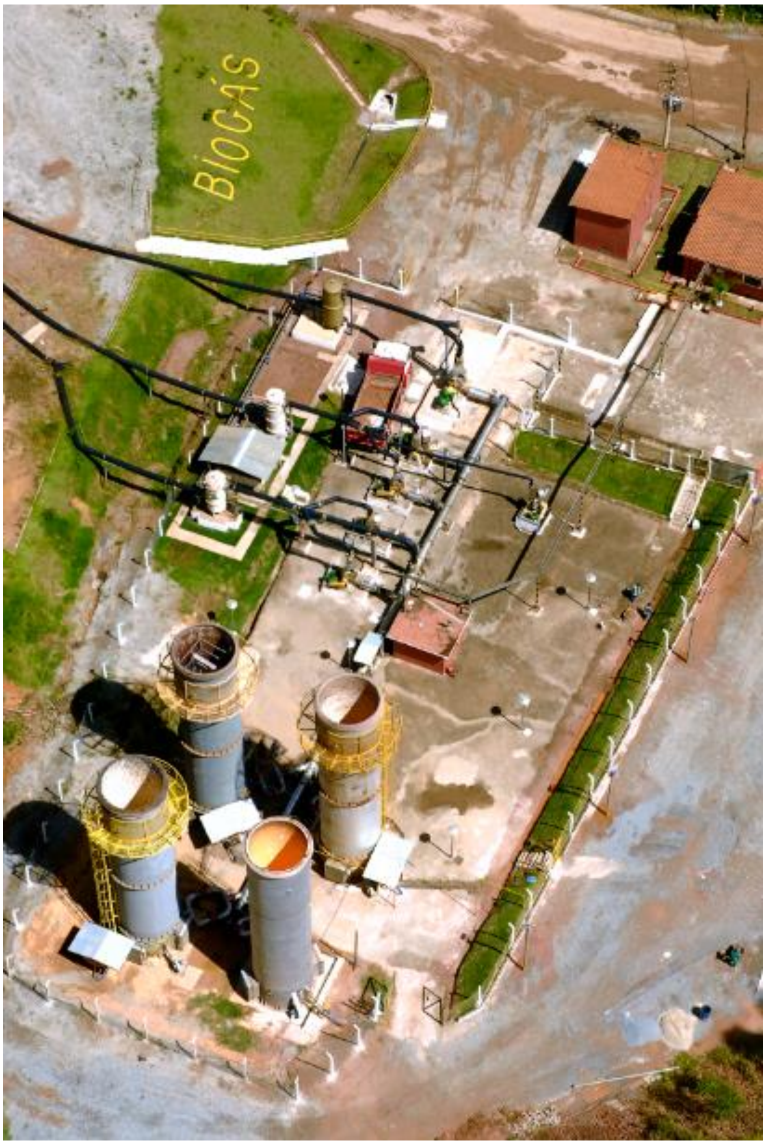


**Figure 4 – View of the project's LFG flaring infrastructure currently equipped with 4 high temperature enclosed flares in its previous location (under operation until 17/12/2015)**

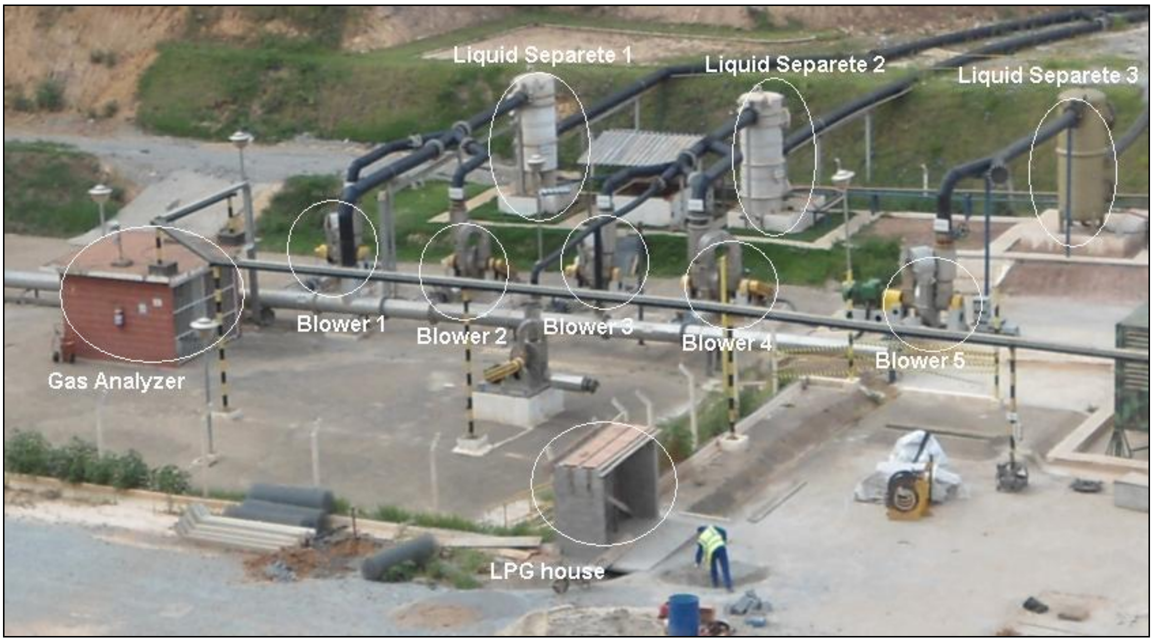


**Figure 5 – Partial view of the project's LFG flaring infrastructure in its previous location (under operation until 17/12/2015)**

(view of the main LFG pipeline, location of the $CH_4$ content gas analyzer unit (marked as "*Gas Analyzer*", centrifugal blowers (marked as "*Blower 1*", …, "*Blower 5*" ), liquid condensation traps (marked as "*Liquid Separate 1*", "*Liquid Separate 3*") and cylinder for LPG supply (marked as "*LPG house*")


**Figure 6 – Partial view of the project's LFG flaring infrastructure in its previous location (under operation until 17/12/2015)**

(view of the 4 high temperature enclosed flares (marked as *"Flare 01", "Flare 02", "Flare 03"* and *"Flare 04"*), location of the $CH_4$ content gas analyser unit (marked as "*Gas analyser*") and location of LPG cylinders (marked as "*LPG house*")


**Figure 7 –View of the project's LFG flaring infrastructure equipped with 4 high temperature enclosed flares in its current location (under operation since 18/12/2015)[29]**

[29] The view of the project's LFG flaring infrastructure under its new/current location does not show all equipment that the infrastructure includes: at the time the picture was taken (early April/2016), not all 4 new centrifugal blowers were operational, one of the condensation trap (for removing moisture from collected LFG) was removed for repair service.

*Box 1: Occurred gradual moving of the whole installed project's LFG flaring infrastructure to other area/region within the UVS - Caieiras landfill during the period from mid-June/2015 to 12/04/2016 (with the project activity operating under reduced activity level during the period)*[30]

The project's LFG flaring infrastructure (incl. high temperature enclosed flares, centrifugal blowers, valves, safety system/equipment and other ancillary and monitoring equipment/instruments) gradually moved to other area/region within the UVS - Caieiras landfill (with moving of two of the flares + ancillary equipment starting in mid-June/2015 and with the whole moving process (incl. all related phased testing and commissioning events) being later concluded on 12/04/2016).

During the about 8-month length occurred infrastructure gradual moving period within the currently expired 2nd 7-year crediting period, the project's LFG flaring infrastructure operated under reduced activity level from 2 different locations within the UVS - Caieiras landfill limits:

- until 17/12/2015: the project's LFG flaring infrastructure operated from its former location with two flares under operation.
- from 18/12/2015 onwards: the project's LFG flaring infrastructure has operated from its new and current location (on the basis of operation of only 2 flares during the period from 18/12/2015 to 12/04/2016 and later with the 4 flares in place since 12/04/2016).

The reason for such occurred change in the location of the project's LFG flaring infrastructure within the limits of the UVS - Caieiras landfill is a previously made decision of Essencis Soluções Ambientais S.A. (the host-country project participant, project owner and operator of the UVS - Caieiras landfill) to use the area/region within the landfill where the project's LFG flaring infrastructure was previously implemented (and has operated since year 2007) as an additional/new area for disposal of MSW at the UVS - Caieiras landfill.

This decision was in line with the previously conceived and approved operational plan for the landfill[31].

In accordance with a previously made infrastructure moving plan, the whole moving process of the project's LFG flaring infrastructure was gradually performed in order not to have the operation of the project activity being completely interrupted for a long time. As part of related performed moving activities, 2 of the 4 installed high temperature enclosed flares (flares referred as "Flare 3" and "Flare 2") were initially disconnected (disassembled and removed) from the former location of the LFG flaring infrastructure in mid-June/2015 and were positioned in the current location for the project's LFG flaring infrastructure (using heavy-duty truck cranes and ancillary equipment). While not assembled and not connected to the project activity since mid-June/2015, these flares became under interrupted operation until 18/12/2015 (date when the project's LFG flaring infrastructure started to operate from its new location (also operating under reduced activity level with only two flares under operation)).

[30] Although the occurred gradual moving of the whole installed project's LFG flaring infrastructure to other area/region within the UVS - Caieiras landfill occurred within the currently expired 2nd crediting period of the project activity, Box 1 is added in the PDD valid for the 3rd and last 7-year crediting period for completeness and transparency reasons. A similar informative box is also included in the latest version of the registered PDD valid for the currently expired 2nd crediting periods of the project activity.

[31] The following references to the previously planned change in the location of project's infrastructure within the limits of the UVS - Caieiras landfill (former CTR Caieiras landfill) is made available in Section A.3. of both registered and revised PDDs for the currently expired 2nd 7-year crediting period (version 5.9, dated 05/09/2013 and version 6.0, dated 17/05/2016):

> *"(…) as per the current plan/forecasts of Essencis Soluções Ambientais S.A. for MSW disposal at the CTR Caieiras landfill, the area where the project's LFG destruction facility is currently located may be used in the future for disposal of MSW. Whenever that occurs, the whole project's LFG destruction facility (incl. flares, centrifugal blowers, safety system/equipment and monitoring equipment/instruments) will thus be moved to another area/region within the CTR Caieiras landfill which is yet to be defined. If required, any relevant change in the project's configuration will be addressed as per applicable procedure/rules for addressing permanent post-registration changes (e.g. correction in information that does not affect the project design)."* [SIC]

SIC: The Latin adverb *sic erat scriptum* (SIC) "*thus was it written*" inserted after a quoted text indicates that the quoted text is transcribed exactly as found in the source text (complete with any erroneous or archaic spelling, surprising assertion, faulty reasoning, or other matter that might otherwise be taken as an error of transcription.).

**Figure 8 –Views of the occurred removal and transferring work of the project's high temperature enclosed flares and related equipment from the former location of the project's LFG flaring infrastructure to its current location during the period from mid-June/2015 to 12/April/ 2016 (by use of heavy-duty cranes)**

After occurred disassemble and moving of two the project's flares (flares referred as "Flare 3" and "Flare 2"), all required construction and implementation of infrastructure for having the project's LFG flaring infrastructure operating in its new location took place: required civil constructions, electrical installations, changes in the LFG pipeline, implementation of new programmable logic controlling (PLC) unit and electrical controls, etc.

The flaring infrastructure location moving process was partially concluded on 17/12/2015 (after conclusion of transferring of equipment from the former location to its new location) and starting of operation of flares referred as "Flare 3" and "Flare 2" from their new and current location occurred on 18/12//2015.

On 18/12/2015, after conclusion of partial installation and configuration of equipment and instruments (+ conclusion of related testing & commissioning work), the project's LFG flaring infrastructure started to operate from its new and permanent location (on the basis of operation of 2 flares only, however with 4 flares now available (where "Flare 1" and "Flare 4" were not yet under operation)). The project activity was finally able to again operate on the basis of 4 flares on 12/04/2016 after the infrastructure moving work was 100% completed.

As a result of the occurred change in the location of the project's LFG flaring infrastructure, the disposition lay-out for main equipment (flares, valves, pipes, etc.) slightly changed in its new location. Moreover, under its new location, the project's LFG infrastructure uses 3 new 4-stage and more efficient centrifugal blowers that were installed and started operating on 18/12/2015 (thus replacing 4 old 3-stage centrifugal blowers and promoting increase in the total combined LFG suction/collection capacity). Furthermore, as an additional improvement in the project activity, a new programmable logic controller (PLC) unit and new electronic database for monitoring records were also installed as part of the project activity (also started to operate on 18/12/2015 (with the old database being kept available for sake of historical monitoring data archiving)).

As a result of all performed internal testing and commissioning work for the project's LFG flaring infrastructure under its new location, it was confirmed that occurred slight change in the disposition lay-

out for main equipment/instruments for the project's LFG flaring infrastructure (when compared to the disposition lay-out for such equipment/instruments under the former location of the flaring infrastructure) does not negatively affect the overall functioning and operational requirements for the installed flares, valves and/or ancillary equipment. Thus, all operational requirements for the installed high temperature flares will be potentially remain being met along the 3rd and last 7-year crediting period for the project activity (like it was met during the remaining share of the currently expired 2nd 7-year crediting period) and/or along its expected remaining lifetime. Moreover, the lay-out of the project's main LFG transportation pipelines across the landfill was also partially modified (by taking into account the new location of the LFG flaring infrastructure).

*Box 2a - Performed service intervention in each one of the installed 4 high temperature enclosed flares for addressing detected undesirable and abnormal intermittent/sporadic vibration + noise problems in the flares (resulting in higher nameplate LFG flaring capacity for each flare)[32]:*

Prior of the starting the occurred moving process for the whole project's LFG flaring infrastructure (as described in the information box above), a service intervention was performed in each one of the installed 4 high temperature enclosed flares in June/2015. The performed service intervention was performed by technical service representative staff trained and authorized by the flares designer and manufacturer BTS - Termodinâmica de Sistemas Ltda. and aimed primarily to address previously detected undesirable and abnormal intermittent/sporadic vibration + noise problems in the flares as part of their operation.
The performed service intervention included re-design and re-commissioning of the LFG burner unit in each one of the flares (through the replacement of the previously existent 5 LFG injectors in the burner unit of each flare by 5 new and larger injectors (with higher firing capacity) + related inspection + testing/commissioning services). The performed service intervention successfully solved the previously detected vibration + noise problems in the flares. Furthermore, by making use of 5 slightly larger LFG injectors in the burner unit of each one of the flares, the performed service intervention also resulted in slightly increase of the nameplate LFG flaring capacity for each one of the installed high temperature enclosed flares as confirmed by the flares' designer and manufacturer BTS - Termodinâmica de Sistemas Ltda. While for each installed flare, the recommended minimum LFG flaring capacity (for continuous operation) remains being 650 $Nm^3/h$, the technical maximum recommended LFG flaring capacity (for continuous operation) after the performed service intervention was confirmed by BTS - Termodinâmica de Sistemas Ltda. as becoming 7,500 $Nm^3/h$ (and not any longer 6,500 $Nm^3/h$).

Under conformance with applicable CDM rules for addressing post-registration changes, such flare specification change required update in the previously defined value of the specification details named "Maximum operational LFG flow (for continuous operation)" in the context of the ex-ante defined parameter "Manufacturer's flare specifications for temperature, flow rate and maintenance schedule interval" ($SPEC_{flare}$)) as outlined in Section B.6.2. While the functioning of the flares and other elements of the project activity are not negatively affected by such occurred flare specification change, this occurred change was previously appropriated acknowledged as not promoting any adverse impact over the previously assessed and demonstrated additionality of the project activity either. At the time of its occurrence (July/2015), the change was also assumed as not adversely affecting the application of the applied CDM baseline and monitoring methodology + applicable methodological tools either. Finally, the previously defined scale of the project activity (registered as large-scale project activity) was also appropriately assumed as not being adversely impacted either.

[32] The performed service intervention in each one of the installed 4 high temperature enclosed flares (resulting in higher nameplate LFG flaring capacity for each flare and requiring updating of the previously defined values in the context of the ex-ante determined parameter $SPEC_{flare}$) was previously successfully addressed and approved by the CDM-EB (on 30/09/2016) as per applicable procedures for addressing post-registration changes with the ref. PRC-0171-003. Related details are available online:

https://cdm.unfccc.int/PRCContainer/DB/prcp724419194/view

**Figure 9 – Views of the inner section of the flares (incl. view of the LFG burner unit (with LFG injectors) of one of the flares)**

*Box 2b) Performed task-force involving capital and labour intensive maintenance, repair and parts replacement work in the existing project's LFG collection infrastructure and operational improvements for such infrastructure held during the period from July/2016 to July/2017*[33]

During the period from July/2016 to July/2017 within the currently expired 2nd 7-year crediting period of the project activity, a coordinated task-force involving capital and labour intensive maintenance, repair and parts replacement work was undertaken in the LFG collection wells within the project's existent LFG collection infrastructure. Such work aimed to increase the quality of LFG collected by the project activity (thus reaching LFG collection efficiency rate for the project as a whole closer to previously made forecasts) and also improving the overall qualitative characteristics of LFG effectively collected (i.e. increment of methane ($CH_4$) fraction, reduction of oxygen ($O_2$) content in collected LFG; better management of condensate in LFG pipeline network, etc.).

The performed task force work (which per se do not represent any occurred change in the design of the project activity and/or occurred change in its monitoring plan) included repairing and/or replacing damaged, worn and/or not anymore functional top manifolds in the existing vertical LFG collection wells by new top manifolds (new units designed in HDPE pipe, with 200 mm of diameter and of improved construction & design).

By including improved design and construction, each one of the installed new top manifolds incorporate a LFG flow adjustment valve which is very well-assembled in the manifold. Furthermore, a significantly improved welding technique is applied in the construction of both the new installed top manifolds and the valves in the manifolds (which are used for adjusting flow of collected LFG in the well), thus significantly reducing undesirable leaks and air injections along the project's LFG collection pipeline network. The performed replacement of damaged, worn and/or not anymore functional top manifolds by new units with identical concept (but with significantly improved design & construction) allowed substantial increase in the overall quality of collected LFG through the project's LFG collecting well network + improvements in operation of the infrastructure (e.g. reduction in entrance of $O_2$ through the top manifold and pipeline, better management of LFG suction pressure, etc.).

In April/2020, all operational LFG collecting wells were of improved design & construction type.

**Figure 10 – Pictures showing replacement work for the top manifold in a LFG collection well + LFG collection well with new design top manifold using 200 mm diameter HDPE pipe + individual performance monitoring work in a project's LFG collection well at the UVS - Caieiras landfill.**

[33] Although the performed task-force involving capital and labour intensive maintenance, repair and parts replacement work in the existing project's LFG collection infrastructure and operational improvements for such infrastructure were held within the currently expired 2nd crediting period of the project activity, Box 2b is added in the PDD valid for the 3rd and last 7-year crediting period for completeness and transparency reasons. A similar informative box is also included in the latest version of the registered PDD valid for the currently expired 2nd crediting periods of the project activity.

As an additional improvement, operation of the project's LFG collection infrastructure was improved with the use of better designed electronic-format mapping for all LFG wells of the project activity (with more frequent and more detailed/reliable data recording and updating for the operational status and performance of each individual LFG collection well that is part of the project activity).

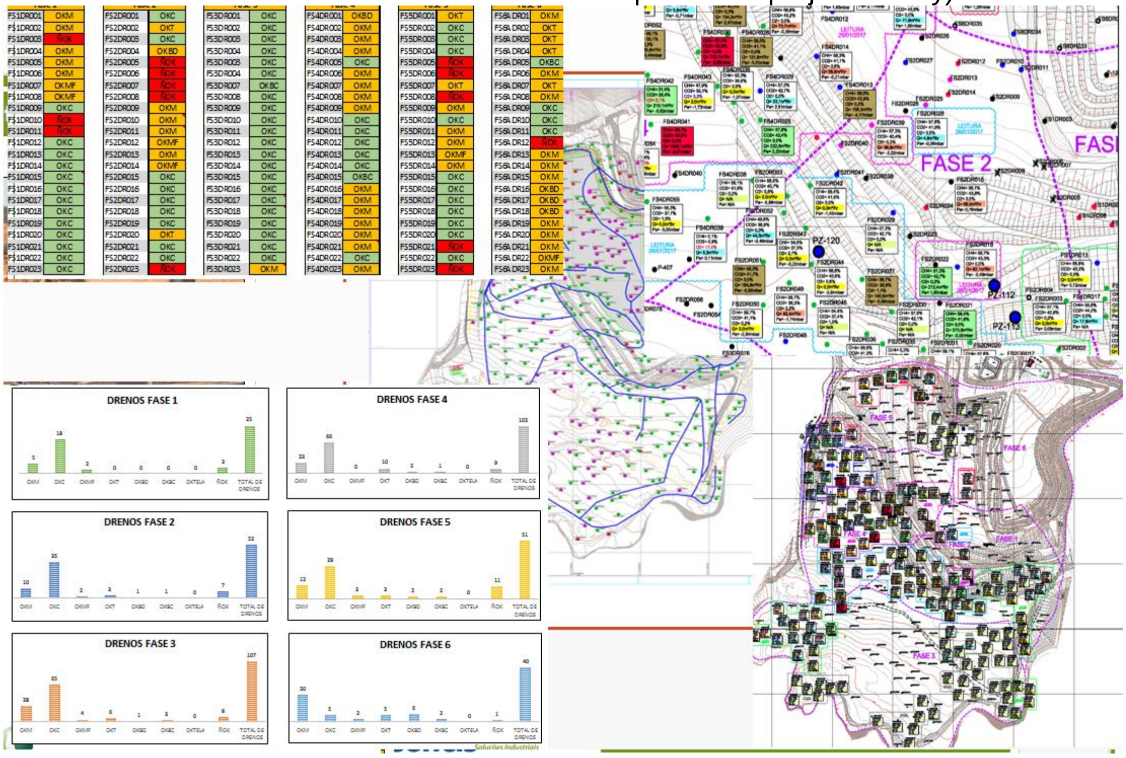


**Figure 11 - Use of better designed electronic format mapping for all LFG wells of the project activity (with more frequent and more detailed/reliable data recording and updating of the operational status/performance of each individual LFG collection well).**

The performed task force work in the project's LFG collection infrastructure and the promoted operational improvements for such infrastructure have already resulted in some increase of the quantity of LFG collected by the project activity as well as increment in $CH_4$ fraction combined with significant reduction of $O_2$ content in collected LFG. Furthermore, new installed LFG network pieces (parts and pipes with better design & construction) have also allowed and facilitated effective draining of condensate through the project's LFG pipeline network.

*<u>Destruction of methane in a set of internal combustion gas engines (since July/2016):</u>*

Since June/2016, methane has been destroyed through combustion of collected LFG in a set of internal combustion gas engines. This set of gas engines represents, at the same time, (i) additional/alternative methane destruction devices for the project activity and (ii) major components of a grid-connected electricity generation infrastructure fuelled by LFG and located within the geographical limits of the UVS-Caieiras landfill since July/2016.

Each one of the internal combustion gas engines is part of an individual state-of-the-art engine-generators set type 4, model/series G-420 manufactured in Austria by GE Jenbacher GmbH & Co OHG and with individual nameplate power generation capacity of 1.4 MW each[34].

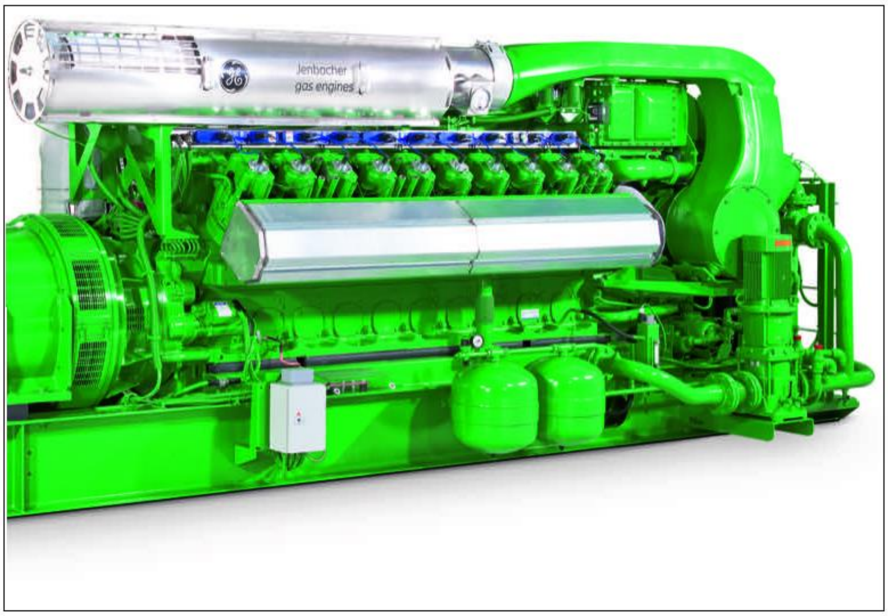


**Figure 12: View of the internal combustion gas engine (regarded as additional/alternative methane destruction devices for the project activity). This engine is the major component of each one of the type 4, G-420 series engine-generator set manufactured by GE Jenbacher GmbH & Co OHG**

[34] Depending on construction and assembly aspects of each individual engine-generator sets Jenbacher, type 4 model/series G-420 (e.g. selection of supplier of alternator and other electrical components), the nameplate installed capacity for assembled units (that includes the internal combustion gas engines) may be slightly higher or lower than 1.4 MW (1,400 kW). In the particular case of the so far installed 21 container-based modular engine-generator packages, all alternators of the unit indicate nameplate power generation capacity of 1,407 kW (1.407 MW). Nevertheless, it is crucial to note that under typical operational conditions, an individual set will never operate under working conditions able to reach exactly 100% of its nameplate power generator capacity (even when operated under full load and under favourable electricity grid conditions). In fact, under typical operational conditions (even under full load), power generation by each individual engine-generator set may be slightly below 1.4 MW.

The GE Jenbacher lean-burn gas engines fuelled by LFG (such as the engine that is part of the type 4, G-420 series engine-generator set) have $CH_4$ destruction efficiency in the range of 99.5%[35]. Such typical very high $CH_4$ destruction efficiency expected for set the internal combustion gas engines is in line with GHG calculation approach of ACM0001 (version 19.0) for the determination of baseline emissions for destruction of $CH_4$ in such additional/alternative methane destruction devices as presented in Section B.6.1.


**Figure 12a: View of the internal combustion gas engine that is the major component of the Type 4, G-420 series engine-generator set manufactured by GE Jenbacher GmbH & Co OHG**

Each one of the currently installed 21 engine-generator sets (and yet to be installed additional 6 identical engine-generator sets as per the currently valid implementation time plan) includes an internal combustion gas engine + ancillary equipment that are all part of a grid-connected electricity generation infrastructure located within the geographical limits of the UVS – Caieiras landfill. The engine-generator sets are assembled in Italy under a modular power generation package set designed. The manufacturer and supplier for the package sets is the company AB Energy SPA from Italy.

By applying and also state-of-the-art technical solution using container-based modular packages, a quicker construction and assembly of the whole power generation infrastructure is ensured when compared to the conventional solution (typically using a unique power house for all engine-generator sets + ancillary devices) that would require additional appropriated edification construction efforts.

When fully implemented in year 2022, the grid-connected electricity generation infrastructure located within the geographical limits of the UVS – Caieiras landfill will encompass a set of 27 identical internal combustion gas engines powered uniquely by LFG and will have final total combined nameplate installed capacity of 37.8 MW. That will represent 27 additional/alternative methane destruction devices operating as part of the project activity by year 2022.

In April/2020, under its so far concluded implementation phase (phase1), the grid-connected electricity generation infrastructure located within the geographical limits of the UVS - Caieiras comprises the simultaneously installation of 21 container-based modular engine-generator packages.

[35] Source: Publicly available declaration from GE Power & Water Jenbacher Gas Engines – USA. Available online: file:///C:/Users/Samsung/Downloads/GE-Power-Water%20(3).pdf

The currently installed and under operation set of 21 internal combustion gas engines (which represents additional/alternative methane destruction devices for the project activity) were physically connected to the project activity (connected to the project's main LFG supply pipeline) on 01/07/2016 and started operating on a continuous basis on 11/07/2016 [36].

[36] The yet to be completely installed 27 container-based modular engine-generator packages (of which 21 are currently already installed and each one including an internal combustion gas engine as major component) are/will all (be) connected to a power substation within the National Electricity Grid of Brazil.

Such power substation is currently located near to the so far installed packages. As per rules and practices of the Brazilian power market, such power substation is remotely operated/controlled by a local power distribution/transmission company. Electricity generated by the packages in 13.8 kV is converted to 138 kV in the power substation through 2 main power transformers.

The so far installed and yet to be completely installed set of container-based modular engine-generator packages are/will be controlled by a common power generation control infrastructure (incl. a shared main plant supervisory control and data acquisition system (SCADA) for the whole power generation infrastructure).

The so far occurred installation and starting of operations of the set of 21 packages on 01/07/2016 and 11/07/2016 respectively accounts to an initial total combined nameplate capacity for the electricity generation infrastructure of 29.4 MW. As per the currently valid implementation forecast for the complete grid-connected electricity generation infrastructure, starting of operations of additional container-based modular engine-generator packages (also with individual nameplate capacity of 1.4 MW) are expected to occur in year 2021 and 2022 (under implementation phases 2 and 3 respectively) as summarized in the table below:

**Implementation schedule for the grid-connected electricity generation infrastructure located within the geographical limits of the UVS – Caieiras landfill (valid in April/2020)**

| Implementation phase for the grid-connected electricity generation infrastructure | Year of starting of operations | Number of container-based modular engine-generator packages installed and/or to be simultaneously installed during the implementation phase (total combined installed capacity encompassed by the implementation phase) | Total combined nameplate installed capacity after the commissioning of the underlying implementation phase |
|---|---|---|---|
| Phase 1 | 2016 (since July/2016) | 21 (29.4 MW) | 29.4 MW |
| Phase 2 | 2021 | 4 (addition of 5.6 MW of installed capacity) | 35.0 MW |
| Phase 3 | 2022 | 2 (addition of 2.8 MW of installed capacity) | 37.8 MW |

While implementation of Phase 2 and Phase 3 were previously considered o occur in years 2019 and 2020, the reasons for not any longer having this phases being implemented as previously forecasted are related to internal financing, procurement and commercial reasons at the enterprise "Termoverde Caieiras Ltda." This company was incorporated and has operated since July/2016 as a power generation company in charge of the whole electricity generation infrastructure located within the geographical limits of the UVS – Caieiras landfill.

Under its implementation phase 1, the grid-connected electricity generation infrastructure located within the geographical limits of the UVS – Caieiras landfill also encompasses the installation and continuous operation of a new LFG treatment and cooling plant where all LFG which is used as gaseous fuel for electricity generation is filtered/cleaned (removal of $SO_x$, siloxanes, furans and other contaminants) in an activated carbon filtering system. Furthermore, in order to meet operational requirements of installed container-based modular engine-generator packages, collected LFG has also be cooled (in an electrical chiller) prior to be sent to the operational engine-generator sets.

No LFG purification process is encompassed by the project activity (under its revised design configuration). The new LFG treatment and cooling plant will not promote removal of $CO_2$, $N_2$ or other gases from collected LFG.

LFG treatment through passage of LFG through activated carbon gas treatment elements (or similar technology) aims to remove siloxane contaminants from collected LFG. LFG cooling through chilled water heat exchangers aims to lower temperature of collected LFG that is directed to the set of internal combustion gas engines of the container-based modular engine-generator packages (in order to meet their operational requirements).

Milestone for the starting of operations of the grid-connected electricity generation infrastructure located within the geographical limits of the UVS – Caieiras landfill (under phase 1):

- 01/07/2016: Connection of the set of internal combustion gas engines to the project's main LFG supply pipeline, thus technically allowing collected LFG to be combusted in such alternative methane destruction devices.

- 08/07/2016: Starting of operations of the whole electricity generation infrastructure as part of the conclusion of testing and commissioning work for such infrastructure.

- 11/07/2016: Upon conclusion of all related testing and commissioning activities for the electricity generation infrastructure and upon conclusion of all required configuration of the project's monitoring data gathering, processing and recording system; continuous operation of the project activity under its revised design configuration (i.e. including the set of internal combustion gas engines as additional/alternative methane destruction devices and with all required monitoring data being measured, processed and recorded) has started.

Upon the forecasted conclusion of implementation phases 2 and 3 of the grid-connected electricity generation infrastructure by years 2021 and 2022 respectively (for which identical gas engines will also represent the major components), LFG collected by the project activity will also be combusted in 6 additional and identical internal combustion gas engines as follows:

- 4 additional and identical container-based modular engine-generator packages (each one including an internal combustion gas engine) are expected to be under operation in year 2021
- 2 additional and identical engine-generator sets are also expected to be under operation in year 2022.

*Box 2c – Approved non-inclusion of electricity generation as additional GHG abatement/mitigation measure as part of the project activity + approved non-accounting of emission reductions associated to displacement of a more-GHG-intensive service (i.e. $CO_2$ emission reductions due to generation of electricity using collected LFG as renewable energy source)*[37]

| |
|---|
| Under its current design configuration, as previously approved by the CDM Executive Board in August /2018, the project activity encompasses only methane destruction GHG abatement measure. Despite of the occurrence of combustion of collected LFG in a set of internal combustion gas engines (that represents the major components of an electricity generation infrastructure) since July/2016, the project activity under its current design configuration is regarded as not including any additional project component and/or extension of technology/measures when compared to its previous design configuration. That means that the project activity does not encompass electricity generation as an additional GHG abatement/mitigation measure since July/2016 and it thus remains having methane destruction as its unique GHG abatement/mitigation measure. Therefore, like also valid for its currently expired 2nd 7-year crediting period, no emission reductions associated to generation of electricity using collected LFG as renewable energy source will be accounted and/or claimed by project activity during its 3rd and last 7-year crediting period either. |

The pictures below include views of the grid-connected electricity generation infrastructure located within the geographical limits of the UVS – Caieiras landfill since July/2016 (under its implementation phase 1) comprising set of 21 container-based modular engine-generator packages (for which the internal combustion gas engines (additional/alternative methane destruction devices for the project activity) represents the major components).

[37] The non-inclusion of electricity generation as additional GHG abatement/mitigation measure (as part of the project activity) + non-accounting of emission reductions associated to displacement of a more-GHG-intensive service (i.e. $CO_2$ emission reductions due to generation of electricity using collected LFG as renewable energy source) were approved by the CDM Executive Board (CDM-EB) in August/2018 in the context of the approval process of post-registration changes for the project activity addressed under PRC-0171-005. Related details and documents (e.g. revised version of the PDD and validation opinion report addressing the design change) are available online:

https://cdm.unfccc.int/PRCContainer/DB/prcp103687569/view

**Figure 13: Aerial partial view of the electricity generation infrastructure located within the geographical limits of the UVS – Caieiras landfill (view of state-of-the-art container-based modular engine-generator packages and power substation) (under its implementation phase 1) (Picture dated September 2016).**

**Figure 13a: Aerial partial view of the electricity generation infrastructure located within the geographical limits of the UVS – Caieiras landfill (view of the container-based modular engine-generator packages) under its implementation phase 1 (Picture dated September 2016).**

**Figure 14: Aerial partial view of the electricity generation infrastructure located within the geographical limits of the UVS – Caieiras landfill (view of the LFG treatment and cooling facility) (under its implementation phase 1) + the project's LFG flaring infrastructure under its current location (Picture dated September 2016).**

**Figure 14a: Aerial partial view of the electricity generation infrastructure + the project's LFG flaring infrastructure (Picture dated September 2016).**

*Timeline with the most relevant facts and events related to the implementation of the grid-connected electricity generation infrastructure fuelled by LFG and located within the geographical limits of the UVS – Caieiras landfill under its 1st implementation phase and its starting of operations in July/2016:*

The table below includes a timeline with the most relevant facts and events related to the implementation of the grid-connected electricity generation infrastructure fuelled by LFG (under phase 1) (for which the set of internal combustion gas engines, as additional/alternative methane destruction devices for the project activity, represents major components).

*Table - Timeline with the most relevant facts and events related to the implementation of the grid-connected electricity generation infrastructure powered by collected LFG and located within the geographical limits of the UVS – Caieiras landfill.*

| Period | Facts and events |
|---|---|
| Year 2014 | As a result of the operation of the project activity (as a LFG collection and flaring initiative) for more than 8 years, the project's operational and management staff from the project participant Essencis Soluções Ambientais S.A. finally managed to develop significant expertise and competence in terms of LFG collection techniques (under the very high volumes applicable for a very large landfill site such as the UVS - Caieiras landfill).<br><br>Right in the beginning of year 2014, Essencis Soluções Ambientais S.A. and the company Solvi Valorização Energética (SVE)[38] initiated the development of further internal field studies and technical and commercial investigations for the implementation of a grid-connected electricity generation infrastructure to be powered by LFG and be located within the geographical limits of the UVS – Caieiras landfill. Such investigations occurred after the effective renewal of the 7-year crediting period for the project activity. At that time, the following technical operational aspects and conditions *inter-alia* represented crucial and/or very relevant aspects/facts in the context of related capital expenditures and investment decision making process for implementing such electricity generation infrastructure:<br><br>- Achievement of reduced uncertainty level about the quantity and quality of LFG collected at the UVS - Caieiras landfill. This was a direct result of development by Essencis Soluções Ambientais S.A. of real field expertise and competence in terms of collection of LFG (after the project activity being operated as a LFG collection and destruction initiative since year 2007).<br><br>- Development of market and technical competence in the host country Brazil for the promotion of utilization of LFG as gaseous fuel for electricity generation (incl. occurred real improvements in terms of conversion efficiency of engine-generator units, use of more advanced electronics for dealing with usual fluctuations in $CH_4$ content/fraction in LFG, reduction of problems of synchronization of engine-generator sets within the electricity grids, etc.).<br><br>- More attractive sale price for generated electricity in Brazil (when compared to sale price previously considered at the time of occurred project initial design conceptualization + CDM consideration (within years 2004 and 2005)).<br><br>- Reduction in the previously existent policy, technical requirements and |

[38] Solvi Valorização Energética Ltda. is a registered company that is owned by Solvi Group (www.solvi.com). Solvi Group is also the main owner of Essencis Soluções Ambientais S.A.

| | |
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| | market uncertainties within the Brazilian power market.<br>- Overall historical slight improvement in macroeconomic conditions in Brazil<br><br>It is relevant to note that in year 2014, the project activity was already registered under its currently expired 2nd 7-year crediting period[39]. |
| 13/01/2015 | As the main outcome of all performed investigations for the implementation of the grid-connected electricity generation infrastructure fuelled by LFG and located within the geographical limits of the UVS – Caieiras landfill, a technical solution involving the installation of container-based modular engine-generator packages (with engine-generator sets manufactured/supplied by the American/Austrian power generation equipment manufacturer GE Jenbacher GmbH & Co OHG) was regarded as the most appropriate and technically sound option.<br><br>On 13/01/2015, an Engineering, Procurement and Commission (EPC) agreement was established/signed between the incorporated/registered companies “Termoverde Caieiras Ltda.”[40] and the company AB Energy do Brasil Ltda. (representative in Brazil for the Italy headquartered company AB Energy SPA) for the gradual/phased implementation of the grid-connected electricity generation infrastructure fuelled by LFG under 3 implementation phases.<br><br>The established technical EPC agreement encompassed design, phased construction, commissioning and operation (under a “turnkey” business model) of a state-of-the-art electricity generation infrastructure with 37.8 MW of total and final combined installed capacity.<br><br>The establishment of such agreement was occurred in the context of the project activity being registered under the CDM for more than 7 years. |
| February/2015 | Starting of the construction work for the grid-connected electricity generation infrastructure in an area in the UVS - Caieiras landfill (next to the project’s LFG flaring infrastructure under its current location) (initial of minor construction work (access, topography work, etc.)) with procurement of all major equipment being in progress with AB Energy SPA from Italy as established in the EPIC agreement established/signed between the Termoverde Caieiras Ltda. and AB Energy do Brasil Ltda. |
| Period within year 2015 and July/2016 | Milestone for the construction and commissioning tasks for the grid-connected electricity generation infrastructure fuelled by LFG and located within the geographical limits of the UVS – Caieiras landfill : |

[39] Since at the time of the first occurred renewal of the 7-year crediting period for the project activity (in year 2013) no technical investigation was performed and decision making process related to capital expenditures (CAPEX) for the implementation of grid-connected electricity generation infrastructure fuelled by LFG located within the geographical limits of the UVS – Caieiras landfill were made, thus the version of the PDD that was previously submitted and considered in the context of such occurred 1st renewal of the 7-year crediting period of the project activity does not include any reference to such electricity generation infrastructure.

[40] In the context of the incurrence of capital expenditures for implementing the grid-connected electricity generation infrastructure, the company/enterprise “Termoverde Caieiras Ltda.” was incorporated and registered as a power generation company in charge of the electricity generation infrastructure located within the geographical limits of the UVS – Caieiras landfill. Termoverde Caieiras Ltda. has Solvi Valorização Energética Ltda. (SVE) as its main owner.

| | |
|---|---|
| | Civil construction:<br>- Foundations for the plant control house and foundations for the 21 engine-generator sets: from Feb./2015 to Oct./2015<br>- Construction of the power substation (incl. firefighting equipment): from Jun./2009 to Sep./2010<br><br>Electrical and power control system:<br>- Installation of the 21 engine-generator sets + ancillary and control system (without testing/commissioning): from Jul./2015 to Oct./2015<br><br>Power substation:<br>- Construction of power station: from Oct./2015 to Jun./2016<br><br>Testing and commissioning for the whole infrastructure: from Jun./2016 to early Jul./2016.<br><br>In January/2016, based on the outcome of its performed surveillance, the São Paulo's state agency for electricity "Agência Reguladora de Saneamento e Energia do Estado de São Paulo" (ARSESP) has issued a Notification Report highlighting the status of the implementation of the electricity generation infrastructure (final construction status) and also highlighting the relative implementation delay for such infrastructure (delay in the implementation of the power substation). As per the report, while as per the initial official time plan for the implementation of the electricity generation infrastructure, the power substation was forecasted to be built within the period from Feb./2015 to Oct./2015, by Jan./2016 its construction was not yet completed.<br><br>Upon difficulties of the conclusion of the power substation (that were caused by delays in the licensing/permit for its installation as a power station connected to a regional 128 kV power transmission line) the construction and assembly of the power substation connecting the electricity generation infrastructure to the electricity grid was delayed[41].<br><br>As outlined in an official communication issued by the Brazil's national grid operator is termed *Operador Nacional do Sistema* (ONS)[42] dated 08/07/2016, upon positive outcome of performance surveillance in the electricity generation infrastructure, all its 21 engine-generator sets were regarded as under conformance with applicable requisites for connection to the National Electricity Grid of Brazil.<br><br>As published in the Diário Oficial da União (DOU) of 15/07/2016 (Section 1)[43], all 21 engine-generator sets of the electricity generation infrastructure located within the geographical limits of the UVS – Caieiras landfill were simultaneously released/approved for starting operating as power generation sources connected to the National Electricity Grid of Brazil. |

[41] Copies of the versions of the master time plan for the implementation of the grid-connected electricity generation infrastructure located within the limits of the UVS- Caieiras landfill as valid in Dez./2014 and Jun. /2016 were made available to the to the DOE in charge of the validation of this revised version of the PDD. The comparison of these different versions of the time plan (that were previously submitted to both the Brazilian Electricity Regulatory Agency (ANEEL) and to the São Paulo's state agency for electricity (ARSESP) allows confirmation of the previously unforeseen/unexpected delay on conclusion of the construction and commissioning work for the electricity generation infrastructure (mainly due to the occurred delay in the construction of the power substation that connects the electricity generation infrastructure to the National Electricity Grid of Brazil).

[42] Brazil's national grid operator is termed *Operador Nacional do Sistema* (ONS) and it is a government agency responsible for the coordination and monitoring of electric power generation and transmission facilities connected to Brazil's national grid (SIN). The agency operates under the supervision and regulation of the country's national power regulator ANEEL.

[43] The *Diário Oficial da União* (DOU) is the official journal of the federal government of Brazil. DOU issue 244, Section 1 dated 22/12/2010 is retrievable online: http://www.imprensanacional.gov.br/

| | |
|---|---|
| 01/07/2016, 08/07/2016 and 11/07/2016 | 01/07/2016: Connection of the set of internal combustion gas engines (additional/alternative methane destruction devices for the project activity) to the project's main LFG supply pipeline, thus technically allowing collected LFG to be sent to such project's new infrastructure for being combusted.<br><br>08/07/2016: Starting of operations of the set of internal combustion gas engines[44].<br><br>11/07/2016: Upon conclusion of all related testing and commissioning activities for the grid-connected electricity generation infrastructure and upon conclusion of all required configuration of the project's monitoring data gathering, processing and recording system; continuous operation of the project activity (with all required monitoring data being measured, processed and recorded) has started under its revised configuration (with the set of 21 internal combustion gas engines acting as additional/alternative methane destruction devices).<br><br><u>*Note: Unforeseen/unexpected delay on conclusion of the construction and commissioning work for the grid-connected electricity generation infrastructure (for which the set of internal combustion gas engines represents major components):*</u><br><br>Due to difficulties and problems with tasks/activities related to equipment procurement unforeseen/unexpected, construction, testing and commissioning phases for the grid-connected electricity generation infrastructure fuelled by LFG, its starting of operations was delayed when compared to previously made forecasts:<br><br>- while the grid-connected electricity generation infrastructure was previously forecasted to start operating in the beginning of year 2016, its continuous operations was initiated on 11/07/2016 (about 6 months or ½ year of delay).<br><br>As established in the contractual agreement established between Termoverde Caieiras Ltda. and the company AB Energy do Brasil Ltda., the starting of operations for the 2nd and 3rd implementation phases of the grid-connected electricity generation infrastructure fuelled by LFG (that represents increment in its total combined installed capacity of 5.6 MW and 2.8 MW respectively) were in July/2016 expected to occur in years 2019 and 2020 respectively[45]. |
| March/2020 | Related efforts for the renewal of the 7-year crediting period were initiated (e.g. completion of the PDD for the 3rd and last 7-year crediting period, selection of DOE for performance of related validation assessment). |

[44] A complete testing and commissioning work for the grid-connected electricity generation infrastructure (of which the set of internal combustion gas engines represents major components) was held on 11/07/2016 as per related commissioning report later issued by AB Energy do Brasil Ltda. on 03/08/2016.

[45] Differently than previously forecasted, the installation of additional 4 + 2 engine-generator sets type 4 G420 series have not occurred and will not any longer occur within year 2019 and year 2020 respectively. The reasons for not any longer having Phase 2 and Phase 3 for the gradual/phased implementation of the grid-connected electricity generation infrastructure occurring in years 2019 and 2020 are related to internal financing, procurement and commercial reasons at the enterprise "Termoverde Caieiras Ltda." As per more recently revised and currently valid time plan for the implementation of remaining phases of the electricity generation infrastructure (fuelled by LFG and located within the limits of the UVS-Caieiras landfill), the starting of operations for their 2nd and 3rd implementation phases are currently expected to occur in years 2021 and 2022 respectively. As per applicable CDM rules, this relative delay in the previously forecasted implementation of the 2nd and 3rd phases of implementation of engine-generator sets per se does not represent a change in the design of the project activity that would need to be addressed as per applicable CDM procedures for post-registration changes.

*Consumption of electricity by the project activity:*
Since the period since the start of operation of the project activity in February/2007 until July/2016, all electricity demand for the project activity has been entirely met by consumption of grid-sourced electricity. During this latest 9-year length period, during events of temporary interruption of supply of grid-sourced electricity to the project activity, the operation of the project activity had to be completely interrupted.
As an occurred post-registration change in the project design, a backup captive off-grid electricity generator (fuelled by diesel and with 700 kVA of nameplate installed capacity) was installed and was put under operational conditions in July/2016. Such captive off-grid electricity generator is planned to be used along the remaining lifetime of the project activity only under temporary circumstances when the project's electricity demand cannot be met by imports of grid-sourced electricity.

The backup electricity generator is activated automatically (through automatic switching control) whenever supply of grid-sourced electricity to the project activity is interrupted. The available automatic switching control does not allow the backup electricity generator being connected to the electricity grid. Thus, under no circumstance the project's electricity demand can be met simultaneously by grid-sourced electricity and by backup electricity generator (fuelled by diesel).

The main specifications of the backup captive off-grid electricity generator (fuelled by diesel) are summarized below:

| Specifications for the installed backup captive off-grid electricity generator (fuelled by diesel) | |
|---|---|
| Manufacturer | STEMAC Grupos Geradores (Brazil) |
| Model/product | G – GMC |
| Power | 700 kVA (560 kW for a power factor of 0.8)<br>(440 V voltage, 60 Hz frequency) |
| Main components | Diesel engine: Scania DC1649A<br>Generator: WEG GTA 312AI45 B35T<br>Command display: model DS7320 |

In summary, the project's electricity demand can technically be met by one of the following sources/approaches:

- Imports of grid-sourced electricity[46], or
- Electricity supply by the installed backup captive off-grid electricity generator (fuelled by diesel) (expected to occur only during temporary planned or unplanned circumstances when supply of grid-sourced electricity is temporarily interrupted).

*Consumption of the fossil-fuel Liquefied Petroleum Gas (LPG) by the project activity:*
Since the start of operation of the project activity, LPG has been used as a start-up fuel to ignite the high temperature enclosed flares whenever it is required (e.g. after maintenance/repair events, after temporary interruptions in grid electricity supply to the project activity, etc.)[47].

[46] As emphasized in Box 2c, since the project activity does not encompass electricity generation as a GHG abatement measure and no emission reductions due to displacement of a more-GHG-intensive service (i.e. emission reductions due to generation of electricity using collected LFG as fuel) are thus eligible and/or claimable; any consumption by the project activity of electricity sourced/generated by the grid-connected electricity generation infrastructure fuelled by LFG located within the geographical limits of the UVS – Caieiras landfill (of which the set of internal combustion gas engines represents the major components) will be regarded and accounted

LPG has been supplied to the project activity in 45 kg standard cylinders by an authorized LPG distributor. The mass of consumed LPG by the project activity has been regularly monitored. It is currently expected that LPG will remain being supplied to the project activity in standard cylinders with net capacity of 45 kg of LPG.

In Section B.3, information about the project's main equipment/infrastructure is complemented by a schematic flow diagram which summarizes the project boundary and delineates the project activity (equipment, parameters to be monitored, and GHGs included in the project boundary).

*Technology transfer:*
While the currently installed four high temperature enclosed flares and some of the monitoring instruments (some of the currently installed meters and sensors) are manufactured in Brazil, the project activity uses imported components (equipment, instruments, etc.). While all currently existent forced (active) LFG collection and destruction systems under operation in landfills located in Brazil were implemented (or are currently being implemented/validated) as project based initiatives under the CDM, such project activities (including the Caieiras landfill gas emission reduction) indeed involve transfer of technology and improvements in practices for LFG management to the host country Brazil.

Regarding the later occurred (and yet to occur) installation of internal combustion gas engines (as additional/alternative methane destruction devices for the project activity), related engine technology remains not being widely applied in Brazil either. Such set of internal combustion gas engines (as the major components of the electricity generation infrastructure located within the geographical limits of the UVS – Caieiras landfill) represents, in the particular case of the project activity, imported state-of-the-art methane destruction devices that were installed and commissioned by local representatives and licensed contractors of the equipment manufacturer upon significant training and transfer of knowledge.

[47] Utilization of LPG for igniting the high temperature enclosed flares is expected to be at least temporary interrupted in the future. The host-country project participant and project owner Essencis Soluções Ambientais S.A. has evaluated the technical possibility of using collected LFG for igniting the flares instead of using LPG (thus saving costs with LPG consumption and its monitoring). In case LPG is permanently not any longer utilized, no project emission due to the consumption of such fossil fuel will thus require to be accounted and no related monitoring will any longer be required. Upon a decision of permanently phase out the utilization of LPG for igniting the flares, this change in the project design will be addressed as per applicable procedures for addressing post-registration changes.

*Occurred pilot tests/evaluation of a portable electricity generation facility fuelled by collected LFG at UVS - Caieiras landfill (using LFG collected by the project activity "Caieiras landfill gas emission reduction)" during a no longer than 3-month period within the currently expired 1st crediting period:*

As further explained in the information box below, a portable 200 kW electricity generation station was installed and operated in the project site during a no longer than 3-month period within the 1st crediting period in the framework of a technical cooperation agreement set between the Biomass Center Institute (CENBIO) of University of São Paulo (USP) and Essencis Soluções Ambientais S.A. in order to have renewable energy experts/scholars of CEMBIO/USP performing some field tests/analysis related to the potential of use of collected LFG as fuel for electricity generation.

*Box 3 - Occurred pilot tests/evaluation of a portable electricity generation facility fuelled by collected LFG at UVS - Caieiras landfill (using LFG collected by the project activity "Caieiras landfill gas emission reduction)" during a no longer than 3-month period within the 1st crediting period*[48]

During the period from April/2009 to June/2009 (thus during a limited and short period within the currently expired 1st 7-year crediting period), in the framework of a technical cooperation agreement set between the Biomass Center Institute (CENBIO) of University of São Paulo (USP) and Essencis Soluções Ambientais S.A., a portable 200 kW electricity generation station was installed in the project site in order to have renewable energy experts/scholars of CEMBIO/USP performing some field tests/analysis related to the potential of use of collected LFG as fuel for electricity generation.

Testing/evaluation work involving electricity generation exploring LFG as fuel was performed by using a portable 200 kW electricity generation station (Model LANDSET 200 assembled by Brasmetano Ind. e Com. Ltda.) with the following specifications:

- Engine: developed and manufactured by Brasmetano (based on the diesel engine Mercedes-Benz 447-LA engine with a modified cylinder head and other minor modifications / adaptations)
- Generator: manufactured by WEG
- Output voltage: 440 V / 60Hz

**Figure 15 - View of the portable 200 kW electricity generator installed under the framework of the temporary technical cooperation agreement set between the Biomass Center Institute (CENBIO) of University of São Paulo (USP) and Essencis Soluções Ambientais S.A.**
**(equipment yet located in the project site, but not in use since June/2009 - when the related 3-month length academic research experiments were finalized)**

[48] Although the occurred pilot tests/evaluation of a portable electricity generation facility fuelled by collected LFG occurred within the currently expired 1st crediting period, Box 3 is added in the PDD valid for the 3rd and last 7-year crediting period for completeness and transparency reasons. A similar informative box is also included in the latest version of the registered PDD valid for the currently expired 1st and 2nd crediting periods of the project activity.

The investment in the prototype power generation equipment (fuelled by LFG) was made by CEMBIO/USP. Equipment was installed at the UVS - Caieiras landfill by contractors hired by CEMBIO/USP.
In the context of the performed field research, a relative small amount of LFG collected by the project activity ended up being consumed for testing purposes only as part of the performed academic field texts/experiments. It is however crucial to note that all LFG used under the academic test/evaluation was collected by installing a temporary "T" junction in a section of the project's LFG pipeline which is located prior to the at that time installed LFG flow meter (which measured the amount of LFG collected by the project activity and sent to the flares). Thus, no LFG measured by the project activity was ever utilized as gaseous fuel for electricity generation under this temporarily field academic research/testing events.
Furthermore, all electricity which was generated under the test/evaluation activities was discharged in a resistive load bank. Thus, in accordance with applicable rules and regulations of the Brazilian power market at that time, no generated electricity was consumed internally by the project activity or by other facilities of the UVS - Caieiras landfill or exported to the grid.
Detailed information about the whole field research initiative performed by CEMBIO/USP are still available on-line (http://cenbio.iee.usp.br/projetos/biogas_aterro/aterro.htm)

In April/2020, almost 11 years after the finalization of the performed field research by the scholars/researchers of CENBIO/USP, the installed equipment was still being located in the project site, but without any use. The equipment was completely disconnected from the project's LFG collection pipeline (since the time the tests were finalized in June/2009). It is also relevant to note that in April/2020 such captive off-grid power generation equipment was under very bad conditions (with not maintained, rusted and even damaged components and controls) and it was probably not even under conditions to be operated anymore without a major overhauling work.
In April/2020, Essencis Soluções Ambientais S.A. was still awaiting a permanent decision/position from CENBIO regarding the date of definitive removal of all related equipment from the project site. Moreover, further developments in the framework of technical cooperation agreement earlier set between Essencis Soluções Ambientais S.A. and CENBIO/USP are also currently uncertain.

As previously outlined in Monitoring Reports for the project activity encompassing different monitoring periods within the 1st 7-year crediting period, Essencis Soluções Ambientais S.A. highlights that the occurred research / tests performed by CENBIO/USP in the project site was never regarded as a change in the design and or operation of the project activity "Caieiras landfill gas emission reduction" that would need to be addressed via applicable procedure for addressing post-registration changes due to the following aspects:

- The temporary and not continuous operation of the small scale electricity generation facility under CENBIO/USP's research consumed LFG which was indeed collected by the project activity. However such relative small LFG stream was not measured and accounted in the context of the monitoring of quantity of LFG collected and combusted by the project activity.
- Essencis Soluções Ambientais S.A. (and the other project participant for the project activity) did not have any economic benefit by allowing CENBIO/USB to use a very small fraction of collected LFG for testing/evaluation purposes under the established technical cooperation agreement: no sale of LFG occurred, no use of generated electricity occurred (as all electricity was generated by using a resistive load bank connected to the power generation equipment), no renting of space occurred either. No electricity generated in the context of the performed research was ever used to meet the electricity demand of the project activity or electricity demand of the UVS - Caieiras landfill.
- The whole concept of the temporary and not continuous operation of the small-scale pilot electricity generation facility was under a technical research and testing focus (not commercial). The interest of the academics and scholars in the issue of utilization of biogas/LFG generated in landfills and waste water treatment plants (WWTP) as fuel was actually trigged by the CDM. This is one of the positive externalities of the CDM in Brazil: promotion investigations (at least at academic level) of the use of non-conventional renewable energy sources.

*No change in the design and operational conditions of the UVS - Caieiras landfill:*

It is important to note that the design and operational conditions of the UVS - Caieiras landfill has not changed after the implementation of the project activity and it is not expected to change in the future. While the surface covered with MSW at the UVS - Caieiras landfill has increased as part of the normal operational dynamics of such very large landfill, the previously conceived landfill design and operational requirements are still being the same since the start to operations of the landfill in year 2002 (regardless of the later occurred implementation (in year 2007) of the project activity, later occurred dramatic increase in the stream of waste daily disposed in the landfill (as explained in Section A.1). Furthermore, design and operational aspects of the UVS - Caieiras landfill are not expected to change during the 3rd and last 7-year crediting period of the project activity either. The UVS - Caieiras landfill is expected to still being operated with the application of the same and previously applied MSW landfilling technics and procedures.

The more recently initiated (in July/2016) of destruction of methane in the so far installed set of 21 internal combustion gas engines (that represent additional/alternative methane destruction devices for the project activity) is not expected to promote any change in the design and/or operational conditions of the UVS - Caieiras landfill either. Essencis Soluções Ambientais S.A. has designed and has managed and operated the UVS - Caieiras landfill in accordance with its design, construction, operational and management requirements as required and established in the environmental permits and licenses applicable for the UVS - Caieiras landfill and as per best available practices for landfill construction and operation in Brazil.

The whole management and operation plan of the UVS - Caieras landfill has been approved and has been regularly monitored by the competent environmental authority of São Paulo State)[49].

The UVS - Caieiras landfill has always been regarded as a very well-designed and very well-managed landfill. As established by the valid environmental and operational permits, disposed MSW is constantly covered and levelled with the use of heavy equipment (excavators, compacting equipment, etc.). Furthermore, safety requirements are defined and addressed as part of the operation of the landfill by using a preventative approach.

## A.4. Parties and project participants

| Parties involved | Project participants | Indicate if the Party involved wishes to be considered as project participant (Yes/No) |
|---|---|---|
| Brazil (host) | Essencis Soluções Ambientais S.A. (Private Entity) | No |
| Norway | Nordic Environment Finance Corporation | No |

## A.5. Public funding of project activity

>>

No public funding is involved for the implementation and operation of this project activity.

## A.6. History of project activity

**>>**

The project activity “Caieiras landfill gas emission reduction” is registered as under the CDM and it (and/or the infrastructure/components it encompasses) was not previously included as a component project activity (CPA) in a registered CDM programme of activities (PoA). Prior of being registered under the CDM, the project activity (and/or the infrastructure/components it

[49] The competent environmental authority in São Paulo State is the Companhia de Tecnologia de Saneamento Ambiental (CETESB). Copies of related construction, design, operational and management documents and procedures valid for the UVS - Caieiras landfill (incl. copies of all licensing and permit documentation) were made available to the DOE in charge of the validation assessment for the renewal of the crediting period for the project activity.

encompasses) did not represent any part or a whole previously registered CDM project activity that had been deregistered. Prior of being registered under the CDM, the project activity (and/or the infrastructure/components it encompasses) were not part of a previous CPA that has been excluded from a previously registered CDM PoA either.

The project activity (and/or the infrastructure/components it encompasses) does not represent or part of a previously registered CDM project activity or a CPA under a previously registered CDM PoA whose crediting period has or has not expired (hereinafter referred to as former project) which existed within the same or other geographical location as the CDM project activity.

### A.7. Debundling

>>
Not applicable.

## SECTION B. Application of methodologies and standardized baselines

### B.1. References to methodologies and standardized baselines

>>
The following CDM baseline and monitoring methodology is applied:

- Consolidated baseline and monitoring CDM methodology ACM0001 - “Flaring or use of landfill gas” (version 19.0) (https://cdm.unfccc.int/methodologies/DB/JPYB4DYQUXQPZLBDVPHA87479EMY9M);

The following methodological tools are applied:

- Emissions from solid waste disposal sites (version 08.0) (https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-04-v8.0.pdf);

- Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation (version 03.0) (https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-05-v3.0.pdf);

- Tool to calculate project or leakage $CO_2$ emissions from fossil fuel combustion (version 03) (https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-03-v3.pdf)

- Project emissions from flaring (version 03.0) (https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-06-v3.0.pdf);

- Tool to determine the mass flow of a greenhouse gas in a gaseous stream (version 03.0) (https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-08-v3.0.pdf);

- Tool to calculate the emission factor for an electricity system (version 07.0) (https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-07-v7.0.pdf/history_view);

- Combined tool to identify the baseline scenario and demonstrate additionality (version 07.0) (https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-02-v7.0.pdf)

- “Assessment of the validity of the original/current baseline and to update the baseline at the renewal of a crediting period” (version 03.0.1) (http://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-11-v3.0.1.pdf).

## B.2. Applicability of methodologies and standardized baselines

>>

The approved baseline and monitoring methodology ACM0001 (version 19.0) is applied. In addition, the above-listed methodological tools (which are referred by this CDM baseline and monitoring methodology or by one of the applied methodological tools) are also applied. Demonstration applicability conditions for ACM0001 (version 19.0) and for all methodological tools referred in Section B.1 are included in the tables below:

| Applicability Condition of CDM baseline and monitoring methodology ACM0001 – "Flaring or use of landfill gas" (version 19.0) | Justification |
|---|---|
| *"The methodology is applicable under the following conditions:*<br>*(a) Install a new LFG capture system in an existing or new (Greenfield) SWDS where no LFG capture system was or would have been installed prior to the implementation of the project activity; or*<br>*(b) Make an investment into an existing LFG capture system to increase the recovery rate or change the use of the captured LFG, provided that:*<br>*(i) The captured LFG was vented or flared and not used prior to the implementation of the project activity; and*<br>*(ii) In the case of an existing active LFG capture system for which the amount of LFG cannot be collected separately from the project system after the implementation of the project activity and its efficiency is not impacted on by the project system: historical data on the amount of LFG capture and* | As per the CDM project standard for project activities (CDM-PS-PA), in the context of the renewal of crediting period for a previously registered CDM project activity, the PDD valid for the 3rd and last 7-year crediting period is to be completed by applying the latest version of applicable CDM baseline and monitoring methodology. The project activity was previously registered as a CDM project activity by applying the CDM baseline and monitoring methodology ACM0001 (version 2). Later the project activity had its 1st renewal of 7-year crediting period processed with the PDD valid for its 2nd crediting period being registered by applying ACM0001 (version 13.0.0) (which was the latest valid version of ACM0001 baseline and monitoring methodology at that time). While version 19.0 currently represents the latest version of ACM0001, ACM0001 (version 13.0.0) is thus selected as the applicable methodology for the 2nd renewal of the crediting period of the project activity.<br>In the context of the previous registration of the project activity under the CDM, as described in the latest version of the registered PDD valid for the 1st 7-year crediting period (PDD version 4, dated 10/01/2013), the project design encompassed the installation of an active (forced) LFG capture system in an existing SWDS partially replacing a previously existent conventional passive LFG combustion system (using conventional passive LFG venting/combustion drains) [50]. The project was implemented in year 2007. In this sense, condition (b – i) of the quoted applicability criteria is met[51]. |

[50] The installed active (forced) LFG capture system as part of the project activity encompasses entirely new equipment (centrifugal blowers, flares, etc.). By assuming that the project activity replaces the previously existent pre-project passive LFG venting and combustion system (using conventional passive LFG venting/combustion drains), in the particular context of the demonstration of meeting of applicability criteria for ACM0001 (version 19.0), it is assumed that condition (a) is not applicable and condition (b – i) is applicable.

[51] As part of the expected implementation and operation of the project activity during its 3rd and last 7-year crediting period, there is a willingness of the project participant Essencis Soluções Ambientais S.A. to convert or replace the still remaining conventional LFG venting/combustion drains into appropriate LFG collecting wells and connect such appropriate wells into the project's LFG collection pipeline network, thus increasing the project's LFG collection efficiency when compared to the situation within the currently expired 1st and 2nd 7-year crediting periods. During the last years of the 2nd 7-year crediting period, due to operational reasons and location/condition of some of the existing conventional passive LFG venting/combustion drains and due to budget restrictions and operational priority related reasons, it was not

| Applicability Condition of CDM baseline and monitoring methodology ACM0001 – "Flaring or use of landfill gas" (version 19.0) | Justification |
|---|---|
| *flared is available;*<br><br>*(c) Flare the LFG and/or use the captured LFG in any (combination) of the following ways:*<br><br>*(i) Generating electricity;*<br><br>*(ii) Generating heat in a boiler, air heater or kiln (brick firing only) or glass melting furnace; and/or*<br><br>*(iii) Supplying the LFG to consumers through a natural gas distribution network;*<br><br>*(iv) Supplying compressed/liquefied LFG to consumers using trucks;*<br><br>*(v) Supplying the LFG to consumers through a dedicated pipeline;*<br><br>*(d) Do not reduce the amount of organic waste that would be recycled in the absence of the project activity."* | It is important to note that, at the time the project design was conceived (during time period encompassing years 2004 and 2005) as declared in the latest version of the PDD valid for the 1st 7-year crediting period and later in 2007 (when the project activity was actually implemented), there were no pre-project active/forced LFG capture system that has been in operation in the last calendar year prior to the start of the project activity (in year 2007). This is also outlined in the latest version of the registered PDD valid for the 1st 7-year crediting period (PDD version 4, dated 10/01/2013).<br><br>The project design encompasses collection of LFG (which is collected as part of the operation of the project activity [52] ) and its destruction through combustion in the installed high temperature enclosed flares and set of internal combustion gas engines (that represents the major components of a grid-connected electricity generation facility fuelled by collected LFG and located within the geographical limits of the UVS – Caieiras landfill). The project design does not encompass any other type of utilization of collected LFG. Thus, the project activity fully fulfills condition (c).<br><br>As a result of the previously occurred implementation of the project activity, there were no quantitative, qualitative, procedural or regulatory change occurred in terms of MSW management activities and policies valid for the UVS - Caieiras landfill or applicable in any other potential waste treatment or disposal facility under the area of influence of this landfill (that would be promoted or triggered by the project activity) in comparison with what would occur in the absence of the project activity (baseline scenario). This situation is expected to remain the same during the 3rd and last 7-year crediting period of the project activity.<br><br>It is crucial to note that, mainly by taking into consideration the nature of the project activity and aspects related to recycling of organic fraction of MSW in the region of landfill and in the rest of Brazil, |

possible to replace or convert all of such still existent conventional passive LFG venting/combustion drains into appropriate LFG collecting wells (and connect such new wells to the project's LFG collection network).

[52] It is important to note that, as further explained ahead besides of the project's LFG collection wells, despite of all improvements made in the project's LFG collection infrastructure, there are still conventional passive LFG venting/combustion drains under operation at the UVS - Caieiras landfill. In areas of the landfill which are not yet covered by the project's LFG collection wells and LFG collection pipeline network, the use of such conventional drains has been a practice. In April/2020, there were about 100 conventional passive LFG venting/combustion drains yet under operation at the landfill. It is always important to take into account the very large area encompassed by the UVS – Caieiras landfill. Such drains are completely independent and not related to the project activity (with no LFG vented or combusted by such drains being accounted in the context of the determination of amount of methane actually destroyed by the project activity).

| Applicability Condition of CDM baseline and monitoring methodology ACM0001 – "Flaring or use of landfill gas" (version 19.0) | Justification |
|---|---|
| | the implementation and operation of the project activity *per se* are not expected to promote or trigger any quantitative change in waste disposal activities undertaken at the UVS - Caieiras landfill.<br>Furthermore, no quantitative or qualitative changes in terms of waste management practices are expected to be promoted or triggered in any other existent or potential waste disposal or waste treatment facility (located or to be located in the region of influence of the UVS - Caieiras landfill) as a direct outcome or consequence of the operation of the project activity during its 3rd and last 7-year crediting period.<br>Thus, the mere previously occurred implementation of the project and its continuous operation during its 3rd and last 7-year crediting period are not expected to promote or trigger any reduction (or prevention) of the amount of organic type of MSW (or any other type of solid waste) that would eventually be recycled or utilized in the region of influence of the UVS - Caieiras landfill (e.g. no prevention by the project activity of the implementation or and non-promotion of any reduction of activity in an existent or hypothetical waste composting facility that would promote utilization/recycling of waste in the region (for example)).<br><br>As demonstrated in the applicable construction, design and operational requirements valid for the UVS - Caieiras landfill (as defined by Essencis Soluções Ambientais S.A. and confirmed in the previously issued environmental permits for the construction and the operation of this particular landfill site), the UVS - Caieiras landfill is not expected to include any activity or initiative promoting recycling or utilization of organic fraction of waste was to be disposed at this landfill (such as implementation of a large scale waste sorting or waste composting facility for example).<br><br>Without any organic waste recycling activity or initiative being under operation within the limits of the UVS - Caieiras landfill, it is thus clearly not expected that the implementation and operation of the project activity could per se eventually reduce organic waste recycling activities in the UVS - Caieiras landfill.<br>It is imperative to note that design, construction and operational aspects for the UVS - Caieiras landfill were previously defined in accordance with the commercial agreements that the project participant Essencis Soluções Ambientais S.A. currently holds and is expected to hold in the position of operator and owner of the UVS - Caieiras landfill and as regional waste management company (service provider) providing MSW disposal services for municipalities located within the Metropolitan Region of São Paulo.<br>Furthermore, it is also crucial to take into account that |

| **Applicability Condition of CDM baseline and monitoring methodology ACM0001 – "Flaring or use of landfill gas" (version 19.0)** | **Justification** |
|---|---|
| | currently there is not even any existent or planned large-scale MSW sorting, recycling or utilization facility for organic fraction of MSW (e.g. a large-scale waste composting plant) with comparable size/capacity and located in the region of influence of the UVS - Caieiras landfill. As a matter of fact, recycling and utilization of organic fraction of MSW is not a common practice in the whole country of Brazil.<br>In this sense, the implementation and the operation of the project activity per se does not represent any perverse incentive or driver for the promotion of any supposed quantitative or qualitative reduction or prevention of waste recycling related activities (or initiatives for any type of organic fraction of solid waste or solid residues) that would occur in the region of influence of this landfill[53] in the absence of the |

[53] As per the Brazilian Federal Law 12.305/10 passed in year 2010, waste recycling is defined as a process of transformation of waste material and residues through promotion of changes in their physical, chemical or biological properties in order to allow and promote use/utilization of such materials as raw material or even as new products. Although waste recycling is being regarded in the national sector directives for waste management as a priority goal in the whole country, solid waste recycling initiatives in Brazil are still being quite limited (especially in the case of organic fraction of MSW) mainly due to economic restrictions. As outlined in the publication "*Panorama dos Resíduos Sólidos no Brasil – 2018/2019*" (tittle translated into English language as "*Outlook of Solid Waste Sector in Brazil – years 2018/2019"* and available online at: http://abrelpe.org.br/download-panorama-2018-2019/), solid waste recycling initiatives in Brazil have encompassed mainly the following by-products/waste types with higher economic value:

- aluminum (mainly beverage aluminum cans),
- pre-separated/sorted clean (not contaminated) paper,
- pre-separated/sorted (not contaminated) plastic material (mainly PET beverage bottles),
- glass material.

The "*Panorama dos Resíduos Sólidos no Brasil*" is a publication annually published by the Associação Brasileira de Empresas de Limpeza Pública e Resíduos Especiais – ABRELPE (translated into English language as "Brazilian Association for Municipal Solid Waste and Special Waste") and has represented one of the most credible annual outlook and statistics source for the solid waste management in the country. The most recent Greenhouse Gases Emissions National Inventory (published by the Brazilian Ministry of Technology and Science in 2010 and available online at: http://www.mct.gov.br/upd_blob/0213/213909.pdf) also confirms that non-conventional MSW treatment alternatives (such as composting of organic fraction of MSW and waste incineration) are not meaningful practices in Brazil (including the region where the project activity is implemented).
In fact, in year 2012 the Brazilian Ministry of City Infrastructure (through its National Secretary of Sanitation) has published the year 2017 edition of a very comprehensive and detailed sectoral analysis/diagnostic about the whole MSW sector in Brazil: the publication "*Diagnóstico do Manejo de Resíduos Sólidos Urbanos – 2017*" (tittle translated into English language as "Diagnostics of Urban Solid Waste Management - 2017" and available online at: http://www.snis.gov.br/diagnostico-residuos-solidos/diagnostico-rs-2017). Like the Report "*Panorama dos Resíduos Sólidos no Brasil – 2018/2019*", this Government official publication also includes relevant and detailed statistics for MSW management for the main municipalities, States and regions in Brazil. Available statistics includes prevailing practices in terms of waste management practices (collection, disposal and re-use/recycle).
In the particular case of the region under potential influence of the UVS – Caieiras landfill (cities which are part of the Metropolitan Region of São Paulo), all solid waste materials (organic or inert) to be eventually/potentially recycled (very small share of collected MSW) are normally previously sorted (under very limited percentiles) in the waste generation sources (prior to be mixed with other types of MSW to be disposed in landfills or waste dump sites in the region). In the particular case of recycling of organic fraction of waste material to be disposed in landfills or dump sites, the current *status quo* is also expected to be the prevailing situation valid in the future: paper waste streams (mixed with other MSW types), food residues, textile, wood waste etc. when ready to be disposed in landfills/dump sites or already disposed in a particular landfills or dump sites) are not even regarded as recyclable material (and thus not even accounted in the available statistics for recyclable material).
Under the category "*organic MSW fraction*" only clean (not contaminated) and previously appropriately sorted pulp/paper/cardboard waste materials have actually been regarded as recyclable material as per both available statistics and available recycling practices. Besides some particular inert waste materials with attractive commercial value (e.g.

aluminum packaging material (e.g. cans), some types of clean plastic material and some types of glass), no other waste materials have been normally collected from stream of MSW to be disposed in landfills in order to be eventually recycled in the region where the project activity is implemented and/or even transported to be recycled in other region. This has also been the typical waste recycling scenario in other regions of Brazil.

Thus, in the particular case of the UVS – Caieiras landfill, both under the baseline and project scenarios (with or without the implementation of the project activity), no organic fraction of solid waste stream that has been directed to this particular landfill would be expected to be collected and directed to any type of recycling facility (e.g. composting facility) after or prior its disposal at the landfill site. This situation is expected to remain being the practice in the future. In fact, as established by related construction and design documents for the UVS – Caieiras landfill, no waste pickers or waste sorting teams have ever operated in the landfill area. No composting plant for organic waste (or any other type of alternative management for MSW organic content) was ever implemented or is expected to be implemented in the area in the future either.

All of the above-summarized facts and aspects confirms that no relevant sorting and collection of recyclable organic material from MSW already disposed in the UVS – Caieiras landfill are expected to occur regardless of the implementation of the project activity (under both baseline and project scenarios). Thus, recycling or alternative use/utilization of organic fraction from waste already disposed in the landfill are not expected to occur either (regardless of the implementation of the project activity).

In summary, based on information and data included in the "*Diagnóstico do Manejo de Resíduos Sólidos Urbanos – 2017*"; information and data available in the "*Panorama dos Resíduos Sólidos no Brasil – 2018/2019*" and also based on common practice for waste collection, currently existing very limited and not relevant recycling initiatives in the region of the project activity and even in other regions in Brazil, and by also taking into account the particular situation at the region of the project site, the following assertions are valid for potential of recycling of organic fraction of MSW in the region of influence of the UVS – Caieiras landfill:

- The current MSW management practice in Brazil (and its trend for the future) represents disposal of collected MSW in existing and new landfills (and still existing open dump sites). This practice currently represents almost all undertaken management for all stream of MSW which is actually collected (in mass basis); with very reduced share of collected MSW in Brazil being currently treated under non-conventional methods such as waste incineration (0.03%) and composting (0.11%) (in mass basis as per data of year 2017 (data organized and published in year 2019)).
- It is important to note that in all regions in Brazil with existing MSW disposal activities using landfilling techniques (in existing landfill or existing dump sites) significant quality improvements in terms of MSW disposal services and techniques are still being required especially for cases where solid waste is disposed in existing not-well-managed landfill or dump sites. Such required improvements include construction of better-designed landfills, use of more appropriated technics for waste compacting and covering, etc. In this particular sense, the UVS – Caieiras landfill represents a very well designed and very well managed landfill. The main barrier for improving MSW management in Brazil is still being lack of capital and investment capacity from municipalities to face high associated costs for implementing environmentally friendly MSW management operations. Under the region of influence of the UVS – Caieiras landfill, organic fraction of solid waste material that is collected as MSW has been historically disposed by applying landfilling techniques.
- In all geographical regions in Brazil, relative very low share of previously sorted pulp/paper/cardboard (clean and not contaminated) waste materials have been used as recycling material in the region. Materials under such conditions are termed in the available statistics as "dry recyclable material" and are normally not mixed with MSW stream to be sent to landfills or dump sites. It is important to note that the initiatives and businesses involving recycling of previously sorted dry pulp/paper/cardboard materials (clean and not contaminated materials) have their particular dynamics and characteristics and with not so detailed statistics in some cases. However, under no circumstance such activities are to be affected or even influenced by change, improvements or aspects related to MSW disposal activities employing good landfilling technics (for example: in most of the well managed landfills in Brazil, the landfill is implemented in a closed and controlled area without waste pickers collecting waste from the landfill as a way or living). By taking into consideration the dynamics of initiatives promoting recycling of paper material, it is correct to assume that, differently than for MSW disposal activities; policies, planning and practices related to MSW collection and sorting could indeed under a certain limit play a role such initiatives.
- By merely promoting efficient collection and destruction/utilization of LFG in a landfill (where LFG is generated due to anaerobic degradation of organic fraction of MSW which is to be disposed in the landfill under the framework of contracts for MSW disposal signed with municipalities in the region), the implementation of the project activity and its continuous operation *per-se* clearly do not represent any driver or incentive for promoting any change in the MSW management situation in the region where it is implemented (including waste recycling practices or initiatives for organic content of MSW to be disposed in landfills or dump sites).

By taking into account (i) the institutional and regulatory framework for the public service of MSW management; (ii) the dynamics of MSW sector in the region where the project activity is to be implemented and in Brazil, and (iii) magnitude of average costs for existing MSW management options (which could be regarded as alternatives to disposal of MSW in landfills (e.g employment of MSW composting techniques)), (iv) the available related statistics, the following aspects are also to be noted:

- it is clear that promotion or even disincentive of recycling of organic fraction of MSW are not waste policy aspects that would be under any influence or willingness of the project participant Essencis Soluções Ambientais S.A. (as owner and operator of the UVS – Caieiras landfill). Aspects and actions related to promotion of any increase or even reduction of recycling of organic fraction of waste (and/or recycling of any

| Applicability Condition of CDM baseline and monitoring methodology ACM0001 – "Flaring or use of landfill gas" (version 19.0) | Justification |
|---|---|
| | project activity at the UVS - Caieiras landfill. The same is actually also applicable for recycling of inert waste material.<br><br>Furthermore, regardless of the non-existence of any MSW recycling or utilization facility with comparable capacity that could eventually somehow compete with the UVS - Caieiras landfill as disposal site for organic fraction of MSW waste, aspects and actions related to promotion of recycling or utilization of organic fraction of solid waste are to be seen as fully dependent on regional and/or national public service policies in the case of Brazil (including policies, laws, regulations and programmes) and such aspects and actions are to be defined/triggered by competent governmental authorities (under a regional and national level) and/or to be eventually implemented/operated by practitioners of waste recycling.<br><br>In Brazil, the administrations of municipalities typically are the entities responsible for all MSW management services. In this context, waste management companies such Essencis Soluções Ambiental S.A. normally acts as service providers, providing MSW collection and disposal services as per directives and contractual requirements set by the municipalities |

other type of solid waste material) in the region where the project activity is implemented, are to be seen as dependent in a last instance on public service policies (including policies, laws, regulations and programmes) to be set by competent governmental authorities (under a regional and national level) and by practitioners of recycling. In Brazil, the administrations of municipalities are responsible for addressing all MSW management services. Furthermore, there are federal directives and laws to be considered by Municipalities for the implementation and operation of their local waste management policies. This is the case in the geographical region of the project site. Waste collection and disposal services are normally performed by the municipality and/or are performed by private companies hired and paid by one or more municipalities (under contractual commercial agreements for provision of public service on behalf of such municipality (ies)) for the provision of MSW collection and/or MSW disposal services by completely following directives and requirements established by the municipalities in signed contracts. In this context, both under the baseline and project scenarios (with or without the implementation of the project activity), the project participant Essencis Soluções Ambientais S.A. is not under a position to design or plan the implementation of any initiative promoting recycling or use of organic waste (e.g. operation of a solid waste composting plant) at the UVS – Caieiras landfill or at other location in the region.

- The implementation and operation of the project-based initiative promoting collection of LFG and its destruction in high temperature flare and utilization as fuel for electricity generation at the UVS – Caieiras landfill *per se* would not trigger any change in the regional policies and practices for MSW management in the region or outside its region of influence either. As further discussed in Sections B.4 and B.6.1, so far, there is still no legal restriction neither requirement for LFG gas collection and its destruction using high temperature enclosed flares in Brazil. Moreover, there is still no legal restriction neither requirement for passive venting of LFG or its combustion in conventional LFG destruction systems either. There is no applicable regulation/law that deals with LFG management in Brazil. Thus, the implementation (and operation) of more appropriate and environmentally safe management of LFG at the UVS – Caieiras landfill as part of the project activity does not represent a driver or incentive to promote incremental disposal of organic waste stream at this landfill thus displacing or preventing such waste stream from being treated under an existent or potential (hypothetical) MSW recycling/utilization facilities (e.g. a hypothetical waste composting plant) instead.

In summary, by taking into consideration the nature of project activity and all facts/aspects and information above-presented, the project activity clearly does not pose any risk or potential to promote any relative decrease of the amount of organic fraction of MSW that would be otherwise recycled or utilized or prevention of any mean of waste recycling or utilization.

| Applicability Condition of CDM baseline and monitoring methodology ACM0001 – “Flaring or use of landfill gas” (version 19.0) | Justification |
|---|---|
| | from which generated MSW are to be managed (collected and disposed). In this sense, in the position of a MSW management company operating a LFG collection and destruction initiative in the landfill it operates and owns, Essencis Soluções Ambientais S.A. is not under a position to trigger, establish or promote any reduction or prevention of organic waste recycling in the region where it operates.<br><br>Finally, the implementation and operation of the project activity has never represented any incentive or driver for involved municipalities, any other public entity or any other relevant recycling practitioner for the promotion of changes in policies and practices related to recycling of inert or organic solid waste in the region of influence of the UVS - Caieiras landfill (or even beyond such region). No change in this sense is expected to occur during the 3rd and last 7-year crediting period either.<br><br>As outlined in Section B.4 and B.6.1, so far, there are still no legal restrictions or requirements for LFG gas collection and its destruction using high temperature enclosed flares or any other device/equipment in Brazil. Moreover, there are still no legal restrictions neither requirements for venting and/or combustion of LFG in conventional passive LFG destruction systems either (where combustion of small and not defined share of generated LFG through use of conventional passive LFG venting/combustion drains is identified as the baseline scenario for the project activity).<br>Actually, there are no applicable regulations that deal with LFG management in Brazil at all. Thus, the implementation of more appropriate and environmentally safe management of LFG at the UVS - Caieiras landfill (as a direct outcome of the implementation and operation of the project activity) *per se* does not represent any driver or incentive to dispose incremental amount of MSW in the UVS - Caieiras landfill (when compared to the situation that would occur in the absence of the project) either. In this sense, under no circumstance, the project activity *per se* potentially promotes any displacement of volumes of organic waste stream from treatment/utilization being performed in an existent or hypothetical MSW recycling/utilization facilities (e.g. a MSW composting plant for example) in order to be disposed at the UVS - Caieiras landfill as a direct result of the implementation and operation of the project activity. Therefore condition (d) is also satisfied. |

| **Applicability Condition of CDM baseline and monitoring methodology ACM0001 – "Flaring or use of landfill gas" (version 19.0)** | **Justification** |
|---|---|
| "*The methodology is only applicable if the application of the procedure to identify the baseline scenario confirms that the most plausible baseline scenario is*<br>*(a) Atmospheric release of LFG or capture of LFG and destruction through flaring to comply with regulations or contractual requirements, to address safety and odour concerns, or for other reasons; and*<br>*(b) In the case that the LFG is used in the project activity for generating electricity and/or generating heat in a boiler, air heater, glass melting furnace or kiln;*<br>*(i) For electricity generation: that electricity would be generated in the grid or in captive fossil fuel fired power plants; and/or*<br>*(ii) For heat generation: that heat would be generated using fossil fuels in equipment located within the project boundary."*<br>*(c) In the case of LFG supplied to the end-user(s) through natural gas distribution network, trucks or the dedicated pipeline, the baseline scenario is assumed to be displacement of natural gas.*<br>*(d) In the case of LFG from a Greenfield SWDS, the identified baseline scenario is atmospheric release of the LFG or capture of LFG in a managed SWDS and destruction through flaring to comply with regulations or contractual requirements, to address safety and odour concerns, or for other reasons.* | As further demonstrated in Section B.4, the most plausible baseline scenario for methane emissions remains being the release of LFG from the SWDS directly into the atmosphere (with minor share of generated LFG being partially destroyed in conventional passive LFG venting/combustion drains). The application of the procedure to identify the baseline scenario thus falls into (a).<br>While the project activity does not encompass supply of LFG to the end-user(s) through natural gas distribution network, trucks or the dedicated pipeline, (c) is thus not applicable. While the UVS - Caieiras landfill does not represent a Greenfield SWDS, (d) is not applicable either. |
| **Non applicability conditions** | **Justification** |
| *"This methodology is not applicable:*<br>*(a) In combination with other approved methodologies. For instance, ACM0001 cannot be used to claim emission reductions for the* | Neither options (a) and/or (b) occur.<br>Under the revised project design configuration, the only GHG emission reductions claimed are due to destruction of methane through combustion (in high temperature enclosed flares and in internal combustion gas engines) |

| Applicability Condition of CDM baseline and monitoring methodology ACM0001 – "Flaring or use of landfill gas" (version 19.0) | Justification |
|---|---|
| *displacement of fossil fuels in a kiln or glass melting furnace, where the purpose of the CDM project activity is to implement energy efficiency measures at a kiln or glass melting furnace;*<br>(b) *If the management of the SWDS in the project activity is deliberately changed in order to increase methane generation compared to the situation prior to the implementation of the project activity.* | After the implementation of the project activity in year 2007, the landfill operator has continued with MSW disposal activities at the UVS - Caieiras landfill as per its normal and previously planned/defined operation conditions and practices (as per the practice prior to the implementation of the project activity). MSW disposal practices and management at the UVS - Caieiras landfill are not expected to change during the 3rd and last 7-year crediting period of the project activity[54].<br>The quoted applicability condition is thus satisfactory met. |

Regarding the applied methodological tools, the table below summarizes how the project activity meets their applicability conditions:

| Methodological tool | Version | Applicability conditions | Comments |
|---|---|---|---|
| "Project emissions from flaring" | 03.0 | *"This tool provides procedures to calculate project emissions from flaring of a residual gas, where the component with the highest concentration is methane. The source of the residual gas is biogenic (e.g. landfill gas or biogas from wastewater treatment) or coal mine methane.*<br><br>*(…)*<br><br>*This tool provides procedures to calculate project emissions from flaring of a residual gas. The tool is applicable to enclosed or open flares and project participants should document in the CDM-PDD the type of flare used in the project activity.*<br><br>*This tool is applicable to the flaring of flammable greenhouse gases where:*<br>*(a) Methane is the component with the highest concentration in the flammable residual gas;* | As part of the project activity, share of collected LFG (whose component with the highest concentration is methane) is combusted in high temperature enclosed flares with other share being combusted in internal combustion gas engines.<br><br>ACM0001 requires that, as part of the determination of baseline emissions, project emissions from flaring are to be determined.<br><br>LFG is a flammable gas generated from the anaerobic decomposition of organic waste material disposed in the UVS - Caieiras landfill. LFG is thus a gas from a biogenic source. Methane is the |

[54] The operation of the UVS - Caieiras landfill in terms of disposal of MSW (practices of waste disposal, covering, levelling, compacting, leachate management, etc.) has not changed after the implementation of the project activity and no change is expected to occur along the 3rd and last 7-year crediting period either. Thus there is no valid action promoting increase in methane generation (like e.g. through addition of liquids, pre-treating waste, changing the shape of the landfill) that was triggered or promoted by the project activity at the UVS - Caieiras landfill when compared to the situation prior to the implementation of the project activity.

| Methodological tool | Version | Applicability conditions | Comments |
|---|---|---|---|
| | | *and*<br><br>*(b) The source of the residual gas is coal mine methane or a gas from a biogenic source (e.g. biogas, landfill gas or wastewater treatment gas).*<br><br>*The tool is not applicable to the use of auxiliary fuels and therefore the residual gas must have sufficient flammable gas present to sustain combustion. For the case of an enclosed flare, there shall be operating specifications provided by the manufacturer of the flare.*<br><br>*This methodological tool refers to the latest approved version of "TOOL08: Tool to determine the mass flow of a greenhouse gas in a gaseous stream".* | component with the highest concentration in LFG[55].<br><br>No auxiliary fuel is required to make the flammability of LFG sufficiently enough to be combusted in the project flares[56].<br><br>As demonstrated below, the applicability conditions for the methodological tool "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" are sufficiently met.<br><br>Thus, the quoted applicability conditions defined in the methodological tool are sufficiently met. |
| "Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation" | 03.0 | *"This tool provides procedures to estimate the baseline, project and/or leakage emissions associated with the consumption of electricity, and procedures to monitor the amount of electricity generated by the project power plant.*<br><br>*(…)*<br><br>*If emissions are calculated for* | As established by ACM0001 (version 19.0), consumption of electricity by the project activity is to be accounted as project emissions.<br><br>Under normal operational situations, electricity demand of the project activity (under its current design configuration) is expected to be met through imports of |

[55] In the particular case of LFG collected and combusted in the enclosed flares as part of the project activity, it has been confirmed that methane is indeed the component of LFG with the highest concentration in the existent LFG analysis reports previously issued by the industrial gas supply company White Martins Gases Industriais Ltda.

[56] In accordance with the design of the four currently installed high temperature enclosed flares, Liquefied Petroleum Gas (LPG) has been used during short time periods for igniting the flares. For starting the flares, LPG is directed to the fuel injectors of the flare and once the flame is sufficiently stable, LFG is directed to the flares and supply of LPG to the injectors is thus interrupted. The use of LPG by the project activity is also outlined in the latest version of the registered PDD valid for the 1st 7-year crediting period (PDD version 4, dated 10/01/2013). By taking into account the type/purpose of use of LPG by the project activity, it is deemed correct to assume that LPG does not represent any auxiliary fuel (which would be required to make the flammability of LFG sufficiently enough to be combusted in the project flares). It is important to note that during the short time LPG is being combusted during the flare ignition process, no measurements of LFG directed to flares are performed with the flare meeting the operational requirements (as set by equipment manufacturer (e.g. min. flow, min. temperature of exhaust gas of the flare, etc.)). Thus, whenever the minor quantity of LPG is being combusted in the flare, no emission reductions due to methane combustion are claimed. It is important to note that as outlined in Section B.6.1, all consumption of LPG by the project activity to ignite the flares are to be accounted as project emissions. It is also crucial to note that utilization of LPG for igniting the high temperature enclosed flares may be temporarily interrupted in the future. The host-country project participant and project owner Essencis Soluções Ambientais S.A. has evaluated the technical possibility of using collected LFG for igniting the flares instead of using LPG. During time periods LPG is not utilized, no project emission due to the consumption of such fossil fuel will thus have to be accounted. Moreover, upon a decision of permanently phase out the utilization of LPG for igniting the flares, this will be addressed as per applicable procedures for addressing post-registration changes in the project design.

| Methodological tool | Version | Applicability conditions | Comments |
| --- | --- | --- | --- |
| | | *electricity consumption, the tool is only applicable if one out of the following three scenarios applies to the sources of electricity consumption:*<br><br>*(a) Scenario A: Electricity consumption from the grid. The electricity is purchased from the grid only, and either no captive power plant(s) is/are installed at the site of electricity consumption or, if any captive power plant exists on site, it is either not operating or it is not physically able to provide electricity to the electricity consumer;*<br><br>*(b) Scenario B: Electricity consumption from (an) off-grid fossil fuel fired captive power plant(s). One or more fossil fuel fired captive power plants are installed at the site of the electricity consumer and supply the consumer with electricity. The captive power plant(s) is/are not connected to the electricity grid; or*<br><br>*(c) Scenario C: Electricity consumption from the grid and (a) fossil fuel fired captive power plant(s). One or more fossil fuel fired captive power plants operate at the site of the electricity consumer. The captive power plant(s) can provide electricity to the electricity consumer. The captive power plant(s) is/are also connected to the electricity grid. Hence, the electricity consumer can be* | grid-sourced electricity. In cases of impossibility of meeting the project's electricity demand through imports of grid-sourced electricity, electricity generated by the backup captive off-grid electricity generator (fuelled by diesel) will be consumed by the project activity[57].<br><br>Thus, Scenario C of the tool is applicable.<br><br>In summary, the quoted applicability criteria defined in the methodological tool are sufficiently met.<br><br>It is important to note that, as further explained in Section A.3, any potential emission reductions associated to generation of electricity by the grid-connected electricity generation infrastructure fuelled by LFG and located within the geographical limits of the UVS – Caieiras landfill will not be accounted during the 3rd and last 7-year crediting period of the project activity. As further explained in Sections B.6.1, B.7.1 and B.7.3, consumption by the project activity of electricity generated by the grid-connected electricity generation infrastructure fuelled by LFG located within the geographical limits of the UVS – Caieiras landfill will be accounted as consumption of grid-sourced electricity (with related project emissions being ex-post determined). |

[57] Since July/2016, the project's electricity demand can technically be met by one of the following sources/approaches:

- Imports of grid-sourced electricity
- Electricity supply by the installed backup captive off-grid electricity generator (fuelled by diesel) (expected to occur only during temporary planned or unplanned circumstances when supply of grid-sourced electricity is also interrupted).

  **Note:** The backup electricity generator is activated automatically (through automatic switching control) whenever supply of grid-sourced electricity to the project activity is interrupted. The available automatic switching control does not allow the backup electricity generator being connected to the electricity grid. Thus, under no circumstance the project's electricity demand can be met simultaneously by grid-sourced electricity and by backup electricity generator (fuelled by diesel).

| Methodological tool | Version | Applicability conditions | Comments |
|---|---|---|---|
| | | *provided with electricity from the captive power plant(s) and the grid."* | |
| "Emissions from solid waste disposal sites" | 08.0 | *"This tool provides procedures to calculate baseline, project or leakage emissions of methane from solid waste disposed or prevented from disposal at a solid waste disposal site (SWDS)."*<br><br>*"The tool can be used to determine emissions for the following types of applications:*<br>*(a) Application A: The CDM project activity mitigates methane emissions from a specific existing SWDS. Methane emissions are mitigated by capturing and flaring or combusting the methane (e.g. "ACM0001: Flaring or use of landfill gas"). The methane is generated from waste disposed in the past, including prior to the start of the CDM project activity. In these cases, the tool is only applied for an ex ante estimation of emissions in the project design document (CDM-PDD). The emissions will then be monitored during the crediting period using the applicable approaches in the relevant methodologies (e.g. measuring the amount of methane captured from the SWDS);*<br><br>*(b) Application B: The CDM project activity avoids or involves the disposal of waste at a SWDS. An example of this application of the tool is ACM0022, in which municipal solid waste (MSW) is treated with an alternative option, such as composting or anaerobic digestion, and is then prevented from being disposed of in a SWDS. The methane is generated from waste disposed or avoided from disposal during the crediting period. In these cases, the tool can be applied for both ex ante and ex post estimation of emissions. These project activities may apply the simplified approach detailed in 0 when calculating baseline emissions.* | The project activity mitigates methane emissions from a landfill. The applicability of the methodological tool is thus met. Application A in the methodological tool is selected and applied in the context of calculations of ex-ante estimates of emission reductions to be achieved by the project activity during its 2nd 7-year crediting period as established by ACM0001 (version 19.0).<br>Thus, the quoted applicability criteria defined in the methodological tool are sufficiently met. |
| "Tool to calculate the emission factor for an electricity | 07.0 | *This methodological tool determines the $CO_2$ emission factor for the displacement of electricity generated by power plants in an electricity system, by* | Project emissions due to the consumption of grid-sourced electricity by the project activity are |

| Methodological tool | Version | Applicability conditions | Comments |
| --- | --- | --- | --- |
| system” | | *calculating the “combined margin” emission factor (CM) of the electricity system.*<br><br>*(…)*<br><br>*The CM is the result of a weighted average of two emission factors pertaining to the electricity system: the “operating margin” (OM) and the “build margin” (BM). The operating margin is the emission factor that refers to the group of existing power plants whose current electricity generation would be affected by the proposed CDM project activity. The build margin is the emission factor that refers to the group of prospective power plants whose construction and future operation would be affected by the proposed CDM project activity.*<br><br>*(…)*<br><br>*This tool may be applied to estimate the OM, BM and/or CM when calculating baseline emissions for a project activity that substitutes grid electricity that is where a project activity supplies electricity to a grid or a project activity that results in savings of electricity that would have been provided by the grid (e.g. demand-side energy efficiency projects).*<br><br>*(…)*<br><br>*In case of CDM projects the tool is not applicable if the project electricity system is located partially or totally in an Annex I country.”* | determined by applying applicable guidance of methodological tool “Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation” (of which ACM0001 version 19.0 refers to).<br><br>The methodological tool “Tool to calculate the emission factor for an electric system” is referred to in the methodological tool “Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation” for the purpose of calculating project emissions in case where a project activity consumes electricity from the grid.<br><br>The $CO_2$ emission factor for the electricity grid which sources electricity to the project activity is determined as the combined margin $CO_2$ emission factor[58].<br><br>The electricity grid (to which the project activity is connected to) is not located partially or totally in an Annex I country.<br><br>The relevant applicability conditions of the methodological tool are thus fully met. |
| “Combined tool to identify the baseline scenario and demonstrate additionality” | 07.0 | “*This tool is only applicable to methodologies for which the potential alternative scenarios to the proposed project activity available to project participants cannot be implemented in parallel to the proposed project activity”*<br>*(…)* | As established by ACM0001 (version 19.0), this methodological tool is applied as per the methodology for the demonstration of the continuation of the baseline scenario. |

[58] The DNA of Brazil has regularly calculated and reported values for the $CO_2$ emission factor of the National Electricity Grid of Brazil. Such values are reported as being determined/calculated through application of the methodological tool “Tool to calculate the emission factor for an electricity system” (version 07.0 and previous versions).

| Methodological tool | Version | Applicability conditions | Comments |
|---|---|---|---|
| | | *For example, in the following situations a methodology could refer to this tool:*<br>- *For an energy efficiency CDM project where the identified potential alternative scenarios are: (a) retrofit of an existing equipment, or (b) replacement of the existing equipment by new equipment, or (c) the continued use of the existing equipment without any retrofits;*<br>- *For a CDM project activity related to the destruction of a greenhouse gas in one site where the identified potential alternative scenarios are: (a) installation of a thermal destruction unit, or (b) installation of a catalytic destruction system, or (c) no abatement of the greenhouse gas.*<br><br>*In these cases, the project proponents could not implement the three alternatives in parallel but they could only implement one of them."*<br>*However, the tool is, for example, not applicable in the following situation: the CDM project activity is the installation of a Greenfield facility that provides a product to a market (i.e. electricity, cement, etc.) where the output could be provided by other existing facilities or new facilities that could be implemented in parallel with the CDM project activity."* | The project activity encompasses destruction of a greenhouse gas in one site where one of the identified potential alternative scenarios is no abatement of the greenhouse gas.<br><br>The continuation of the baseline scenario is demonstrated by applying the stepwise procedure of ACM0001 (version 19.0) for the determination of the baseline scenario. Baseline emissions are also determined by applying methodological approach also established by ACM0001 (version 19.0) and applicable methodological tools.<br><br>The applicability condition of the methodological tool is thus met. |
| "Tool to calculate project or leakage $CO_2$ emissions from fossil fuel combustion" | 03.0 | This tool provides procedure to determine and calculate project and/or leakage $CO_2$ emissions from the combustion of fossil fuels. It is used in cases where $CO_2$ emissions from fossil fuel combustion (for use other than for electricity generation) are calculated based on the quantity of fuel combusted and its properties. | As established by ACM0001 (version 19.0), this methodological tool is applied for the determination of project emissions due to the consumption of fossil fuel by the project activity (with fossil fuel being use for purposes other than for electricity generation).<br>In the particular case of the project activity Liquefied Petroleum Gas (LPG) has been used to ignite the flares.<br>The applicability condition of the methodological tool is thus met. |

| Methodological tool | Version | Applicability conditions | Comments |
|---|---|---|---|
| “Tool to determine the mass flow of a greenhouse gas in a gaseous stream” | 03.0 | “*Typical applications of this tool are methodologies where the flow and composition of residual or flared gases or exhaust gases are measured for the determination of baseline or project emissions, which is the case of the present project activity”* | As established by ACM0001 (version 19.0), this tool is applied as per the methodology for determining the mass flow of $CH_4$ which is sent for combustion in the set of flares and/or in the set of internal combustion gas engines.<br><br>The applicability condition of the methodological tool is thus met. |
| Methodological tool “Assessment of the validity of the original/current baseline and to update the baseline at the renewal of a crediting period” | 03.0.1 | “*This tool provides a stepwise procedure to assess the continued validity of the baseline and to update the baseline at the renewal of a crediting period, as required by paragraph 49 (a) of the modalities and procedures of the clean development mechanism. The tool consists of two steps. The first step provides an approach to evaluate whether the current baseline is still valid for the next crediting period. The second step provides an approach to update the baseline in case that the current baseline is not valid anymore for the next crediting period.*” | The application of this tool in the context of the renewal of the 7-year crediting period is required as per the CDM project standard for project activities (CDM-PS-PA). The applicability condition of the methodological tool is thus met. |

## B.3. Project boundary, sources and greenhouse gases (GHGs)

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The boundary for the project activity includes the landfill site where LFG rich in methane is captured and destroyed (through combustion of LFG in a set of enclosed high temperature flares and/or in a set of internal combustion gas engines (collectively regarded as methane destruction devices for the project activity)). The electricity grid to which the project activity is connected to[59] is the National Electricity Grid of Brazil. The table below provides a summary of the delineation of greenhouse gases (GHG) and sources included and excluded from the project boundary:

[59] Since July/2016, the project's electricity demand can technically be met by one of the following sources/approaches:

- Imports of grid-sourced electricity (with electricity sourced by the grid-connected electricity generation infrastructure fuelled by LFG and located within the geographical limits of the UVS – Caieiras landfill being regarded and accounted as consumption of grid-sourced electricity as justified in Box 2c in Section A.3).
- Electricity supply by the installed backup captive off-grid electricity generator (fuelled by diesel) (expected to occur only during temporary planned or unplanned circumstances when supply of grid-sourced electricity is also interrupted).

  **Note:** The backup electricity generator is activated automatically (through automatic switching control) whenever supply of grid-sourced electricity to the project activity is interrupted. The available automatic switching control does not allow the backup electricity generator being connected to the electricity grid. Thus, under no circumstance the project's electricity demand can be met simultaneously by grid-sourced electricity and by backup electricity generator (fuelled by diesel).

| | Source | GHG | Included? | Justification/Explanation |
|---|---|---|---|---|
| Baseline | Emissions from decomposition of waste at the SWDS site. | $CO_2$ | No | $CO_2$ emissions from decomposition of organic waste are not accounted since the $CO_2$ is also released under the project activity. |
| | | $CH_4$ | Yes | The major source of GHG emissions in the baseline |
| | | $N_2O$ | No | $N_2O$ emissions are very small when compared to $CH_4$ emissions from SWDS (in $tCO_2e$). This is conservative. |
| | Emissions from electricity generation | $CO_2$ | No | As explained in Box 2c in Section A.3, baseline emissions associated to electricity generation by the grid-connected electricity generation infrastructure (fuelled by LFG collected by the project activity) and located within the geographical limits of the UVS – Caieiras landfill are not accounted since the project activity does not encompass electricity generation as additional GHG abatement measure. |
| | | $CH_4$ | No | Excluded for simplification. This emission source is assumed to be very small. |
| | | $N_2O$ | No | Excluded for simplification. This emission source is assumed to be very small. |
| Project activity | Emissions from consumption of LPG by the project activity | $CO_2$ | Yes | May be an important/material emission source. |
| | | $CH_4$ | No | Excluded for simplification. This emission source is assumed to be very small. |
| | | $N_2O$ | No | Excluded for simplification. This emission source is assumed to be very small. |
| | Emissions from consumption of grid-sourced electricity by the project activity | $CO_2$ | Yes | May be an important/material emission source. |
| | | $CH_4$ | No | Excluded for simplification. This emission source is assumed to be very small. |
| | | $N_2O$ | No | Excluded for simplification. This emission source is assumed to be very small. |
| | Emissions from consumption of electricity sourced by the backup captive off-grid electricity generator (fuelled by diesel) | $CO_2$ | Yes | May be an important/material emission source. |
| | | $CH_4$ | No | Excluded for simplification. This emission source is assumed to be very small. |
| | | $N_2O$ | No | Excluded for simplification. This emission source is assumed to be very small. |

The schematic flow diagram below summarizes the project boundary and delineates the project activity (equipment, parameters to be monitored, and GHG included in the project boundary).

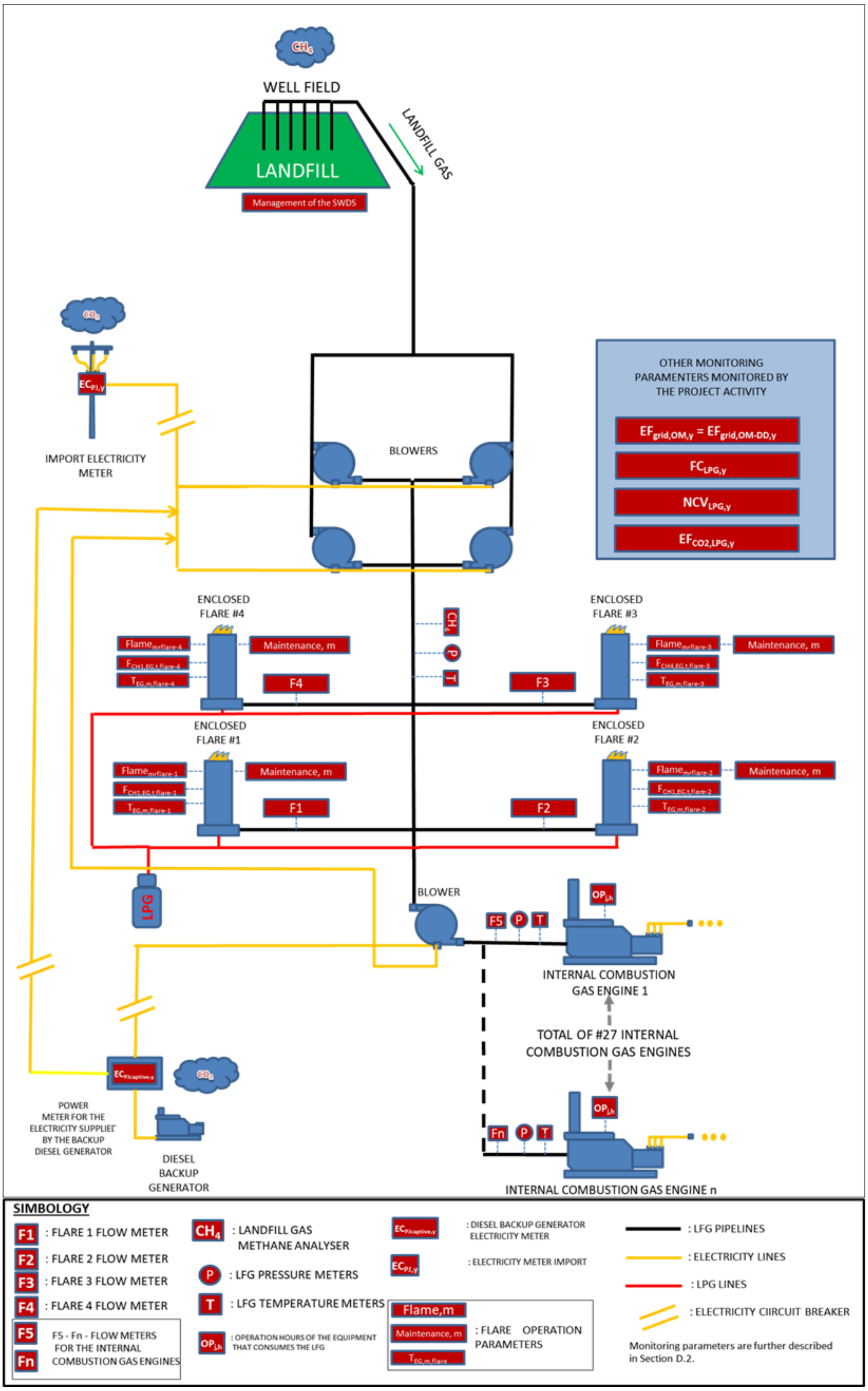


Figure 16 - Diagram summarizing the project boundary and delineating the project activity (equipment, parameters to be monitored, and GHG included in the project boundary)[60]

[60] The reference "*TOTAL OF #27 INTERNAL COMBUSTION GAS ENGINES*" represents the number of gas engines in which methane is also destroyed upon conclusion of the whole gradual/phased implementation of the grid-connected electricity generation infrastructure fuelled by LFG and located within the geographical limits of the UVS – Caieiras landfill (currently forecasted to be concluded by year 2022).

## B.4. Establishment and description of baseline scenario

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This Section includes the application of the stepwise approach of the latest version of methodological tool “Assessment of the validity of the original/current baseline and to update the baseline at the renewal of a crediting period” in order to confirm the identification of the baseline scenario for the project activity within its 3rd and last 7-year crediting period.

***<u>Application of the stepwise approach of the methodological tool “Assessment of the validity of the original/current baseline and to update the baseline at the renewal of a crediting period”:</u>***

As per applicable guidance of the CDM project cycle procedure for project activities (CDM-PCP-PA), the stepwise approach of the methodological tool “Assessment of the validity of the original/current baseline and to update the baseline at the renewal of a crediting period” (version 03.0.1) (hereinafter referred to as “baseline validity tool”) is to be applied in order to confirm the validity of the previously determined baseline scenario of the project activity.

***Step 1 (of the “baseline validity tool”): Assess the validity of the current baseline for the next crediting period***

***Step 1.1 (of the “baseline validity tool”): Assess compliance of the current baseline with relevant mandatory national and/or sectoral policies***

As further explained in Section B.6.1, prior to the registration of the project as a CDM, there was indeed no legal obligation to capture and destroy/utilize LFG (by using active (forced) collection systems and high temperature enclosed flares, internal combustion gas engines and/or any other methane destruction devices) at the UVS - Caieiras landfill and/or in any other existing (under operation or not) landfills in Brazil. This situation currently remains prevailing[61].

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[61] In April/2020, there were still no legal requirements for LFG gas collection and its destruction using active or passive high temperature enclosed flares in Solid Waste Disposals Sites (SWDS’s) in Brazil (from open waste dumpsites to well-managed landfills). Moreover, in April/2020 there were still no legal restrictions neither legal requirements for passive venting of LFG or combustion of LFG in conventional LFG destruction systems (e.g. passive flares) valid for SWDS’s located in the country either. Actually, there are still no applicable regulations that deals with LFG management in Brazil. *The Brazilian National Policy on Waste Management:* After years of studies and negotiations, the Brazilian Regulation termed National Policy on Waste Management, established by Decree No. 7,404/10 (the Decree) was finally published on 23/12/2010. In force since its publication and with no modifications/complementation since its issuance, this decree regulates the National Policy on Waste Management (PNRS) as established by Federal Law No. 12,305 (the LPNRS), and creates the Steering Committee for the Implementation of Reverse Logistics Systems (Steering Committee) and the PNRS Interministerial Committee. This most recent Brazilian Regulation of the National Policy on Waste Management does not establish any requirement, obligation or recommendation related to LFG management at landfills in Brazil. The following is pointed out by the law firm “Tauil & Chequer Advogados“ about the *Regulation of the National Policy on Waste Management* in an article published in year 2011 (of which content remains valid since no related regulatory change was made since year 2011):

> *“(...) The Regulation of the National Policy on Waste Management, established by Decree No. 7,404/10 (the Decree), was published on December 23, 2010. In force since its publication, the Decree regulates the National Policy on Waste Management (PNRS), established by Federal Law No. 12,305/10 (the LPNRS), and creates the Steering Committee for the Implementation of Reverse Logistics Systems (Steering Committee) and the PNRS Interministerial Committee. The main purpose of the PNRS Interministerial Committee is to support the PNRS structuring and implementation, in order to enable the accomplishment of the provisions and goals set forth by the LPNRS. The Steering Committee has the basic function of guiding the implementation of reverse logistics. Among the instruments regulated by the Decree are the Reverse Logistics Systems, the Waste Management Plans (PGRS) and the National Registry for Hazardous Waste Operators. The Decree lists three specific instruments for the implementation and operation of the reverse logistic systems: (i) sectorial agreements, executed between public authorities and the industry; (ii) regulations, issued by the executive branch; and (iii) commitment agreements—which are to be adopted in the absence of sectorial agreements and regulations and when specific circumstances require more restrictive obligations—to be approved by the competent environmental agency. Regarding the obligation to prepare a PGRS, which should be required within environmental permitting proceedings, the Decree mentions the possibility of jointly submitting the PGRS under specific conditions and in cases where activities are conducted in the same condominium, municipality, micro-region or metropolitan/urban areas. Additionally, the Decree establishes that small companies that generate household waste, as provided for by article 30 of the LPNRS, are not required to submit a PGRS. Regarding the National Registry for Hazardous Waste Operators, which must be integrated to the already existing Federal*

Although there are still no regional or national legal requirements in Brazil establishing LFG to be collected and destroyed or even utilized in landfills located in Brazil, in the particular case of the UVS - Caieiras landfill, it is anyhow assumed that in order to meet applicable design and operational requirements for this particular landfill site (in order to address safety and odor requirements), a set of conventional passive LFG venting/combustion drains would remain being existent and used as the unique LFG management measure in place for meeting such requirements in the absence of the project activity (baseline scenario).
The demonstration of continuation of the previously derived baseline scenario for the project activity in terms of methane emissions (under its revised design configuration) is thus under full compliance with existing/valid applicable mandatory national, regional and/or sectorial policies and requirements.

***Step 1.2 (of the "baseline validity tool"): Assess the impact of circumstances***

The previously identified baseline scenario for emissions of methane at UVS - Caieiras landfill for the project activity was previously demonstrated as not changed at the time of requesting renewal of the crediting period[62]. While the baseline scenario for emissions of methane at the UVS - Caieiras landfill (previously identified at the validation stage of the project activity) was the continuation of the pre-project practice without any investment, an assessment of the changes in market characteristics was thus required for the renewal of the crediting period. This is required by the methodological tool "Assessment of the validity of the original/current baseline and to update the baseline at the renewal of a crediting period" (version 03.0.1).

As an outcome of such analysis, it is confirmed the following:

- The conditions and circumstances previously considered or taken into account to determine the baseline emissions of methane at the UVS - Caieiras landfill in the previous and currently expired crediting periods remain being valid. LFG (rich in $CH_4$) generated at the UVS - Caieiras landfill would still be freely emitted into the atmosphere (with minor share of generated LFG being destroyed in conventional passive LFG venting/combustion drains in order to address safety and odor requirements) in the absence of the project activity. Generated LFG would remain being freely emitted into the atmosphere through both the surface of the landfill and through the conventional passive LFG venting/combustion drains (whenever such drains are not alight).

- There are no changes in market or regulatory characteristics/aspects (incl. legal requirements) or new market or regulatory circumstances that would demand any type

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*Technical Registry of IBAMA, the Decree establishes a registration obligation for companies that manipulate or operate hazardous waste. The Decree also describes those who are considered generators or operators of hazardous waste, establishing several requirements for their authorization or permitting. These include the preparation of hazardous waste management plan, the demonstration of technical and economic capacity and the obtaining of civil liability insurance for environmental damages."* [SIC]

[62] Although the previously identified baseline scenario of methane emissions for the project activity remains the same, it is important to note that baseline emissions and ex-ante estimations of emission reductions to be achieved by the project activity during its 3rd and last 7-year crediting period have slightly changed when compared assumptions as presented in the latest version of the PDD (and related emission reduction spreadsheet) valid for the currently expired 1st and 2nd 7-year crediting periods. While the versions of ACM0001 baseline and monitoring methodology which was previously applied in the PDD for the 1st crediting period (ACM0001, version 2) for the 2nd crediting period (ACM0001, version 13.0.0) includes a methodological approach for determining the baseline emissions due to methane destruction which is based in specific set of methodological assumptions and approaches, the methodological assumptions (incl. default values and/or GHG calculation formulas) applicable as per ACM0001 (version 19.0) and applied methodological tools are slightly different. Such differences promote a relative decrease in estimations of ex-ante estimations of baseline emissions of methane to be achieved by the project activity along its 3rd and last 7-year crediting period. Furthermore, it is also noteworthy that the ex-ante selected value for Global Warming Potential (GWP) for methane ($CH_4$) which is valid for the 3rd 7 year crediting period (the value valid for the 2nd commitment period of the Kyoto Protocol) is higher than the one previously applied along the majority of the currently expired 1st crediting period of the project activity (value of 25 instead of 21 values previously applied).

of re-assessment or re-evaluation for the determination of the baseline scenario for emissions of methane at UVS - Caieiras landfill for the 3rd and last 7-year crediting period of the project activity.

***Step 1.3 (of the "baseline validity tool"): Assess whether the continuation of the use of current baseline equipment(s) or an investment is the most likely scenario for the crediting period for which renewable is requested.***

While the baseline scenario identified at the previously performed validation stage of the project activity was not selected at that time as "*the continuation of use of the current equipment(s) without any investment and, the projects proponents or third party (or parties) would undertake an investment later due, for example, to the end of the technical lifetime of the equipment(s) before the end of the crediting period or the availability of a new technology*", this step is thus not applicable in the context of determination of baseline for emissions of methane.

***Step 1.4 (of the "baseline validity tool"): Assessment of the validity of the data and parameters***

It is relevant to note that selected methodological requirements, ex-ante selected data and parameters which were previously determined in year 2006 (prior to the start of the 1st 7-year crediting period of the project activity) as per the applicable requirements of the previously applied CDM baseline and monitoring methodology (ACM0002 (version 2)) became not any longer be valid/applicable for the also currently expired 2nd 7-year crediting period and for the 3rd and last 7-year crediting period of the project activity (since other/more recent CDM baseline and monitoring methodologies (ACM0001 (version 13.0.0) and ACM0001 (version 19.0)) are applied for the currently expired 2nd and 3rd 7-year crediting periods of the project activity respectively).

As per the applied version of the valid CDM baseline and monitoring methodology (ACM0001 (version 19.0)) and related methodological tools, there are differentiated applicable methodological approaches considered (when compared to the previously applied for the project activity under ACM002 (version 2) and ACM0001 (version 13.0.0) (incl. some of the ex-ante determined parameters, other default values and even other assumptions). Due to that, new data and ex-ante determined parameters were previously applied in the context of the demonstration of the validity of the previously derived baseline scenario and also applied in the determination of baseline emissions for methane valid for the 3rd and last 7-year crediting period of the project activity. Thus, some of data and parameters as presented in the latest version of the PDDs valid for the currently expired 1st and 2nd 7-year crediting periods are not any longer valid.

As a conclusion, since (i) the demonstration of validity of the previously derived baseline scenario, (ii) determination of baseline emissions of methane for the 3rd and last 7-year crediting period and (iii) ex-ante determined parameters and default values are all determined/calculated as per applicable guidance of ACM0001 (version 19.0) + applicable methodological tools, the validity of most of the previously defined ex-ante determined parameters is thus limited for the project activity. The methodological approaches for the demonstration of validity of the previously derived baseline scenario, baseline emissions during the 3rd and last 7-year crediting period, ex-ante determined parameters and monitored parameters for the project activity under its revised design configuration are all presented and justified in this Section, in Section B.6.1, Section B.6.2, and Section B.7.1 + B.7.3 respectively.

***Step 2 (of the "baseline validity tool"): Update the current baseline and the data and parameters***

***Step 2.1 (of the "baseline validity tool"): Update the current baseline***

The whole determination of the baseline scenario for the project activity (as per applicable guidance of ACM0001 (version 19.0) + applicable methodological tools) is included below under "*Determination of the baseline scenario*".

It is important to note that while the baseline scenario for the project activity are not changed for the 3rd and last 7-year crediting period (when compared to the baseline scenario assumed for the previous crediting period), the applied methodological approaches for the determination of baseline scenario and baseline emissions (as per ACM0001 (version 19.0) + applicable methodological tools) are indeed slightly different than the ones required by the previously applied methodology ACM0001 (version 13.0.0).

Thus, for completeness reasons, this updated version of the PDD includes the whole determination of the baseline scenario and baseline emissions for the project activity as per the applicable guidance and requirements and stepwise approaches of ACM0001 (version 19.0) (regardless the fact baseline scenario in terms of methane emissions remains being the same as the one valid for its currently expired previous 7-year crediting periods).

The determination of baseline emissions (by following all applicable guidance and requirements of ACM0001 (version 19.0) and applicable related methodological tools) is presented in Section B.6.1. Related ex-ante estimations of baseline emissions for the 3rd and last 7-year crediting period of the project activity are summarized in Section B.6.3.

***Determination of the baseline scenario for the project activity*** *(in order to demonstrate the continuation of previously identified baseline scenario by following applicable stepwise procedure of the "Combined tool to identify the baseline scenario and demonstrate additionality" (version 07.0) as required by ACM0001 (version 19.0)):*

On the next steps, the continuation of the previously identified project's baseline scenario for methane emissions is confirmed/demonstrated through the application of the stepwise approach for determining baseline scenario as per the "Combined tool to identify the baseline scenario and demonstrate additionality"[63] (version 07.0) as required by ACM0001 (version 19.0).

[63] As outlined in Section B.5, this revised version of the PDD includes the whole assessment and demonstration of additionality for the project activity under its revised design configuration in order to demonstrate that the previously assessed additionality of the project activity (under its previous and not any longer valid design configuration) is not undermined by the post-registration change in its design. This is in accordance with applicable procedures and rules for addressing post-registration changes in registered CDM project activities.

*Application of the stepwise approach for determining baseline scenario for both emissions of methane at the UVS - Caieiras landfill and for electricity generation as per the "Combined tool to identify the baseline scenario and demonstrate additionality" (hereafter in this Section termed as "Combined tool"):*

**STEP 0 (of the "Combined tool"): Demonstration whether the proposed project activity is the *First-of-its-kind***

This optional step is not applied for the renewal of the crediting period of a registered CDM project activity.

**STEP 1 (of the "Combined tool"): Identification of alternative scenarios**

**SUB-STEP 1a (of the "Combined tool"): Define alternatives to the proposed CDM project activity**

*Identification of alternatives for the destruction of LFG:*

In this step, the following baseline alternatives for the destruction of LFG are taken into consideration:

LFG1: The project activity undertaken without being registered as a CDM project activity. (i.e. capture and landfill or use of LFG). This is a plausible alternative scenario, however involves significant investment and operation & maintenance costs.

LFG2: Atmospheric release of the LFG or capture of LFG in a managed SWDS and destruction through flaring to comply with regulations or contractual requirements, or to address safety and odour concerns or for other reasons. This scenario corresponds to the continuation of the current situation (the proposed project activity or any other alternatives are not implemented).

LFG3: Atmospheric release of the LFG or capture of LFG in an unmanaged SWDS and destruction through flaring to comply with regulations or contractual requirements, to address safety and odour concerns, or for other reasons. While the UVS - Caieiras landfill is a well-managed SWDS, this alternative is not applicable.

LFG4: LFG is partially not generated because part of the organic fraction of the solid waste is recycled and not disposed in the SWDS;

LFG5: LFG is partially not generated because part of the organic fraction of the solid waste is treated aerobically and not disposed in the SWDS;

LFG6: LFG is partially not generated because part of the organic fraction of the solid waste is incinerated and not disposed in the SWDS.

The project activity was developed and it is currently implemented at the UVS – Caieiras landfill site, which is a well-managed landfill site. This particular SWDS has been under continuous operation since year 2002. The purpose of the UVS – Caieiras landfill is promoting final disposal of municipal solid waste through adopting of appropriate landfilling practices and techniques. The design, construction and operation of the UVS - Caieiras landfill do not encompass any recycling of the organic fraction of waste and its design is not expected to change in the future. Furthermore, as further explained in Section B.2, the project activity has not previously promoted and is not expect to promote any change in waste recycling activities in the region where the UVS – Caieiras landfill is located. In this context, it is crucial to note that with or without the project activity being implemented, no recycling of the organic fraction of waste disposed at the UVS – Caieiras landfill, neither aerobic treatment, neither incineration of disposed waste streams have occurred or have prevented (or would have occurred or would have prevented) at this particular landfill and/or in any other landfill, or recycling station located in the region where the landfill is located.

Thus, alternative scenarios LFG3, LFG4, LFG5 and LFG6 are hereby automatically excluded from the determination of baseline alternatives. Such exclusions is in accordance with applicable guidance of ACM0001 (version 19.0).

In fact, recycling of organic matter, aerobic treatment and incineration of Municipal Solid Waste (MS) has not been common practice in Brazil[64]. The implementation and operation of project activity has never promoted and is not expected to promote any quantitative change (including reduction) in the amount of organic solid waste that could or would be eventually recycled. This is an applicability condition/criteria of ACM0001 (version 19.0) of which compliance is further explained in Section B.2.

*Identification of alternatives for electricity generation:*

While the project activity (under its current design configuration) includes methane destruction as its unique measure, identification of alternatives for electricity generation is thus not applicable in the particular context of the application of the stepwise procedure of the methodological tool for the identification of baseline scenario.

*Identification of alternatives for heat generation:*

Heat generation scenarios using LFG collected at the landfill as fuel are not part of the project activity either, as there are no heat requirements at the landfill and the project activity does not encompass use of collected LFG for heating or thermal purposes (i.e. use of collected LFG as gaseous fuel in boiler, air heater, glass melting furnace(s) and/or kiln). Therefore, scenarios H1 trough H7 are not considered either. This is also in accordance with ACM0001 (version 19.0).

*Identification of alternatives for supply of LFG to a natural gas distribution network and/or distribution of compressed/liquefied LFG by using trucks:*

Supply of LFG to a natural gas distribution network and/or distribution of compressed/liquefied LFG by using trucks are currently not considered as part of the project activity either. Therefore, this option is not considered on the present analysis.

[64] In fact, organic content of generated Municipal Solid Waste MWS in Brazil has been historically managed through disposal on solid waste dump sites or landfills (either controlled or uncontrolled). This is outlined in Figure 4.1.3.1 on page 46 of the publication “*Panorama dos Resíduos Sólidos no Brasil – 2018/2019*”. Available online:

http://www.abrelpe.org.br/panorama_apresentacao.cfm

**Outcome of SUB-STEP 1a**: The only alternatives to be taken into consideration, after STEP 1a) are LFG1, LFG2 (in the particular context of identification of the baseline scenario for the project activity – that includes methane destruction as its unique measure).

**SUB-STEP 1b (of the "Combined tool"): Consistency with mandatory applicable laws and regulations:**

So far, there are still no legal restrictions or requirements/obligations for LFG collection and destruction in Brazil. Moreover, there are still no legal restrictions or requirements/obligations for utilizing collected LFG for generation of electricity (or any other type of LFG utilization) in Brazil either. Therefore alternative LFG1 and LFG2 are thus under compliance with applicable mandatory laws and regulations.

**Outcome of SUB-STEP 1b:** the only remaining alternatives to be taken into consideration after SUB-STEP 1b) are identified as LFG1 and LFG2 (in the particular context of identification of the baseline scenario for the project activity – that includes methane destruction as its unique measure).

| |
|---|
| **Application of STEP 2: Barrier analysis** + **STEP 3: Investment analysis + STEP 4: Common practice analysis (of the "Combined tool"):**<br>Differently than the previous version of the PDD (version 9.0 dated 20/07/2018) valid for the currently expired 2nd 7-year crediting period of the project activity which addresses occurred permanent changes in the project design, the application of the following subsequent steps of the methodological tool "Combined tool to identify the baseline scenario and demonstrate additionality" (version 07.0) are not included/presented in Section B.5:<br>- STEP 2: Barrier analysis<br>- STEP 3: Investment analysis<br>- STEP 4: Common practice analysis<br><br>The main reason for such non-inclusion of the application of such steps as content of Section B.5 of this PDD is that demonstration of additionality is not applicable/required for the renewal of the crediting period of a registered CDM project activity[65]. |

[65] It is relevant to note that as per the applicable methodological guidance of both ACM0001 (versions 13.0.0 and 19.0) and the methodological tool "Combined tool to identify the baseline scenario and demonstrate additionality" (version 07.0), determining baseline scenario for a LFG collection and destruction/utilization under the CDM is a task which is somehow combined with the assessment and demonstration of additionality for such project activity.
In terms of demonstration of additionality of the project activity, as outlined in the previous version of the PDD (version 9.0 dated 20/07/2018), the subsequent application of the stepwise approach of the methodological tool aimed to demonstrate that the previously assessed of additionality of the project activity (under its initial and not any longer valid design configuration) was not undermined by the occurred permanent post-registration changes in the project design.
Such demonstration was previously performed in year 2018 by re-assessment of additionality of the project activity by taking into account its revised design configuration and as per the currently valid approaches for demonstration of additionality.
While in the particular case of the renewal of the 7-year crediting period of the project activity, it is not required/necessary to re-assess and re-demonstrate the additionality neither demonstrating the validity of the previously assessed/demonstrated additionality, the application of STEP 2, STEP 3 and STEP 4 of the methodological tool "Combined tool to identify the baseline scenario and demonstrate additionality" (version 07.0) are thus automatically regarded as not applicable / not required in the particular context of the demonstration of the continuation of the previously identified baseline scenario for emissions of methane at the UVS – Caieiras landfill for the project activity during its 3rd and last 7-year crediting period. This is in accordance with the methodological tool "Assessment of the validity of the original/current baseline and to update the baseline at the renewal of a crediting period" and other applicable CDM guidelines and rules.

*Conclusion of the confirmation of the previously identified baseline scenario for the project:*

In summary, by taking into account the content of this section (Section B.4) and the content of the Section (Section B.5) in the previous version of the PDD (version 9.0 dated 20/07/2018), it is demonstrated the following:

Alternative LFG1 (*"The project activity undertaken without being registered as a CDM project activity"*) does not represent baseline alternative.

Thus, the baseline alternative for the project activity is confirmed as being as follows:

- LFG2 ("*Atmospheric release of the LFG or partial capture of LFG and destruction to comply with regulations or contractual requirements, or to address safety and odors concerns*").

**Procedure for estimating the end of the remaining lifetime of existing equipment:**

While remaining lifetime of existing equipment and prior consideration of CDM are also aspects that, if applicable, are required to be considered in the context of the determination of the baseline scenario, the following details are also relevant in the particular context of the demonstration of validity of the previously derived baseline scenario for the project activity:

As per ACM0001 (version 19.0), this procedure is only applicable (in the context of the determination of baseline scenario for the project activity) if LFG has been ever utilized in existing equipment that was in operation prior to the implementation of the project activity.

The project activity started to operate in year 2007 in a landfill of which previous starting of operations is dated year 2002. No type of LFG destruction and/or LFG utilization equipment was ever in place prior to the implementation of the project activity as there was no appropriate LFG management prior of the implementation of the project activity.

This step of ACM0001 (version 19.0) is thus not required in the context of the demonstration of the continuation of the baseline scenario for the project activity.

*Conclusion about the demonstration of the continuation of validity of the previously identified baseline scenario):*

As an outcome of the application of the applicable guidance of the "Combined tool to identify the baseline scenario and demonstrate additionality" (version 07.0) and ACM0001 (version 19.0), it is demonstrated the following:

Alternative "*LFG1" ("The project activity under its revised design configuration (i.e. capture of landfill gas (rich in methane) and its combustion (destruction) by flaring and/or combustion in internal combustion gas engines) undertaken without being registered as a CDM project activity")* does not represent the baseline alternative.

Thus, the baseline alternative for the project activity is identified as corresponding to alternative *LFG2* ("*Atmospheric release of the LFG or partial capture of LFG and destruction to comply with regulations or contractual requirements, or to address safety and odors concerns*").

***Step 2.2 (of the "baseline validity tool"): Update the data and parameters***

All applicable and required ex-ante determined parameters valid for the project activity along its 3rd and last 7-year crediting period are presented in Sections B.6.1 and B.6.2.

While some of the ex-ante determined parameters (which are summarized in Sections B.6.1.and B.6.2) are applied only in the context of ex-ante estimations of emission reductions to be achieved by the project activity along the 3rd crediting period, other ex-ante determined parameters will however be used for the calculation/determination of emission reductions in an ex-post basis (in conjunction with parameters determined ex-post) along the 3rd and last 7-year crediting period of the project activity.

It is also important to consider that ACM0001 (version 19.0) and applicable methodological tools include set of parameters (ex-ante or ex-post determined) which were not previously applied/considered in the PDD valid for the 1st and 2nd 7-year crediting periods (as the PDDs for such currently expired crediting periods were previously completed in accordance requirements and guidance of the baseline and monitoring methodologies valid/applicable at that time). Furthermore, as also outlined in Section B.6.2 the value for the Global Warming Potential (GWP) for the GHG methane is also changed for the share of the 1st crediting period (from 01/01/2013 onwards) and for the 2nd crediting period when compared to the GWP value previously applied during the largest share of the 1st crediting period. This is 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".

## B.5. Demonstration of additionality

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As also indicated in Section B.4, demonstration of additionality is not applicable/required for the renewal of the crediting period of a registered CDM project activity. Due to that, this Section is not completed[66].

## B.6. Estimation of emission reductions

### B.6.1. Explanation of methodological choices

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In accordance with ACM0001 (version 19.0) and applicable methodological tools, emission reductions ($ER_y$) to be achieved by the project activity during its 3rd and last 7-year crediting period are determined (in $tCO_2e$) as the difference between baseline emissions ($BE_y$) and project emissions ($PE_y$) as follows:

$$ER_y = BE_y - PE_y \qquad \textbf{(0)}$$

Where:

| | |
|---|---|
| $BE_y$ | Baseline emissions in year *y* (in $tCO_{2e}$/yr) |
| $PE_y$ | Project emissions in year *y* (in $tCO_{2e}$/yr) |

[66] The previous version of the PDD (version 9.0 dated 20/07/2018) (valid for the currently expired 2nd 7-year crediting period and addressing previously occurred permanent changes in the project design) includes the whole assessment/demonstration of the non-undermining by the occurred post-registration changes in the project design of the previously demonstrated additionality of the project activity. Such demonstration demonstrates that the project activity is still regarded as additional when the previously occurred post-registration changes in the project design are considered/taken into account, thus meeting applicable CDM requirement for addressing post-registration changes in the project design.

***Determination of Baseline Emissions ($BE_y$):***

As per ACM0001 (version 19.0), baseline emissions ($BE_y$) for the project activity during its 3rd and last 7-year crediting period are determined according to equation (1) and comprises the following emission sources:

a) Baseline methane emissions from the SWDS[67] in the absence of the project activity;

b) Baseline emissions for electricity generation using fossil fuels or supplied by the grid in the absence of the project activity;

c) Baseline emission for heat generation using fossil fuels in the absence of the project activity; and

d) Baseline emissions for natural gas use from existing natural gas network in the absence of the project activity.

$$BE_y = BE_{CH4,y} + BE_{EC,y} + BE_{HG,y} + BE_{NG,y} \quad \textbf{(1)}$$

Where:

| | |
|---|---|
| $BE_y$ | Baseline emissions in year *y* (in $tCO_2e/yr$) |
| $BE_{CH4,y}$ | Baseline emissions of methane from the SWDS in year *y* (in $tCO_2e/yr$) |
| $BE_{EC,y}$ | Baseline emissions associated with electricity generation in year *y* (in $tCO_2e/yr$) |
| $BE_{HG,y}$ | Baseline emissions associated with heat generation in year *y* (in $tCO_2e/yr$) |
| $BE_{NG,y}$ | Baseline emissions associated with natural gas use in year *y* (in $tCO_2e/yr$) |

In the particular case of the project activity, no collected LFG is currently expected to be used as gaseous fuel for heat generation purposes; and no LFG collected by the project activity is expected to be injected in a natural gas distribution pipeline or even displace/complement the use of natural gas either. Due to that, $BE_{HG,y}$ and $BE_{NG,y}$ are not applicable in the context of the determination of baseline emissions for the project activity during its 3rd and last 7-year crediting period and are thus regarded as null. Furthermore, since electricity generation using LFG as fuel is not considered/regarded as an additional GHG abatement/mitigation measure for the project activity, $BE_{EC,y}$ is not applicable in the context of the determination of baseline emissions for the project activity during its 3rd and last 7-year crediting period either. Thus, $BE_{EC,y}$ is also regarded as null.

Thus, the determination approach for baseline emissions is summarized as follows:

$$BE_y = BE_{CH4,y} \quad \textbf{(2)}$$

Baseline methane emissions ($BE_{CH4,y}$) is calculated in conformance with ACM0001 (version 19.0) + applicable methodological tools respectively by following the approaches presented below:

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

Baseline methane emissions from the anaerobic waste decomposition in the considered SWDS ($BE_{CH4,y}$) are determined (in $tCO_2e/yr$) as per the formulas presented below. The determination of $BE_{CH4,y}$ is based on the amount of methane that is actually captured and combusted by the project activity (in the set of high temperature enclosed flares and/or set of internal combustion gas

[67] As established by the methodological tool "Emissions from solid waste disposal sites" (version 08.0), "SWDS" refers to Solid Waste Disposal Site.

engines) and also by taking in account the amount of methane that would be captured and destroyed in the landfill in the absence of the project activity (baseline scenario).

In addition, the effect of methane oxidation (that is assumed as existing in the baseline and not in the project scenario) is also taken into account as also required by ACM0001 (version 19.0)[68]:

$$BE_{CH4,y} = \left(\left(1 - OX_{top\_layer}\right) * F_{CH4,PJ,y} - F_{CH4,BL,y}\right) * GWP_{CH4} \quad \textbf{(3)}$$

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 (dimensionless) |
| $F_{CH4,PJ,y}$ | Amount of methane which is destroyed by the project activity through combustion of collected LFG in project's methane destruction devices in year *y* (in $tCH_4$/yr) |
| $F_{CH4,BL,y}$ | Amount of methane that would be destroyed through flaring of LFG in the baseline scenario (absence of project activity) in year *y* (in $tCH_4$/yr) |
| $GWP_{CH4}$ | Global warming potential of $CH_4$ (in $tCO_2e/tCH_4$) |

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

As per ACM0001 (version 19.0), the amount of methane which is destroyed by the project activity through combustion of collected LFG in project's methane destruction devices (in $tCH_4$/yr) during its 3rd and last 7-year crediting period is to be ex-post determined as the sum of quantities of methane destroyed through combustion of collected LFG in flare(s), power plant(s), boiler(s), air heater(s), glass melting furnace(s), kiln(s) (methane destruction devices) and/or by supply of collected LFG to consumer(s) through natural gas distribution network based on ex-post measurements, as follows:

$$F_{CH4,PJ,y} = F_{CH4,flared,y} + F_{CH4,EL,y} + F_{CH4,HG,y} + F_{CH4,NG,y} \quad \textbf{(4)}$$

Where:

| | |
|---|---|
| $F_{CH4,flared,y}$ | Amount of methane which is destroyed through combustion of collected LFG in the flares in year *y* (in $tCH_4$). |
| $F_{CH4,EL,y}$ | Amount of methane which is destroyed through combustion of collected LFG in the internal combustion gas engines in year *y* (in $tCH_4$). |

[68] As established by ACM0001 (version 19.0), the ex-ante determined parameter $OX_{top\text{-}layer}$ is the fraction of the methane that would be oxidized in the top layer of the considered SWDS (UVS - Caieiras landfill) in the absence of the project activity (baseline scenario). As per ACM0001 (version 19.0), it is assumed that for a typical landfill hosting a LFG collection and destruction and/or utilization CDM project activity, this effect is reduced as part of the LFG which is captured does not pass through the top layer of the considered SWDS. This oxidation effect is also accounted for in the methodological tool "Emissions from solid waste disposal sites" (version 08.0). In addition to this effect, the installation of a LFG capture system under the project activity may result in the suction of additional air into the considered SWDS. In some cases, such as project activities where the LFG collection is based on high suction pressure, the suction effort may decrease the amount of methane that is generated in the landfill under the project scenario. However, in most circumstances where the LFG is captured and used this effect was considered to be very small, as the operators of landfills have, in most cases, an incentive to main a high methane concentration in the LFG. For this reason, this effect is neglected as a conservative assumption.

$F_{CH4,HG,y}$ Amount of methane which is destroyed through combustion of collected LFG in heat generation device(s) in year *y* (in $tCH_4$/yr). The project design currently does not encompass combustion of collected LFG in heat generation device(s). Thus, $F_{CH4,HG,y}$ is assumed as null (zero).

$F_{CH4,NG,y}$ Amount of methane which is destroyed by supply of collected LFG to consumer(s) through natural gas distribution network in year *y* (in $tCH_4$/yr). The project design currently does not encompass supply of collected LFG to consumer(s) through natural gas distribution network. Thus, $F_{CH4,NG,y}$ is assumed as null (zero).

As also established by ACM0001 (version 19.0), $F_{CH4,EL,y,}$ $F_{CH4,HG,y}$ and $F_{CH4,NG,y}$ are to be determined by using the methodological tool "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" (version 03.0), and by monitoring the working hours of the power plant(s), boiler(s), air heater(s), glass melting furnace(s) and/or kiln(s) (if applicable), so that no emission reduction are claimed for methane destruction during non-working hours of the methane destruction device(s) in question. This is taken into account by monitoring the hours *h* that the equipment/device *j* promoting destruction of methane is operating in year *y* ($Op_{j,h,y}$).

In summary, the amount of methane which is destroyed by the project activity through combustion of collected LFG in project's methane destruction devices will be ex-post determined as follows:

$$F_{CH4,PJ,y} = F_{CH4,flared,y} + F_{CH4,EL,y} \quad \textbf{(5)}$$

**Determination of the amount of methane which is destroyed through combustion of collected LFG in the flares ($F_{CH4,flared,y}$)**

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

$F_{CH4,flared,y}$ is determined as the difference between the amount of methane supplied to each individual flare and methane emissions from the flare in question, as follows:

$$F_{CH4,flared,y} = F_{CH4,sent\_flare,y} - \frac{PE_{flare,y}}{GWP_{CH4}} \quad \textbf{(6)}$$

Where:

$F_{CH4,flared,y}$ Amount of methane which is destroyed through combustion of collected LFG in the flares in year *y* (in $tCH_4$/yr)

$F_{CH4,sent\_flare,y}$ Amount of methane in collected LFG which is sent to the flare(s) in year *y* (in $tCH_4$/yr)

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

$GWP_{CH4}$ Global warming potential of $CH_4$ (in $tCO_2e/tCH_4$)

For each individual high temperature enclosed flare, $F_{CH4,sent\_flare,y}$ is determined by following applicable guidance of the methodological tool "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" (version 03.0). As per the ACM0001 (version 19.0), the following requirements apply for the determination of $F_{CH4,sent\_flare,y}$:

- The gaseous stream that shall be considered in the application of the methodological tool is the stream of collected LFG which is sent for combustion in the flares
- $CH_4$ is the greenhouse gas for which the mass flow is determined;;

- The simplification offered for calculating the molecular mass of the gaseous stream is valid (equations 3 or 17 in the methodological tool); and
- The mass flow should be calculated at least on a an hourly basis for each hour *h* in year *y*;

*Determination of the amount of amount of methane which is destroyed through combustion of collected LFG in the internal combustion gas engines ($F_{CH4,EL,y}$):*

$F_{CH4,EL,y}$ is directly determined by following applicable guidance of the methodological tool "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" (version 03.0) and by taking into account the following requirements defined by ACM0001 (version 19.0):

- The gaseous stream the methodological tool shall be applied to is the stream of collected LFG which is sent to each internal combustion gas engine *j*.
- $CH_4$ is the greenhouse gas for which the mass flow is determined;
- The simplification offered for calculating the molecular mass of the gaseous stream is valid (equations 3 or 17 in the methodological tool); and
- The mass flows should be calculated at least on a an hourly basis for each hour *h* in year *y*;
- The mass flow calculated for hour *h* is 0 if the equipment/device is not working in hour *h* ($Op_{j,h}$ = not working). Accumulated hourly values are summed to a yearly unit basis.

Applicable guidance of the methodological tool "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" (version 03.0) will be applied to determine $F_{CH4,sent\_flare,y}$ and $F_{CH4,EL,y}$ [69] by using one of the options A, B, C or D. The selection of the determination option will depend on project conditions and/or monitoring equipment/instruments under operation during monitoring periods within the 3rd and last 7-year crediting period of the project activity.

*Use of Option A, B, C or D for the determination of $F_{CH4,sent\_flare,y}$ and $F_{CH4,EL,y}$:*

Depending on the project conditions, one of the following measurement options will be chosen and the following formulas applied for the determination of as $F_{i,t}$ [70]:

| Option | Flow of gaseous stream | Volumetric fraction |
|---|---|---|
| A | Volume flow dry basis | Dry or wet basis[71] |
| B | Volume flow wet basis | Dry basis |
| C | Volume flow wet basis | Wet basis |
| D | Mass flow dry basis | Dry or wet basis |

<u>*Option A:*</u>
Flow measurement on a dry basis is not doable for a wet gaseous stream. Therefore, it is necessary to demonstrate that the gaseous stream is dry to use this option. There are two ways to do this:

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

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[69] In the methodological tool "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" (version 03.0), the mass flow of greenhouse gas in a gaseous stream (which in the particular case of the project activity are the amount of methane in collected LFG which is sent to the flares ($F_{CH4,sent\_flare,y}$) and the amount of methane which is destroyed through combustion of collected LFG in the internal combustion gas engines ($F_{CH4,EL,y}$)) is actually represented as $F_{i,t}$.

[70] The selection of option A, B, C or D will occur on an ex-post basis depending on the type and/or specifications of monitoring equipment installed and under operation within the 3rd and last 7-year crediting period of the project activity.

[71] Flow measurement on a dry basis is not feasible at reasonable costs for a wet gaseous stream, so there will be no difference in the readings for volumetric fraction in wet basis analysers and dry basis analysers and both types can be used indistinctly for calculation Options A and D.

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

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

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

$$F_{i,t} = V_{t,db} * v_{i,t,db} * \rho_{i,t} \quad \textbf{(7)}$$

with

$$\rho_{i,t} = \frac{P_t * MM_i}{R_u * T_t} \quad \textbf{(8)}$$

Where:

| | |
|---|---|
| $F_{i,t}$ | Mass flow of greenhouse gas *i* in the gaseous stream in time interval *t* (in kg gas/h) |
| $V_{t,db}$, | Volumetric flow of the gaseous stream in time interval *t* on a dry basis at normal conditions (in m³ dry gas/h) |
| $v_{i,t,db}$ | Volumetric fraction of greenhouse gas *i* in the gaseous stream in time interval *t* on a dry basis (in m³ gas *i*/m³ dry gas) |
| $\rho_{i,t}$ | Density of greenhouse gas *i* in the gaseous stream (in kg gas *i*/m³ gas *i*) |
| $P_t$ | Absolute pressure of the gaseous stream in time interval *t* (in Pa) |
| $MM_i$ | Molecular mass of greenhouse gas *i* (in kg/kmol) |
| $R_u$ | Universal ideal gases constant (in Pa.m³/kmol.K) |
| $T_t$ | Temperature of the gaseous stream in time interval *t* (in K) |

*Option B:*
The mass flow of greenhouse gas *i* ($F_{i,t}$) is determined using equations (7) and (8). The volumetric flow of the gaseous stream in time interval *t* on a dry basis ($V_{t,db}$) is determined by converting the measured volumetric flow from wet basis to dry basis as follows:

$$V_{t,db} = V_{t,wb} /(1 + v_{H2O,t,db}) \quad \textbf{(9)}$$

Where:

| | |
|---|---|
| $V_{t,db}$ | Volumetric flow of the gaseous stream in time interval *t* on a dry basis (in m³ dry gas/h) |
| $V_{t,wb}$ | Volumetric flow of the gaseous stream in time interval *t* on a wet basis (in m³ wet gas/h) |

$v_{H2O,t,db}$ Volumetric fraction of $H_2O$ in the gaseous stream in time interval *t* on a dry basis (in $m^3$ $H_2O/m^3$ dry gas)

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

$$v_{H2O,t,db} = \frac{m_{H2O,t,db} * MM_{t,db}}{MM_{H2O}} \quad \textbf{(10)}$$

Where:

$v_{H2O,t,db}$ Volumetric fraction of $H_2O$ in the gaseous stream in time interval *t* on a dry basis (in $m^3$ $H_2O/m^3$ dry gas)

$m_{H2O,t,db}$ Absolute humidity in the gaseous stream in time interval *t* on a dry basis (in kg $H_2O$/kg dry gas)

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

$MM_{H2O}$ Molecular mass of $H_2O$ (in kg $H_2O$/kmol $H_2O$)

In case this Option is selected, the absolute humidity of the gaseous stream ($m_{H2O,t,db}$) will be determined using Option 2 specified below under "*Determination of the absolute humidity of the gaseous stream"* and the molecular mass of the gaseous stream ($MM_{t,db}$) will be determined using the following equation:

$$MM_{t,db} = \sum_k (v_{k,t,db} * MM_k) \quad \textbf{(11)}$$

Where:

$v_{k,t,db}$ Volumetric fraction of gas *k* in the gaseous stream in time interval *t* on a dry basis (in $m^3$ gas k/$m^3$ dry gas) $MM_k$ = Molecular mass of gas *k* (kg/kmol)

*k* All gases, except $H_2O$ contained in the gaseous stream (e.g. $N_2$, $CO_2$, $O_2$, CO, $H_2$, $CH_4$, $N_2O$, NO, $NO_2$, $SO_2$, $SF_6$ and PFCs). See simplification below. The determination of the molecular mass of the gaseous stream ($MM_{t,db}$) requires measuring the volumetric fraction of all gases (*k*) in the gaseous stream. However as a simplification, the volumetric fraction of only the gases k that are greenhouse gases and are considered in the emission reduction calculation in the underlying methodology must be monitored and the difference to 100% may be considered as pure nitrogen. The simplification is not acceptable if it is differently specified in the underlying methodology.

*<u>Option C:</u>*

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

$$F_{i,t} = V_{t,wb,n} * v_{i,t,wb} * \rho_{i,n} \quad \textbf{(12)}$$

with

$$\rho_{i,n} = \frac{P_n * MM_i}{R_u * T_n} \quad \textbf{(13)}$$

Where:

| | |
|---|---|
| $F_{i,t}$ | Mass flow of greenhouse gas *i* in the gaseous stream in time interval *t* (in kg gas/h) |
| $V_{t,wb,n}$ | Volumetric flow of the gaseous stream in time interval *t* on a wet basis at normal conditions (in $m^3$ wet gas/h) |
| $v_{i,t,wb}$ | Volumetric fraction of greenhouse gas *i* in the gaseous stream in time interval *t* on a wet basis (in $m^3$ gas *i*/$m^3$ wet gas) |
| $\rho_{i,n}$ | Density of greenhouse gas *i* in the gaseous stream at normal conditions (in kg gas *i*/$m^3$ wet gas *i*) |
| $P_n$ | Absolute pressure at normal conditions (in Pa) |
| $T_n$ | Temperature at normal conditions (in K) |
| $MM_i$ | Molecular mass of greenhouse gas *i* (in kg/kmol) |
| $R_u$ | Universal ideal gases constant (in $Pa.m^3/kmol.K$) |

The following equation should be used to convert the volumetric flow of the gaseous stream from actual conditions to normal conditions of temperature and pressure:

$$V_{t,wb,n} = V_{t,wb} * (T_n / T_t) * (P_t / P_n) \quad \textbf{(14)}$$

Where:

| | |
|---|---|
| $V_{t,wb,n}$ | Volumetric flow of the gaseous stream in a time interval *t* on a wet basis at normal conditions (in $m^3$ wet gas/h) |
| $V_{t,wb}$ | Volumetric flow of the gaseous stream in time interval *t* on a wet basis (in $m^3$ wet gas/h) |
| $P_t$ | Pressure of the gaseous stream in time interval *t* (in Pa) |
| $T_t$ | Temperature of the gaseous stream in time interval *t* (in K) |
| $P_n$ | Absolute pressure at normal conditions (in Pa) |
| $T_n$ | Temperature at normal conditions (in K) |

*Option D:*

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

- Measure the moisture content of the gaseous stream ($C_{H2O,t,db,n}$) and demonstrate that this is less or equal to 0.05 kg $H_2O/m^3$ dry gas; or
- Demonstrate that the temperature of the gaseous stream ($T_t$) is less than 60ºC (333.15 K) at the flow measurement point.

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

The mass flow of greenhouse gas *i* ($F_{i,t}$) is determined using equations (7) and (8). The volumetric flow of the gaseous stream in time interval *t* on a dry basis ($V_{t,db}$) is determined by converting the mass flow of the gaseous stream to a volumetric flow as follows:

$$V_{t,db} = M_{t,db} / \rho_{t,db} \quad \textbf{(15)}$$

Where:

$V_{t,db}$ Volumetric flow of the gaseous stream in time interval *t* on a dry basis (in $m^3$ dry gas/h)

$M_{t,db}$ Mass flow of the gaseous stream in time interval *t* on a dry basis (in kg/h)

$\rho_{t,db}$ Density of the gaseous stream in time interval *t* on a dry basis (in kg dry gas/$m^3$ dry gas)

The density of the gaseous stream ($\rho_{t,db}$) should be determined as follows:

$$\rho_{t,db} = \frac{P_t * MM_{t,db}}{R_u * T_t} \quad \textbf{(16)}$$

Where:

$\rho_{t,db}$ Density of the gaseous stream in a time interval *t* on a dry basis (in kg dry gas/$m^3$ dry gas)

$P_t$ Pressure of the gaseous stream in time interval *t* (in Pa)

$T_t$ Temperature of the gaseous stream in time interval *t* (in K)

$MM_{t,db}$ Molecular mass of the gaseous stream in a time interval *t* on a dry basis (in kg dry gas/kmol dry gas). The molecular mass of the gaseous stream ($MM_{t,db}$) is estimated by using equation (11).

*Determination of the absolute humidity of the gaseous stream*

The absolute humidity is as parameter required for Options B and E only, thus it will be used only in case Option B is adopted (as Option E is not selected as a measurement option for the project activity). Option 2 of the tool is selected for the project activity:

*Option 2: Simplified calculation without measurement of the moisture content*

This option provides a simple and conservative approach to determine the absolute humidity by assuming the gaseous stream is dry or saturated depending on which is the conservative situation. If it is conservative to assume that the gaseous stream is dry, then $m_{H2O,t,db}$ is assumed to equal 0. If it is conservative to assume that the gaseous stream is saturated, then $m_{H2O,t,db}$ is assumed to equal the saturation absolute humidity ($m_{H2O,t,db,sat}$) and calculated using equation (7).

$$m_{H_2O,t,db,SAT} = \frac{p_{H2O,t,Sat} * MM_{H2O}}{(P_t - p_{H2O,t,Sat}) * MM_{t,db}} \quad \textbf{(17)}$$

Where:

| | |
|---|---|
| $m_{H2O,t,db,sat}$ | Saturation absolute humidity in time interval *t* on a dry basis (in kg $H_2O$/kg dry gas) |
| $p_{H20,t,sat}$ | Saturation pressure of $H_2O$ at temperature $T_t$ in time interval *t* (in Pa) |
| $T_t$ | Temperature of the gaseous stream in time interval *t* (in K) |
| $P_t$ | Absolute pressure of the gaseous stream in time interval *t* (in Pa) |
| $MM_{H2O}$ | Molecular mass of $H_2O$ (in kg $H_2O$/kmol $H_2O$) |
| $MM_{t,db}$ | Molecular mass of the gaseous stream in a time interval *t* on a dry basis (in kg dry gas/kmol dry gas). $MM_{t,db}$ is estimated by using equation (11). |

*Determination of $PE_{flare,y}$ (required for the determination of $F_{CH4,flared,y}$)*:
As established by ACM0001 (version 19.0), $PE_{flare,y}$ is determined by following applicable guidance of the methodological tool “Project emissions from flaring” (version 03.0). Since share of collected LFG is expected to be combusted (by flaring) in a set of installed high temperature enclosed flares, $PE_{flare,y}$ is thus calculated as the sum of the related emissions for each individual flare (where project emissions from flaring from each one of the flares are calculated separately (as established by the methodological tool)).

For each individual flare, the calculation procedure in the referred methodological tool is applied to determine project emissions from flaring the residual gas ($PE_{flare,y}$) based on the flare efficiency ($\eta_{flare,m}$) and the mass flow of methane to the flare in question ($F_{CH4,RG,m}$). The flare efficiency is determined for each minute *m* of year *y* based either on monitored data or default values.

Calculation procedure for the determination of project emissions from flaring applied as follows under a stepwise approach:

*STEP 1*: Determination of the methane mass flow of the residual gas;

*STEP 2*: Determination of the flare efficiency;

*STEP 3*: Calculation of project emissions from flaring.

*Step 1: Determination of the methane mass flow in the residual gas:*
The methodological tool "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" (version 03.0) shall be used to determine, in kg, the mass flow of methane in the residual gaseous stream in the minute *m*: $F_{CH4,m}$.

The following requirements apply for the determination of the mass flow of methane in the gaseous stream in minute *m*:

- The methodological tool "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" (version 03.0) shall be applied to the residual gas.
- The flow of the gaseous stream shall be measured continuously;
- $CH_4$ is the greenhouse gas *i* for which the mass flow should be determined;
- The simplification offered for calculating the molecular mass of the gaseous stream is valid (equations 3 and 17 in the tool); and
- The time interval *t* for which mass flow should be calculated is every minute *m*.

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

*Step 2: Determination of flare efficiency:*
As required by ACM0001 (version 19.0), the flare efficiency values will be determined for each installed flare. Also as per ACM0001 (version 19.0), flare efficiency represents the combustion efficiency of LFG in the flare in terms of $CH_4$ by considering *inter alia* the time and conditions that the flare in question is operating. For determining the combustion efficiency for the enclosed flare in question, the selected option of the methodological tool "Project emissions from flaring" (version 03.0) are (i) the option to apply a default efficiency value or (ii) determining the flare efficiency based on monitored data (based on applicable measurements and calculations).

The time each of the project's high temperature enclosed flare has operated is determined by monitoring the flame combustion status/condition by using a flame detector and, for the case of the installed enclosed high temperature flares, the monitoring requirements related to operational requirements/conditions (as provided by the manufacturer's specifications for operating conditions) shall be met in addition to the confirmation of flare status/condition.

In the case of the project activity, the flare efficiency for each minute *m* ($\eta_{flare,m}$) will be, as a priority, determined by following applicable guidance as per Option B.1 of the methodological tool "Project emissions from flaring" (version 03.0), where the flare efficiency will be determined on the basis of the performance of at least biannual basis related measurements. In case at least biannual related measurements are not available for a particular monitoring period, applicable guidance as per Option A (application of default values) of the methodological tool "Project emissions from flaring" (version 03.0) will be used as an alternative.

Both options are summarized below:

Option A: Apply default value for flare efficiency.

Option B: Measure the flare efficiency.

*Option A: Application of default value:*
For each one of the high temperature enclosed flares installed as part of the project activity, the flare efficiency for each minute *m* ($\eta_{flare,m}$) is 90% when the following two operational conditions/requirements are simultaneously met (in order to demonstrate that the flare is operating as per the recommendations and requirements set by the equipment manufacturer for the minute *m* in question):

(1) The temperature of the exhaust gases of the flare (monitoring parameter $T_{EG.m}$) and the flow rate of LFG to the flare (monitoring parameter $F_{RG,m}$) is within the manufacturer's specification/requirements for the flare (monitoring parameter $SPEC_{flare}$) in minute *m;*

(2) Flame is detected in the flare in minute *m* (monitoring parameter $Flame_m$).

If for the minute *m*, conditions (1) and/or (2) are not met, $\eta_{flare,m}$ is set as 0% for the minute in question. Furthermore, as also established by the methodological tool "Project emissions from flaring" (version 03.0), for enclosed flares that are defined as low height flares, the flare efficiency shall be adjusted, as a conservative approach, by subtracting 10 percentile points. For example, the default value applied shall be 80%, rather than 90%.

*Option B: Measured flare efficiency:*
For each one of the high temperature enclosed flares which are part of the project activity, the flare efficiency in the minute *m* is determined as a value which is calculated based on performed related measurements ($\eta_{flare,m} = \eta_{flare,calc,m}$) when the following two conditions are simultaneously met (in order to demonstrate that the flare is operating):

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

(2) Flame is detected in the flare in minute *m* (monitoring parameter $Flame_m$).

Otherwise $\eta_{flare,m}$ is set as 0%.

By applying Option B.1, where the measurement is performed by an accredited independent third party entity (e.g. an independent inspection/analysis service company) on a biannual basis, the following calculation formula is applied:

*Option B.1: Biannual measurement of the flare efficiency:*

The calculated flare efficiency $\eta_{flare,calc,m}$ is determined as the average of at least two measurements of the flare efficiency made in year *y* ($\eta_{flare,calc,y}$), adjusted by an uncertainty factor of 5 percentile points as follows:

$$\eta_{flare,calc,y} = 1 - \frac{1}{2}\sum_{t=1}^{2}\left(\frac{F_{CH4,EG,t}}{F_{CH4,RG,t}}\right) - 0.05 \qquad \textbf{(18)}$$

Where:

$\eta_{flare,calc,y}$ Flare efficiency in the year *y*

$F_{CH4,EG,t}$ Mass flow of methane in the exhaust gas of the flare on a dry basis at reference conditions in the time period *t* (in kg)

$F_{CH4,RG,t}$ Mass flow of methane in the residual gas on a dry basis at reference conditions in the time period *t* (in kg)

*t* The two time periods in year y during which the flare efficiency is measured, each a minimum of one hour and separated by at least six months[72]

**Note:** $F_{CH4,EG,t}$ is measured for each individual flare according to an appropriate national or international standard. $F_{CH4,RG,t}$ is calculated for each flare according to Step 1[73], and consists of the sum of methane flow in the minutes *m* that makes up the time period *t*.

*Step 3: Calculation of project emissions from flaring:*
For each individual flare, project emissions from flaring are calculated as the sum of emissions for each minute *m* in year *y*, based on the methane mass flow in the residual gas ($F_{CH4,RG,m}$) and the flare efficiency ($\eta_{flare,m}$), as follows:

$$PE_{flare,y} = GWP_{CH4} * \sum_{m=1}^{525,600} F_{CH4,RG,m} * \left(1 - \eta_{flare,m}\right) * 10^{-3} \quad \textbf{(19)}$$

Where:

$PE_{flare,y}$ Project emissions from flaring of the residual gas in year *y* (in $tCO_{2e}$)

$GWP_{CH4}$ Global warming potential of methane valid for the commitment period (in $tCO_2e/tCH_4$)

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

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

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

*Ex-ante* estimates of $F_{CH4,PJ,y}$ is required to estimate methane baseline emissions from the UVS - Caieiras landfill in the context of annual estimates the emission reductions to be achieved by project activity during its 3rd and last 7-year crediting period.

As established by ACM0001 (version 19.0), $F_{CH4,PJ,y}$ is estimated as follows:

$$F_{CH4,PJ,y} = \eta_{PJ} * BE_{CH4,SWDS,y} / GWP_{CH4} \quad \textbf{(20)}$$

Where:

[72] As also established by the methodological tool "Project emissions from flaring" (version 03.0), if the monitoring period is shorter than one year, the measurement should be at least twice in a monitoring period and in a maximum timeframe of six months between each measurement.

[73] As per Step 1 $F_{CH4,RG,t}$ is equal to the sum of methane flow values ($F_{CH4,sent\_flare,y}$) in the minutes *m* that make up the time period *t*.

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

$\eta_{PJ}$ Efficiency of the LFG capture system that will be installed in the project activity

$GWP_{CH4}$ Global warming potential of $CH_4$ (in $tCO_2e/tCH_4$)

$BE_{CH4,SWDS,y}$ is determined using the methodological tool "Emissions from solid waste disposal sites" (version 08.0). The following guidance should be taken into account when applying the tool:

- $f_y$ as per the methodological tool shall be assigned a value of 0 because the amount of LFG that would have been captured and destroyed is already accounted for when applying ACM0001 (version 19.0);
- In the tool, *x* begins with the year that the SWDS started receiving wastes (e.g. the first year of SWDS operation); and
- Sampling to determine the fractions of different waste types is not necessary because the waste composition can be obtained from previous studies.

Thus, for the ex-ante estimation of the amount of methane which is destroyed by the project activity through combustion of collected LFG in project's methane destruction devices ($F_{CH4,PJ,y}$) during each year y of its 3rd and last 7-year crediting period, the calculation of $BE_{CH4,SWDS,y}$ is given by:

$$BE_{CH4,SWDS,y} = \varphi_y * (1 - f_y) * GWP_{CH4} * (1 - OX) * \frac{16}{12} * F * DOC_{f,y} * MCF_y * \sum_{x=1}^{y} \sum_{j} W_{j,x} * DOC_j * e^{-k_j \cdot (y-x)} * \left(1 - e^{-k_j}\right) \qquad \textbf{(21)}$$

Where:

$BE_{CH4,SWDS,y}$ Baseline methane emissions occurring in year *y* generated from waste disposal at a SWDS during a time period ending in year *y* (in $tCO_2e$ / yr)

*x* Years in the time period in which waste is disposed at the SWDS, extending from the first year in the time period (*x* = 1) to year *y* (*x* = *y*)

*y* Year of the crediting period for which methane emissions are calculated (*y* is a consecutive period of 12 months)

$DOC_{f,y}$ Fraction of degradable organic carbon (DOC) that decomposes under the specific conditions occurring in the SWDS for year *y* (weight fraction)

$W_{j,x}$ Amount of solid waste type *j* disposed or prevented from disposal in the SWDS in the year *x* (t)

$\varphi_y$ Model correction factor to account for model uncertainties for year *y*. The default value (as per Option 1 of applicable guidance in the methodological tool) is selected. Thus, $\varphi_y = \varphi_{default}$

$f_y$ Fraction of methane captured at the SWDS and flared, combusted or used in another manner that prevents the emissions of methane to the atmosphere in year *y*. $f_y$ in the methodological tool "Emission from solid waste disposal sites" shall be assigned a value of 0 because the amount of LFG that would have been captured and destroyed is already accounted for when applying ACM0001 (version 19.0). While as per the methodological tool "Emissions from solid waste disposal sites" (version 08.0), $f_y$ is presented as a parameter to be monitored ex-post; by

considering the related methodological approach of ACM0001 (version 19.0) and assigned value for $f_y$, this parameter will thus not be monitored ex-post during the 3rd and last 7-year credtiting period of the project activity.

$GWP_{CH4}$ Global Warming Potential of methane

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

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

$MCF_y$ Methane correction factor for year *y*

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

$k_j$ Decay rate for the waste type *j* (1 / yr)

*j* Type of residual waste or types of waste in the MSW

The value and source of information for each of the variables above are given in section B.6.2. It is important to note that the approach to take into account characteristics of the disposed waste (used as inputs for the ex-ante estimation) are the ones recommended by IPCC. Due to that, no sampling of waste is necessary. This is in accordance with both the methodological tool “Emissions from solid waste disposal sites” (version 08.0) and ACM0001 (version 19.0). While the design of the project activity is limited to the promotion of collection and destruction/utilization of LFG at the UVS - Caieiras landfill (without promoting any change in the management and operation of this particular landfill), the project activity thus does not prevent any solid waste from being disposed at the UVS - Caieiras landfill.

The determination of $BE_{CH4,SWDS,y}$ in the context of the calculation of ex-ante estimations of emission reductions to be achieved by the project activity during its 3rd and last 7-year crediting period is included in Section B.6.3. An emission reduction calculation spreadsheet which includes all related calculations for figures presented in Section B.6.3 is enclosed to this PDD.

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

As required by ACM0001 (version 19.0), this section represents the application of the stepwise procedure for the determination of the amount of methane that would have been captured and destroyed in the baseline scenario (absence of the CDM project activity) at the UVS – Caieiras landfill due to eventually applicable regulatory or contractual requirements and/or to address eventually existent applicable safety and odors concerns (which are collectively referred to as “*requirement”* under this step).

The four cases summarized in the table below are distinguished in ACM0001 (version 19.0). As also required by ACM0001 (version 19.0), the appropriate case for the particular baseline context of the project activity is identified and justified below.

**Possible cases for determining methane captured and destroyed in the baseline as per ACM0001 (version 19.0)**

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

*Requirement to destroy methane:*

*Non-existence of regional, national regulatory or contractual requirements related to LFG management in the region of the project site and/or in Brazil:*

Like the situation valid prior to the start of the 1st 7-year crediting period of the project activity and during the whole periods encompassing its currently expired 1st and 2nd 7-year crediting periods, currently there is still being no legally obliged promoting any kind of capture and/or destruction/utilization of LFG at the UVS - Caieiras landfill[74]. Furthermore, this situation is currently

[74] In April/2020, there was still no legal requirement for LFG gas collection and its destruction using active or passive high temperature enclosed flares in Brazil. Moreover, there was still no legal restriction neither requirement for passive venting of LFG or its combustion in conventional LFG destruction systems. Actually, there is still no applicable regulation that deals with LFG management in Brazil. The recently implemented National Policy on Waste Management does not deal with LFG management either.

Some facts about the Brazilian National Policy on Waste Management: After years of studies and negotiations, the Brazilian Regulation of the National Policy on Waste Management, established by Decree No. 7,404/10 (the Decree), was published on 02/08/2010 and entered into force on 23/12/2010. This decree regulates the National Policy on Waste Management (PNRS), established by Federal Law No. 12,305/10 (the LPNRS), and creates the Steering Committee for the Implementation of Reverse Logistics Systems (Steering Committee) and the PNRS Interministerial Committee. This new Brazilian Regulation of the National Policy on Waste Management does not establish any requirement, obligation or recommendation related to LFG management at landfills in Brazil. The following is outlined by the law firm "Tauil & Chequer Advogados" in an article published in year 2011 of which content remains being valid:

> *"(...) The Regulation of the National Policy on Waste Management, established by Decree No. 7,404/10 (the Decree), was published on December 23, 2010. In force since its publication, the Decree regulates the National Policy on Waste Management (PNRS), established by Federal Law No. 12,305/10 (the LPNRS), and creates the Steering Committee for the Implementation of Reverse Logistics Systems (Steering Committee) and the PNRS Interministerial Committee. The main purpose of the PNRS Interministerial Committee is to support the PNRS structuring and implementation, in order to enable the accomplishment of the provisions and goals set forth by the LPNRS. The Steering Committee has the basic function of guiding the implementation of reverse logistics. Among the instruments regulated by the Decree are the Reverse Logistics Systems, the Waste Management Plans (PGRS) and the National Registry for Hazardous Waste Operators. The Decree lists three specific instruments for the implementation and operation of the reverse logistic systems: (i) sectorial agreements, executed between public authorities and the industry; (ii) regulations, issued by the executive branch; and (iii) commitment agreements—which are to be adopted in the absence of sectorial agreements and regulations and when specific circumstances require more restrictive obligations—to be approved by the competent environmental agency. Regarding the obligation to prepare a PGRS, which should be required within environmental permitting proceedings, the Decree mentions the possibility of jointly submitting the PGRS under specific conditions and in cases where activities are conducted in the same condominium, municipality, micro-region or metropolitan/urban areas. Additionally, the Decree establishes that small companies that generate household waste, as provided for by article 30 of the LPNRS, are not required to submit a PGRS. Regarding the National Registry for Hazardous Waste Operators, which must be integrated to the already existing Federal Technical Registry of IBAMA, the Decree establishes a registration obligation for companies that manipulate or operate hazardous waste. The Decree also describes those who are considered generators or operators of hazardous waste, establishing several requirements for their authorization or permitting. These include the preparation of hazardous waste management plan, the demonstration of technical and economic capacity and the obtaining of civil liability insurance for environmental damages."* [SIC]

Paper is available online: http://www.tauilchequer.com.br/publications/detailprint.aspx?publication=1179

not expected to be changed during the time period to be encompassed by the 3rd and last 7-year crediting period of the project activity either.

*Existence of non-regulatory and non-contractual requirements to destroy methane due to safety and odor concerns:*

In the case of the UVS - Caieiras landfill, it is assumed that a requirement to destroy methane due to safety and odor concerns does exist since its starting of operations due to following related aspects/facts:

- Although there is indeed no regional or national regulatory requirement in Brazil establishing or requiring LFG to be collected and destroyed in landfills (such as the UVS - Caieiras landfill) or waste dump sites, and although there is no contractual requirement to collected and destroy LFG either; in the particular case of the UVS - Caieiras landfill, as per the previously conceived design, construction and operational requirements (which were previously set by Essencis Soluções Ambientais S.A. and which are still valid/applicable for the UVS - Caieiras landfill), it is acknowledged that in the absence of the project activity a small and non-defined share of generated LFG would be expected to be collected and vented and/or destroyed through combustion in a set of existent pre-project conventional passive LFG venting/combustion drains in order to appropriately address safety and odor concerns under the baseline scenario (absence of the project activity)[75]. It is important to note that there has been no contractual requirement set by any official (governmental) or private party establishing/requiring collected LFG to be destroyed through combustion.
- While the methodological approach of ACM0001 (version 19.0) applied for determination of $F_{CH4,BL,y}$ explicitly determines that any required or existent destruction of LFG to address safety and/or odor concerns are to be regarded as "*an existing requirement to destroy methane*", by taking into account the related definition of "*requirement*" as per ACM0001 (version 19.0), it is thus assumed that there is indeed a requirement to destroy methane (in the absence of the project activity) in the particular case of the UVS - Caieiras landfill.

By taking such assumptions into account, the following is thus valid/applicable for the UVS - Caieiras landfill in the absence of the project activity (baseline scenario):

- Requirement to destroy methane: YES

By considering the requirement situation above summarized, Case 1 and Case 3 (which are options/cases associated to no requirement to destroy methane in the absence of the project activity) are thus directly regarded as not applicable cases for the determination of $F_{CH4,BL,y}$ (in the particular contexts of the demonstration of the continuation of the previously derived baseline scenario and determination of baseline emissions for the 3rd and last 7-year crediting period of the project activity). Thus, the remaining possibly valid alternatives (cases) (after the analysis of existence of non-regulatory and/or non-contractual requirements to destroy methane due to safety and/or odor concerns) are thus Case 2 and Case 4.

[75] As also established by applicable design, construction and operational requirements for the UVS - Caieiras landfill (as defined by Essencis Soluções Ambientais S.A. taking into consideration the best practice for the construction and operation of landfills in Brazil), besides of the installation of the conventional passive LFG venting/combustion drains, practice of covering disposed waste + other best practices for waste landfilling were also implemented in the landfill in the pre-project scenario during the period from February/2002 to February/2007 in order to address safety and odor concerns (measures that promote reduction of pressure and volume of LFG in the inner section of the landfill thus minimizing risks of fire, explosion and instability in the landfill cells that could result in slides of disposed material). Such operational requirements are still valid. It is important to note that the licensing and operational permits for the UVS - Caieiras landfill (as set by the competent environmental authority) do not require any management for generated LFG in the landfill.

*Existence of LFG capture and destruction system at the UVS - Caieiras landfill:*

Prior to the implementation of the project activity (pre-project scenario during the period from year 2002 until February/2007[76]), a very small and not defined fraction of methane generated at the UVS - Caieiras landfill was destroyed through combustion (very reduced share of generated LFG being combusted through use of conventional passive LFG venting/combustion drains). Such conventional and rudimentary LFG management solution was at that time the only existent infrastructure for LFG management existent at the project site (situation prior to the implementation of the project activity (which occurred in February/2007)).

Under the baseline scenario (absence of the project), it is assumed that such practice would continue to exist at the UVS – Caieiras landfill [77]. Destruction of a very small and undefined share of generated methane would continue to occur in the absence of the project through the utilization of the previously existent conventional LFG venting/combustion drains (and through additional conventional LFG venting/combustion drains that would otherwise been implemented under the baseline scenario along the landfill lifetime as part of the forecasted expansion of the area of the landfill). By taking into account the existent requirement of destroying methane at the UVS - Caieiras landfill in order to address safety and odor concerns, it is thus assumed that all pre-project infrastructure encompassing the use of passive and conventional LFG venting/combustion drains would be kept/maintained in the absence of the project activity[78].

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[76] February/2007 is when the project activity initiated its operations

[77] In fact, the use of conventional passive LFG venting/combustion drains has been a practice at the UVS - Caieiras landfill even after the implementation of the project activity. In areas of the landfill which are not yet covered by the project's LFG collection wells and LFG collection pipeline network, the use of such conventional drains has been a practice to address safety concerns mainly. In Abril/2020, there were yet about 100 conventional passive drains under operation at the landfill. It is always important to take into account the very large area encompassed by the landfill. The existence of such conventional drains is further explained ahead.

[78] It is important to note that currently (under the project scenario), besides of having LFG being effectively collected and destroyed by the active (forced suction) LFG collection and destruction system (which currently comprises more than 500 LFG collection wells and which is implemented and has been operated as part of the CDM project activity), there are still existing a set of conventional passive LFG venting/combustion drains spread around the landfill (about 100 units in April/2020). In these conventional passive LFG venting/combustion drains, very small share of generated LFG has been sometimes combusted and sometimes just vented into the atmosphere. These remaining conventional LFG venting/combustion infrastructure are not connected to the project activity's LFG collection pipeline network. Venting of LFG has been a practice because although addressing safety and odor concerns are operational requirements, the large area of the landfill makes it difficult to the landfill operational staff keep all existing conventional drains alighted. Moreover, combustion of small and not defined share of generated LFG only a also non-defined fraction of the existing LFG venting/combustion drains has been assumed as per applicable design, construction and operational requirements for the UVS - Caieiras landfill as a deemed sufficient practice to address safety and odor concerns. It is noteworthy that the applicable licensing and operational permits for the UVS - Caieiras landfill do not establish or require any management for LFG generated at this landfill.

*Challenging/difficulties in converting all conventional passive LFG venting/combustion drains into appropriated active LFG collecting well connected to the project activity:* By taking into account the very large scale of the UVS - Caieiras landfill (which is one of largest landfill in Latin America), as part of the implementation and operation of the CDM project activity implemented in this landfill, there is an obvious willingness from the project participant Essencis Soluções Ambientais S.A. in converting all or most of the still existent conventional LFG venting/combustion drains into appropriate LFG collecting wells (and thus connect such wells into the project's forced LFG collection pipeline network). It is however important to note that due to operational and technical reasons (depending on the location and/or condition of such conventional LFG venting/combustion drains) or mainly due to budget/capital reasons, it has not been possible along the project's operational life to convert all of such drains into appropriate LFG collecting wells. The more the still existent conventional venting/combustion drains are converted into LFG collection wells (connected to the forced LFG collection system of the project activity), the higher would be the overall efficiency of the project's LFG collection and destruction system and the higher would be the GHG emission reductions achieved by the project activity. It is important however to note that:

(a) the emission reductions are determined on the basis of the amount of methane that is actually collected and measured by the project activity

(b) as shown in the application of this step, the amount of methane assumed to be destroyed in the absence of the project activity (baseline scenario) is also determined as a function/percentage of the amount of methane actually collected and destroyed by the project activity.

By taking into account the definitions of "*LFG capture system*", "*Existing LFG capture system*" and "*existing LFG capture system*" as per ACM0001 (version 19.0)[79], it is thus assumed that there were an "*existing LFG capture and destruction system*" at the UVS - Caieiras landfill in the pre-project scenario (prior to the implementation of the project activity). It is also assumed that such existing LFG capture and destruction system would also be existent along the baseline scenario (scenario in the absence of the project activity).

While combustion of LFG in passive (conventional) venting/combustion drains clearly represents destruction of methane (despite of its relatively very low efficiency), it is thus assumed that there were a pre-project conventional LFG capture and destruction system implemented at the UVS - Caieiras landfill prior to the implementation of the project activity (which was replaced (under a certain extent) by the project's LFG collection and destruction infrastructure). It is also assumed that such conventional system would also be existent along the whole baseline scenario in the absence of the project activity.

By taking the above presented facts and assumptions into account, the following is thus valid/applicable for the UVS - Caieiras landfill in the absence of the project activity (baseline scenario) in the context of the application of the methodological guidance of ACM0001 (version 19.0):

- Existing LFG capture and destruction system: YES

Therefore, Case 2 (which is an option/case associated to no existence of LFG capture and destruction in the absence of the project activity) is regarded as a not applicable case for the determination of $F_{CH4,BL,y}$ in the context of the demonstration of the continuation of baseline scenario and determination of baseline emissions for the 3rd and last 7-year crediting period of the project activity. Thus, the only remaining possibly valid alternative (case) (after the analysis of Existence of LFG capture and destruction system at the UVS - Caieiras landfill) is Case 4.

In summary, the only option/case applicable for the UVS - Caieiras landfill (in the absence of the project activity) is Case 4.

The following is thus valid in the context of the application of the stepwise procedure for the determination of $F_{CH4,BL,y}$ for the project activity during its 3rd and last crediting period:

- Requirement to destroy methane = YES
- Existing LFG capture and destruction system = YES

*Relevant design, construction and operational aspects for the conventional LFG venting/combustion drains in the baseline scenario:*

As set by the construction and design aspects of the UVS – Caieiras landfill and also as set by operational requirements for the landfill, in the absence of the project activity (baseline scenario), the set of pre-project rudimentary, passive and conventional LFG venting and combustion drains would remain being the only available infrastructure on-site to promote any type of management of LFG at the

By taking into consideration (a) and (b), it is thus clear that the still existence of conventional passive LFG venting/combustion drains at the UVS - Caieiras landfill does affect the integrity of the determination of emission reductions to be achieved by the project activity during its 3rd and last 7-year crediting period.

[79] As per ACM0001 (version 19.0), "*LFG capture system*" is defined as follows: "*A system to capture LFG. The system may be passive, active or a combination of both active and passive components. Passive systems capture LFG by means of natural pressure, concentration, and density gradients. Active systems use mechanical equipment to capture LFG by providing pressure gradients. Captured LFG can be vented, flared or used."*
As per ACM0001 (version 19.0), "*existing LFG capture system*" is defined as follows: "*An existing active LFG capture system is a system that has been in operation in the last calendar year prior to the start of the operation of the project activity."*

landfill (with LFG being assumed as being combusted at such drains (instead of venting of LFG) as a priority).

As per the design and construction of such conventional passive LFG venting/combustion drains, whenever the drains are not lid, LFG is just freely vented into the atmosphere (through the drains). In practical terms, only a very small fraction of total amount of LFG generated at the landfill have been actually combusted in the set of conventional LFG venting/combustion drains prior to the implementation of the project activity due to the following reasons:

- The design and construction of the pre-project conventional passive LFG venting/combustion drains is somehow rudimentary and it does not allow continuous combustion of LFG through the drains (as such drains are not conceived for assuring continuous combustion of LFG). Due to construction aspects and conditions of the drains (such as the diameter of the LFG venting drains, pressure of LFG in the drains, influence of wind and other climate aspects (e.g. rain)) as well as due to the typical day-today operational conditions at the UVS - Caieiras landfill prior to the implementation of the project activity (where no working staff were ever been required to attempt to ensure continuous combustion of LFG in the drains and/or monitor the conditions/state of such drains (e.g. regular checking whether the drains are alight)), LFG has never been continuously combusted in such pre-project passive LFG venting/combustion drains prior to the implementation of the project activity[80]. Thus, in the absence of the CDM project activity, no continuous and/or not quantitatively relevant combustion of LFG in the pre-project the drains (and additional drains that would be otherwise installed instead of the project's LFG collection wells) would occur. As above-highlighted, there is still no legal requirement to destroy methane in the UVS - Caieiras landfill. The assumed requirement is of operational and/or design nature: requirement to address safety and odor concerns. It is also important to note that, as the owner and operator of the UVS – Caieiras landfill, Essencis Soluções Ambientais S.A. would not have any economic or operational incentive/motivation to convert the such previously existing LFG venting/combustion drains into more a appropriate LFG flaring system (passive or active) in the absence of the project activity (baseline scenario).
- It is also important to note that non-continuous and/or non-quantitatively relevant combustion of LFG through conventional LFG venting/combustion drains has been the practice not only at the UVS - Caieiras landfill, but also in several others landfills and dump sites in Brazil and other countries in Latin America where no legal requirements for destruction of LFG exists. In most of the cases (where combustion of LFG in order to address safety and odor requirements is not a relevant issue), LFG is actually directly vented through the drains and/or directly through the surface of the landfill (without any LFG being combusted)[81].

[80] No continuous combustion of LFG has also been the practice in most of the currently still existing remaining conventional passive LFG venting/combustion wells at the UVS - Caieiras landfill. As per the practice at the UVS - Caieiras landfill, operational staff are currently not required to ensure or monitor whether all conventional drains are alighted. Alighted drains shuts off normally under influence of weather conditions (wind, rain, etc.) and also due low pressure or pressure fluctuations in the flow of LFG which is released by the drains.

[81] It is important to observe that as per the situation valid in April/2020, the implementation of effective active LFG collection and destruction or utilization infrastructure in landfills in Latin America has so far been occurred in the context of the emission reduction project-based initiatives under the CDM. In the absence of the incentives of the CDM, converting conventional and rudimentary LFG venting/combustion drains into appropriate LFG flaring system at the UVS - Caieiras landfill would be an effort requiring capital investment, would face operational costs and would also represent extra work to be faced by Essencis Soluções Ambientais S.A. which would not economically justified as there is still no national or regional legal or regulatory requirements in Brazil.

By taking into account the outcome of the above presented analysis the following methodological approach is valid for the determination of $F_{CH4,BL,y}$:

*Application of methodological guidance valid for Case 4:*

Under Case 4 of the methodological guidance for the determination of $F_{CH4,BL,y}$, the following is applicable as per ACM0001 (version 19.0):

"*$F_{CH4,BL,y}$ shall be determined based on information in contract of regulation requirements and data related to the existing LFG capture system, as follows:*

$$F_{CH4,BL,y} = max \{F_{CH4,BL,R,y}; F_{CH4,BL,sys,y}\} \quad \textbf{(22)}$$

*Where:*

| | |
|---|---|
| $F_{CH4,BL,R,y}$ | *Amount of methane in the LFG which is flared in the baseline due to a requirement in year y (in $tCH_4/yr$)* |
| $F_{CH4,BL.sys,y}$ | *Amount of methane in the LFG that would be flared in the baseline in year y for the case of an existing LFG capture system (in $tCH_4/yr$)* |

*$F_{CH4,BL,R,y}$ and $F_{CH4,BL.sys,y}$ shall be determined according to the respective procedures for Case 2 and Case 3 (...)*".

By considering the above-quoted requirement, $F_{CH4,BL,R,y}$ and $F_{CH4,BL.sys,y}$ are thus determined as follows:

*Determination of $F_{CH4,BL,R,y}$ by following applicable guidance/procedure for Case 2 (in the context of application of Case 4):*

By (i) taking into account the applicable definition of "*requirement*" as per ACM0001 (version 19.0); by (ii) also ackowledging that Case 2 is not an applicable case for the project activity, but by applying the applicable guidance of Case 2 as part of application of the guidance valid for Case 4, it is assumed the following in the particular context of the UVS - Caieiras landfill:

While in the context of the assumed existent non-regulatory and non-contractual requirement for addressing safety and odor concerns at the UVS - Caieiras landfill, it was never assumed or considered any particular previously defined or recommended amount (quantity) or percentage of generated LFG that is to be combusted in order to address such concerns, by taking into consideration the nature, non-regulatory and the non-contractual characteristics of the assumed/considered requirement (where the concerns about safety and odor are assumed as required to be addressed by partial combustion of LFG which is vented through the drains under a undefined quantity[82]), the installation of a conventional passive system to destroy LFG (applying conventional passive LFG venting/combustion drains) with an assumed default and conservative $CH_4$ destruction efficiency of 20% (as

[82] Under the baseline scenario, as per the construction, design and operational requirements applicable for the UVS - Caieiras landfill, it is assumed by Essencis Soluções Ambientais S.A. that venting LFG through all conventional venting/combustion drains (without promoting LFG combustion in a non-defined share of the existent drains) would not regarded as a sufficient practice to address the existent odor and safety concerns. Indeed during the pre-project scenario (prior to the implementation of the project activity), combustion of LFG is a non-defined but representative share of the existent venting/combustion drains were indeed a practice. Combustion of LFG is thus seen as required to address the existent concerns (especially the existent odor concerns). Under the baseline scenario, it is assumed that operating the landfill with no combustion of LFG at all in the conventional drains would not represent a landfill operational practice where the available operational requirements for odor would be sufficiently met.

established by ACM0001 (version 19.0)) is thus considered under a conservative and simplified approach [83].

[83] As per ACM0001 (version 19.0), the following is valid for the application of guidance of Case 2 (as part of the application of guidance for Case 4):

*"Case 2: Requirement to destroy methane exists and no existing LFG capture system*
*(…)*
$F_{CH4,BL,y} = F_{CH4,BL,R,y}$
$F_{CH4,BL,R,y}$ *should be determined based on the information contained in the requirement to destroy methane, as follows:*
*(…)*
*If the requirement does not specify the amount or percentage of LFG that should be destroyed but requires the installation of a capture system, without requiring the captured LFG to be flared then:*
$F_{CH4,BL,R} = 0$*"*

This is not an applicable equation for the baseline scenario of the project activity as although the existent requirement does not specify the amount or percentage of LFG that should be destroyed and indeed requires the installation of a capture system, it is however required that captured LFG is to be flared in a non-defined share of the existent drains. Thus the term "*without requiring the captured LFG to be flared"* is clearly not applicable for the particular case of the baseline scenario of the project activity.
The following is also valid for the application of guidance of Case 2 (as part of the application of guidance for Case 4) as per ACM0001 (version 19.0):

*"(…)*
*If the requirement does not specify any amount or percentage of LFG that should be destroyed but requires the installation of a system to capture and flare the LFG, then a typical destruction rate of 20% is assumed:*

$F_{CH4,BL,R} = 0.2 * F_{CH4,PJ,capt,y}$

*This default value of 20% is based on assuming a situation in which: the efficiency of the LFG capture system in the project is 50%; the efficiency of the LFG capture system in the baseline is 20%; and, the amount captured in the baseline is flared using an open flare with a destruction efficiency of 50% (consistent with the default value provided in the .Tool to determine project emissions from flaring gases containing methane)."*

By taking into account the combustion of LFG in pre-project existent conventional LFG venting/combustion drains have previously occurred in order to address an existent design and operational requirement for the UVS - Caieiras landfill in terms of safety and odor concerns, the equation above is thus assumed as applicable.

*System to capture and flare the LFG in the baseline scenario:*
The situation quoted above indeed represents the case/circumstance applicable for the baseline scenario. As the assumed existent non-regulatory and non-contractual requirement to collect LFG does not specify any amount or percentage of LFG that should be collected and destroyed but indeed requires LFG to be combusted (destroyed), the installation of a system to capture and flare LFG is implicitly assumed as required. The system in the particular case of the project activity are the conventional LFG venting/combustion drains which are used to vent and combust (flare) LFG in a non-controlled, non-continuous and non-systematic manner. The pre-project and baseline conventional LFG venting/combustion drains sufficiently meet the definition of "*existing LFG capture system*" as per ACM0001 (version 19.0). By promoting combustion of LFG, such system also meets the definition of "*LFG capture and destruction system*" of ACM0001 (version 19.0). It is important to note that the table above with the summary of the cases for determining methane captured and destroyed in the baseline as per ACM0001 (version 19.0) (Case 1, Case 2, Case 3 and Case 4) includes the criteria "*Existing LFG capture and destruction system*" (at the start of the project activity). It is crucial to note that in the context of the application of the whole stepwise approach for determining $F_{CH4,BL,y}$. it is required to take into consideration the practical difference/distinction between an "*Existing LFG capture system*" and an "*Existing LFG capture and destruction system*", where, as per the applied methodological approach, the latest definition is applicable for any system that promotes effective and/or real destruction of LFG through combustion in conventional flares or drains (such as in the situation in the particular case of the UVS - Caieiras landfill in the baseline scenario (absence of the project activity)). In this context, the formulae above ($F_{CH4,BL,R} = 0.2 * F_{CH4,PJ,capt,y}$) is indeed the applicable one.

*Considerations about the efficiency of the LFG capture and destruction system in the baseline scenario:*
Although, based on existent technical literature and years of field experience, it is the perception of the project participant Essencis Soluções Ambientais S.A. that assuming a default value of 20% represents a very conservative and not realistic methodological approach (at least in the particular case of the project activity, which is implemented in a very big landfill), the selection of the 20% default value is any way applied in the context of the determination of baseline emissions for the project activity during its 3rd and last 7-year crediting period in order to follow the guidance. By considering that in April/2020, more than 18,000 $Nm^3/h$ of LFG has been continuously collected and combusted as part of the operation of the project activity, it is the opinion of Essencis Soluções Ambientais S.A. that assuming that in the absence of the project activity more than 3,600 $Nm^3/h$ of LFG would be destroyed by combustion conventional passive LFG venting/combustion drains does represent a very conservative and not realistic assumption.

Thus, the following equation is applicable:

$$F_{CH4,BL,R,y} = 0.2 * F_{CH4,PJ,capt,y} \quad \textbf{(23)}$$

Where:

$F_{CH4,PJ,capt,y}$ Amount of methane in the LFG which is captured in the project activity in year *y* (in $tCH_4/yr$).

<u>*Determination of $F_{CH4,BL.sys,y}$ by following applicable guidance/procedure for Case 3 (in the context of application of Case 4):*</u>

By (i) taking into account the applicable definition of "*requirement*" as per ACM0001 (version 19.0); by (ii) also ackowledging that Case 3 is not an applicable case for the project activity, but by applying the applicable guidance of Case 3 as part of application of guidance for Case 4 in the particular context of the UVS - Caieiras landfill, it is assumed the following[84]:

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

$$F_{CH4,BL.sys,y} = 0.2 * F_{CH4,PJ,y} \quad \textbf{(24)}$$

By comparing the aplicable guidance for Case 2 and Case 3 (both in the context of application of guidance for Case 4), the following is relevant:

While the term "$0.2 * F_{CH4,PJ,capt,y}$" > "$0.2 * F_{CH4,PJ,y}$ " (by considering the equation valid for the determination of $F_{CH4,PJ,y}$); it is thus fair and correct to assume that $F_{CH4,BL,R,} > F_{CH4,BL,sys,y}$ .

Thus, the following is applicable for the determination of $F_{CH4,BL,y}$ by following the guidance for Case 4:

$$F_{CH4,BL,y} = F_{CH4,BL,R,y} = 0.2 * F_{CH4,PJ,capt,y} \quad \textbf{(25)}$$

Where: In accordance with applicable guidance of ACM0001 (version 19.0), $F_{CH4,PJ,capt,y}$ is assumed as the sum of the amount of methane that is sent to the project's methane destruction devices (e.g. set of internal combustion gas engines and set of high temperature enclosed flares) in year *y*, however by not taking into account the working hours of such devices and by not taking into account flare efficiency in the particular case of its utilization for the determination of $F_{CH4,BL,y}$ ).

[84] As per ACM0001 (version 19.0), the following is valid for the application of guidance of Case 3 (as part of the application of guidance for Case 4):

*"Case 3: No requirement to destroy methane exists and a LFG capture system exists*
*In this situation:*
$F_{CH4,BL,y} = F_{CH4,BL,sys,y}$
*(…)*

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

$F_{CH4,BL,sys,y} = 0.2 * F_{CH4,PJ,,y}$
*(…)"*

In summary, $F_{CH4,BL,y}$ is determined as follows:

$$F_{CH4,BL,y} = 0.2 * F_{CH4,PJ,capt,y} \quad \textbf{(26)}$$

Where:

In accordance with applicable guidance of ACM0001 (version 19.0), $F_{CH4,PJ,capt,y}$ is to be determined as the sum of the amount of methane that is sent to the project's methane destruction devices (i.e. set of internal combustion gas engines and set of the high temperature enclosed flares) in year *y* (however by not taking into account the working hours of such devices and by not taking into account flare efficiency in the particular case of its utilization for the determination of $F_{CH4,BL,y}$ [85]).

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

Not applicable. The only type of GHG abatement/mitigation measure encompassed by the project activity remains being destruction of methane emissions.

The project activity does not encompass electricity generation as an additional GHG abatement/mitigation measure. Thus, no emission reductions due to displacement of a more-GHG-intensive service (i.e. emission reduction due to generation of electricity using collected LFG as fuel) are eligible and/or claimable for the project activity.

Due to that Baseline emissions associated with electricity generation ($BE_{EC,y}$) are not considered. In summary, this step is not applicable.

***Baseline emissions associated with heat generation ($BE_{HG,y}$)***

As the project activity does not encompass any utilization of collected LFG for heat generation (in boiler, air heater, glass melting furnace(s) and/or kiln), baseline emissions associated with heat generation in year *y* ($BE_{HG,y}$) are not considered. In summary, this step is not applicable.

***Baseline emissions associated with natural gas use ($BE_{NG,y}$)***

As the project design does not encompass any utilization of collected LFG displacing the use of natural gas or injection of collected LFG into a natural gas distribution network or used by trucks, baseline emissions associated with natural gas use in year *y* ($BE_{NG,y}$) are not considered. Thus, this step is not applicable.

[85] In the particular case of the determination of $F_{CH4,BL,y}$ for project activity, while for a given monitoring period, $F_{CH4,PJ,capt,y}$ is thus equal to the sum of the accumulated values for amount of methane in the LFG which is destroyed by flaring in year *y* (in $tCH_4$) ($F_{CH4,flared,y}$) + values for amount of methane in the LFG which is sent to the set of internal combustion gas engines used in year *y* (in $tCH_4$/yr) ($F_{CH4,EL,}$y) for the underlying period (with values being calculated/determined without considering/monitoring the hours *h* that each individual flare has operated under conformance with operational requirements (as established/defined by the flare manufacturer) and by assuming a flare efficiency of 100% (project emissions from flaring being considered as zero (null) and, finally, by not taking into account the working hours and/or other status conditions of the internal combustion gas engines either). This represents a conservative approach as the calculated value for $F_{CH4,BL,y}$ is maximized, and baseline emissions are reduced proportionally.

***Monitoring of the management of the landfill:***

As required by ACM0001 (version 19.0), during the 3rd and last 7-year crediting period of the project activity, the design and operational conditions of the UVS – Caieiras landfill will be annually monitored on the basis of different sources, including *inter alia*:

- Original design of the landfill;
- Technical specifications for the management of the UVS – Caieiras landfill;
- Applicable local or national regulations

During the 3rd and last 7-year crediting period of the project activity, original operational design of the UVS – Caieiras landfill should be confirmed not to be modified in order to ensure that no practice to deliberately or intentionally increase methane generation at the landfill have been occurring during the 3rd crediting period, when compared to the landfill management and operation condition prior to implementation of the project activity and/or during its currently expired 1st and 2nd crediting periods. As required by ACM0001 (version 19.0), any change in the management of the landfill after the implementation of the project activity should be justified by referring to technical or regulatory specifications and impacts of such changes in the determination of baseline emissions should in this case be taken into account appropriately. Such monitoring requirement will be used for the determination/confirmation of baseline emissions and/or confirmation of the project's implementation as described in the PDD (in terms of operation and management conditions of the landfill from which LFG is combusted). Further monitoring details are included in Section B.7.1 (under parameter "Management of SWDS").

***Determination of project emissions ($PE_y$):***

As established by ACM0001 (version 19.0), project emissions ($PE_y$) for the 3rd and last 7-year crediting period of the project activity are calculated (in $tCO_2$/yr) as follows:

$$PE_y = PE_{EC,y} + PE_{FC,y} + PE_{DT,y} \quad \textbf{(27)}$$

Where:

| | |
|---|---|
| $PE_y$ | Project emissions in year *y* (in $tCO_2$/yr) |
| $PE_{EC,y}$ | Emissions from consumption of electricity due to the project activity in year *y* (in $tCO_2$/yr) |
| $PE_{FC,y}$ | Emissions from consumption of fossil fuels due to the project activity, for purpose other than electricity generation, in year *y* (in $tCO_2$/yr) |
| $PE_{DT,y}$ | Emissions from the distribution of compressed/liquefied LFG using trucks, in year y (in $tCO_2$/yr) |

Since the project activity will not encompass any distribution of compressed/liquefied LFG, there will be no project emissions from the distribution of compressed/liquefied LFG using trucks ($PE_{DT,y}$ = 0).

*Determination of project emissions from consumption of fossil fuels due to the project activity (for purpose other than electricity generation) ($PE_{FC,y}$):*

Since its start of operations, the project activity has consumed Liquefied Petroleum Gas (LPG) for igniting the currently installed high temperature enclosed flares. As required by ACM0001 (version 19.0), project emissions from consumption of fossil fuels due to the project activity (for purpose other than electricity generation) ($PE_{FC,y}$) shall be calculated using the "Tool to calculate project or leakage $CO_2$ emissions from fossil fuel". ACM0001 (version 19.0) establishes the following when applying this methodological tool:

- "*Processes j in the tool correspond to the sources of fossil fuel consumption due to the project activity other than for electricity generation or and any on-site transportation by trucks or cars;(…)".* In the particular case of the project activity, process *j* corresponds to the use of LPG for igniting the flares.

- *"If in the baseline a proportion of LFG is captured and flared ($F_{CH4,BL,y} > 0$), then the fossil fuels consumption used in calculation ($F_{Ci,j,y}$) should refer to the net of that consumed in the baseline. The determination of the amount of fossil fuels consumed in the baseline shall be transparently documented in the CDM-PDD."* In the particular case of the project activity, while no fossil fuel has been used in the pre-project and baseline scenarios for collecting and destroying LFG, this requirement is thus not applicable.

Thus,

$$PE_{FC,y} = PE_{LPG,y} \quad \textbf{(28)}$$

Where:

$PE_{LPG,y}$ Project emissions due to the consumption of Liquefied Petroleum Gas by the project activity in year *y* (in $tCO_2$/year)

In order to determine $PE_{LPG,y}$, applicable guidance of the "Tool to calculate project or leakage $CO_2$ emissions from fossil fuel combustion" (version 03.0) is applied as follows:

$$PE_{LPG,y} = FC_{LPG,y} * COEF_{LPG,y} \quad \textbf{(29)}$$

Where:

$FC_{LPG,y}$ Quantity of LPG consumed (in ton LPG). $FC_{LPG,y}$ will be monitored ex-post based on measurements as per monitoring details included in Section B.7.1 and B.7.3.

$COEF_{LPG,y}$ $CO_2$ emission coefficient for LPG (in $tCO_2$/ton LPG).
$COEF_{LPG,y}$ is determined by following applicable guidance of Option B of the "Tool to calculate project or leakage $CO_2$ emissions from fossil fuel combustion" as follows:

$$COEF_{LPG,y} = NCV_{LPG,y} * EF_{CO2,LPG,y} \quad \textbf{(30)}$$

Where:

$NCV_{LPG,y}$ Net calorific value of the fuel LPG (in GJ/ton LPG). $NCV_{LPG,y}$ will be monitored ex-post as per monitoring details included in Section B.7.1 and B.7.3.

$EF_{CO2,LPG,y}$ $CO_2$ emission factor of fuel LPG (in $tCO_2$/GJ LPG). $EF_{CO2,LPG,y}$ will be monitored ex-post as per monitoring details included in Section B.7.1 and B.7.3.

*Determination of project emissions from consumption of electricity due to the project activity ($PE_{EC,y}$):*

As required by ACM0001 (version 19.0), project emissions from consumption of electricity by the project activity ($PE_{EC,y}$) shall be calculated by applying the methodological approach established by the methodological tool "Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation" (version 03.0).

While the project activity (under its revised design configuration) fits under "Scenario C (*Electricity consumption from the grid and (a) fossil fuel fired captive power plant(s)*) of this methodological tool, the following is also established by the tool:

> "*In the generic approach, project, baseline and leakage emissions from consumption of electricity are calculated based on the quantity of electricity consumed, an emission factor for electricity generation and a factor to account for transmission losses (…)*"[86]

ACM0001 (version 19.0) establishes the *following* when applying this methodological tool:

- *"$EC_{PJ,k,y}$[87] in the tool is equivalent to the amount of electricity consumed by the project activity in year y ($EC_{PJ,y}$)."*
- *"If in the baseline a proportion of LFG is destroyed ($F_{CH4,BL,y}$ > 0), then the electricity consumption in the tool ($EC_{PJ,j,y}$) should refer to the net quantity of electricity consumption (i.e. the increase due to the project activity). The determination of the amount of electricity consumed in the baseline shall be transparently documented in the CDM-PDD."*

In the particular case of the project activity under its revised design configuration, electricity sources *j* in the tool corresponds to the sources of electricity consumed due to the project activity: (i) grid-sourced electricity and (ii) electricity generated by the backup captive off-grid electricity generator (fuelled by diesel) are expected to be consumed for the operation of the project activity. No sources of electricity other than (i) and (ii) are currently expected to be used to meet the electricity demand of the project activity during its 3rd and last 7-year crediting period.

In the particular case of the project activity, although LFG is destroyed in the baseline scenario ($F_{CH4,BL,y}$ > 0), while the no electricity has been previously used in the pre-project and baseline scenarios (absence of the project activity) for collecting and destroying LFG through the utilization of conventional LFG venting/combustion drains, determination of the amount of electricity consumed in the baseline scenario (absence of the project activity) is thus not applicable/considered.

According to the methodological tool "Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation" (version 03.0), project emissions due to electricity consumption by the project activity ($PE_{EC,y}$) are calculated as follows:

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[86] Since July/2016, the project's electricity demand is to be met by one of the following sources/approaches:

- Imports of grid-sourced electricity (with electricity sourced by the grid-connected electricity generation infrastructure fuelled by LFG and located within the geographical limits of the UVS – Caieiras landfill being always regarded and accounted as consumption of grid-sourced electricity as justified in Box 2 in Section A.3).
- Electricity supply by the installed backup captive off-grid electricity generator (fuelled by diesel) (expected to occur only during temporary planned or unplanned circumstances when supply of grid-sourced electricity is also interrupted).

[87] As per the methodological tool "Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation" (version 03.0), $EC_{PJ,j,y}$ is the quantity of electricity consumed by the project electricity consumption source j in year y.

$PE_{EC,y} = \sum EC_{PJ,j,y} * EF_{EL,j,y} * (1 + TDL_{j,y})$ **(31)**

Where:

| | |
|---|---|
| $EC_{PJ,j,y}$ | Quantity of electricity consumed by the project electricity consumption source *j* in year y (in MWh). |
| $EF_{EL,j,y}$ | $CO_2$ emission factor for electricity generation for source j in year y (in $tCO_2$/MWh). |
| $TDL_{j,y}$ | Average technical transmission and distribution losses for providing electricity to source *j* in year *y* |

In the particular case of the project activity, as grid-sourced electricity and electricity generated by the backup captive off-grid electricity generator (fuelled by diesel) are the only sources of electricity consumed by the project activity, $PE_{EC,y}$ can thus be calculated as:

$PE_{EC,y} = PE_{EC,grid,y} + PE_{EC,captive,y}$ **(32)**

Where:

| | |
|---|---|
| $PE_{EC,grid,y}$ | Project emissions from consumption of grid electricity due to the project activity in year y (in $tCO_2$/yr) |
| $PE_{EC,captive,y}$ | Project emissions from consumption of electricity generated by a captive off-grid electricity generator fuelled by fossil fuel (diesel) in year *y* (in $tCO_2$/yr) |

$PE_{EC,grid,y}$ and $PE_{EC,captive,y}$ are calculated according to the following approach:

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

By following applicable guidance of the methodological tool "Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation" (version 03.0), valid for Scenario C (Electricity consumption from the grid and (a) fossil fuel fired captive power plant(s)) with Case C.III (Electricity from both the grid and captive power plant(s)) being selected as a generic approach; project emissions due to grid electricity consumption by the project activity ($PE_{EC,grid,y}$)[88] are determined as follows:

[88] Since July/2016, the project's electricity demand can technically be met by one of the following sources/approaches:

- Imports of grid-sourced electricity (with electricity sourced by the grid-connected electricity generation infrastructure fuelled by LFG and located within the geographical limits of the UVS – Caieiras landfill being regarded and accounted as consumption of grid-sourced electricity as justified in Box 2c in Section A.3).
- Electricity supply by the installed backup captive off-grid electricity generator (fuelled by diesel) (expected to occur only during temporary planned or unplanned circumstances when supply of grid-sourced electricity is also interrupted).

$$PE_{EC,grid,y} = EC_{PJ,grid,y} * EF_{EL,grid,y} * (1 + TDL_{grid,y}) \quad \textbf{(33)}$$

Where:

$EC_{PJ,grid,y}$ Quantity of grid sourced electricity consumed by the project activity in year y. As detailed in Section B.7.1 and B.7.3, $EC_{PJ,grid,y}$ will be measured and monitored in MWh as per the provisions of the methodological tool “Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation” (version 03.0).

$TDL_{grid,y}$ Average technical transmission and distribution losses for grid sourced electricity consumed by the project activity in year *y.*

$EF_{EL,grid,y}$ $CO_2$ emission factor for grid-sourced electricity in year y (in $tCO_2$/MWh). $EF_{EL,grid,y}$ is determined by following applicable guidance of the “Tool to calculate baseline, project and/or leakage emissions from electricity consumption” as follows:

> *“Where case C.III has been identified, as a conservative simple approach, the emission factor for electricity generation should be the more conservative value between the emission factor determined as per guidance for scenario A and B respectively. This means that the more conservative value should be chosen between a) the result of applying either option A1 or A2 and b) the result of applying either option B1 or B2.”*
>
> *“Where case C.I has been identified, the guidance for scenario A (…) should be applied (use option A1 or option A2).”*

The following above-quoted options of the methodological tool (Options A.1, A.2, B.1 and B.2.) may thus be analysed ex-post for the determination of $EF_{EL,grid,y}$ (with the most conservative (higher) value being chosen in the particular case of Scenario C.III) as follows:

---

**Note:** The backup captive off-grid electricity generator (fuelled by diesel) currently installed as part of the project activity is activated automatically (through automatic switching control) only under unexpected situations in which supply of grid-sourced electricity to the project activity is interrupted. The available automatic switching control does not allow such electricity generator to be connected to the electricity grid. Thus, under no circumstance the project’s electricity demand can be met simultaneously by grid-sourced electricity and by backup electricity generator (fuelled by diesel). It is also relevant to note that, while the project activity is connected to a very stable and reliable electricity transmission/distribution line, since its installation of in July/2016, the installed backup captive off-grid electricity generator (fuelled by diesel) has not been utilized (with exception of limited testing/commissioning event and preventive maintenance procedures when the generator is manually turned on for very short instants without having electricity being supplied to project activity). Anyhow, for sake of conservativeness case C.III is considered as a generic approach. However, for sake of correctness, if within a specific monitoring period along the 3rd and last 7-year crediting period of the project activity it is confirmed that the installed backup captive off-grid electricity generator (fuelled by diesel) was (as expected) not indeed used during the period in question, Case C.I (Grid Electricity) may be considered as an alternative for the ex-post determination of project emissions due to consumption of grid-sourced electricity by the project activity within such period under Scenario C (with direct application of option A.1 or A.2 of the methodological tool “Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation” (version 03.0) for the ex-post determination of $EF_{EL,grid,y}$ as established by guidance of tool for Case C.I). Under such expected circumstance/condition, project emissions due to the consumption of electricity from the installed backup captive generator (fuelled by diesel) will thus directly be determined as null/zero.

- Option A.1: $EF_{EL,grid,y}$ is calculated ex-post as the combined margin (CM) emission factor ($EF_{grid,CM,y}$) as per the methodological tool "Tool to calculate the emission factor for an electricity system" (version 07.0) by following approach summarized below in this Section under "*Approach for determination of combined margin (CM) emission factor ($EF_{grid,CM,y}$ = $EF_{EL,grid,y}$)".*

- Option A.2: $EF_{EL,grid,y}$ is directly determined as 1.3 $tCO_2$/MWh (applicable conservative default value of the methodological tool "Tool to calculate baseline, project and/or leakage emissions from electricity consumption").

- Option B.1.: $EF_{EL,grid,y}$ is calculated ex-post based in the $CO_2$ emissions for the fossil fuel diesel consumed by the installed backup captive off-grid electricity generator as well as based on the ration between the amount of fuel consumed by such generator and amount of generated electricity during the time period *t* (with the fuel net caloric value also being considered) as follows:

$$EF_{EL,grid,y} = \frac{FC_{Diesel,t} \times NCV_{Diesel} \times EF_{CO2,Diesel}}{EG_{Diesel\text{-}generator}} \qquad \textbf{(34)}$$

Where:

| | |
|---|---|
| $FC_{Diesel,t}$ | Amount of fossil fuel diesel consumed by the installed backup captive off-grid electricity generator during the time period *t* (in liters or kg) |
| $NCV_{Diesel}$ | Net calorific value for fossil fuel diesel (in GJ/liters or GJ/kg) |
| $EF_{CO2,Diesel}$ | $CO_2$ emission factor of fuel diesel (in $tCO_2$/GJ) |
| $EG_{Diesel\text{-}generator,y}$ | Amount of electricity generared by the installed backup captive off-grid electricity generator during the period *t* (in MWh) |

Option B.2: $EF_{EL,grid,y}$ is directly determined as 1.3 $tCO_2$/MWh (applicable conservative default value of the methodological tool "Tool to calculate baseline, project and/or leakage emissions from electricity consumption").

*<u>Approach for determination of combined margin (CM) emission factor ($EF_{grid,CM,y}$ = $EF_{EL,grid,y}$):</u>*

As per Option A.1 of the methodological tool "Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation" (version 03.0) the following guidance is applicable:

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

Calculation of $EF_{grid,CM,y}$

Combined margin $CO_2$ emissions factor ($EF_{grid,CM,y}$) is calculated in accordance with the methodological tool "Tool to calculate the emission factor for an electricity system" (version 07.0). This methodological tool determines the $CO_2$ emission factor for the displacement of electricity generated by grid-connected power plants connected to a particular electricity grid, by calculating the combined margin emission factor ($EF_{CM,y}$) of the electricity system. As per the "Tool to calculate the emission factor for an electricity system" (version 07.0), $EF_{grid,CM,y}$ is determined as a weighted average of following two $CO_2$ emission factors pertaining to the electricity system:

- the $CO_2$ operating margin emission factor ($EF_{OM,y}$) and;
- the build margin emission factor ($EF_{BM,y}$).

The operating margin emission factor refers to the group of existing power plants whose current electricity generation would be potentially affected by the proposed CDM project activity.
The build margin emission factor refers to the group of prospective power plants whose construction and future operation would be potentially affected by the proposed CDM project activity.

The applicable procedures of "Tool to calculate the emission factor for an electricity system" (version 07.0) tool are described in the following steps:

*- Step 1. Identify the relevant electricity systems:*
For determining the electricity emission factors, a project electricity system is defined by the spatial extent of the power plants that are physically connected through transmission and distribution lines to the project activity and that can be dispatched without significant transmission constraints. For the particular case of the project activity, the spatial extent of the project boundary includes the project site which is connected to the National Electricity Grid of Brazil which is named National Interconnected System (*Sistema Interligado Nacional – SIN*).

*- Step 2. Choose whether to include off-grid power plants in the project electricity system (optional):* Option I of the tool is chosen (which is to include only grid power plants in the calculation).

*- Step 3. Select a method to determine the operating margin (OM):*
The calculation of the operating margin emission factor ($EF_{grid,OM,y}$) is based on one of the following methods:
(a) Simple OM; or
(b) Simple adjusted OM; or
(c) Dispatch data analysis OM; or
(d) Average OM.

Any above method can be utilized. However, the simple OM method (option a) can only be used if low-cost/must-run resources constitute less than 50% of total grid generation in: 1) average of the five most recent years, or 2) based on long-term averages for hydroelectricity production. This is not the case for the project electricity system being considered.
Since the simple adjusted OM (option b) emission factor is a variation of the simple OM, where the power plants/units (including imports) are separated in low-cost/must-run power sources and other power sources, this is also not applicable to this project activity either.
For the similar reason, the option (d), average OM emission factor is not eligible for this project, since it is calculated as the average emission rate of all power plants serving the grid, using the methodological guidance for the simple OM, but including in all equations also low-cost/must-run power plants.

Therefore, for the OM calculation method, the option (c) dispatch data analysis is preferred, since the Ministry of Science, Technology, Innovation and Communication (MCTIC) of Brazil has been updated and published annually the information for power units[89].

For the dispatch data analysis OM, the year in which the project activity displaces grid electricity and the emission factor updating annually during monitoring is utilized.

*- Step 4. Calculate the operating margin emission factor according to the selected method:*
In order to determine the combined margin emission factor, the dispatch data analysis method has been selected among four options proposed in the methodology, since it is publicly available in Brazil.

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

The operating margin emission factor is calculated as follows:

$$EF_{grid,OM\text{-}DDy} = \frac{\sum_h EG_{PJ,h} \cdot EF_{EL,DD,h}}{EG_{PJ,y}} \quad \textbf{(34)}$$

Where:

| | |
|---|---|
| $EF_{grid,OM\text{-}DD,y}$ | = Dispatch data analysis operating margin $CO_2$ emission factor in year $y$ (in $tCO_2$/MWh) |
| $EG_{PJ,h}$ | = Electricity displaced by the project activity in hour $h$ of year $y$ (in MWh) |
| $EF_{EL,DD,h}$ | = $CO_2$ emission factor for grid power units in the top of the dispatch order in hour $h$ in year $y$ (in $tCO_2$/MWh) |
| $EG_{PJ,y}$ | = Total electricity displaced by the project activity in year $y$ (in MWh) |
| $h$ | = Hours in year $y$ in which the project activity is displacing grid electricity |
| $y$ | = Year in which the project activity is displacing grid electricity |

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

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

> <u>Option 1:</u> *For the first crediting period, calculate the build margin emission factor ex ante based on the most recent information available on units already built for sample group m at the time of CDM-PDD submission to the DOE for validation. For the*

[89] The Ministry of Science, Technology, Innovation and Communications (MCTIC) of Brazil has been calculating the $CO_2$ emission factor for the national electricity grid of Brazil according to the methodology tool "Tool to calculate the emission factor for an electricity system" (version 07.0 and previous versions). The $CO_2$ emission factor for the national electricity grid of Brazil can be directly obtained from the website of the Designated National Authority (DNA) of Brazil. The actual latest annual value (year 2019) has been calculated by Ministry of Science, Technology, Innovation and Communications (MCTIC), Brazilian Designated National Authority (DNA). The Emission Factor will be monitored through ex-post calculation, following the latest version of Tool to calculate the emission factor for an electricity system. The Combined Margin is calculated through a weighted-average formula, considering both the $EF_{grid,OM\text{-}DD,y}$ and the $EF_{grid,BM,y}$ and the weights $w_{OM}$ and $w_{BM}$ (default values of 0.25 and 0.75, respectively).

*second crediting period, the build margin emission factor should be updated based on the most recent information available on units already built at the time of submission of the request for renewal of the crediting period to the DOE. For the third crediting period, the build margin emission factor calculated for the second crediting period should be used. This option does not require monitoring the emission factor during the crediting period.*

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

*Option 1* was previously selected for the currently expired $2^{nd}$ 7-year crediting period of the project activity. The build margin emissions factor is the generation-weighted average emission factor (in $tCO_2/MWh$) of all power units m during the most recent year *y* for which power generation data is available. The value previously determined for the currently expired $2^{nd}$ 7-year crediting period is also used for the $3^{rd}$ and last 7-year crediting period of the project activity.

- *Step 6. Calculate the combined margin (CM) emissions factor*

The combined margin emissions factor is calculated as follows:

$$EF_{grid,CM,y} = EF_{grid,OM,y} * w_{OM} + EF_{grid,BM,y} * w_{BM} \qquad \textbf{(35)}$$

Where:

| | |
|---|---|
| $EF_{grid,BM,y}$ | Build margin $CO_2$ emission factor in year *y* ($tCO_2/MWh$) |
| $EF_{grid,OM,y}$ | Operating margin $CO_2$ emission factor in year *y* ($tCO_2/MWh$) |
| $w_{OM}$ | Weighting of operating margin emissions factor (%) |
| $w_{BM}$ | Weighting of build margin emissions factor (%) |

The values for $w_{OM}$ and $w_{BM}$ are ex-ante selected as per applicable guidance of the "Tool to calculate the emission factor for an electric system", which includes the following as a requirement:

*"The following default values should be used for $w_{OM}$ and $w_{BM}$:*

*(a) Wind and solar power generation project activities: $w_{OM}$ = 0.75 and $w_{BM}$ = 0.25 (owing to their intermittent and non-dispatchable nature) for the first crediting period and for subsequent crediting periods;*

*(b) All other projects: $w_{OM}$ = 0.5 and $w_{BM}$ = 0.5 for the first crediting period, and $w_{OM}$ = 0.25 and $w_{BM}$ = 0.75 for the second and third crediting period, unless otherwise specified in the approved methodology which refers to this tool."*

While values for the parameters $EF_{grid,BM,y}$, $w_{OM}$ and $w_{BM}$ which are applicable for the $3^{rd}$ and last 7-year crediting period are selected ex-ante, annual values for $EF_{grid,OM,y}$ will be determined ex-post within the crediting period as required by the methodological tool "Tool to calculate the emission factor for an electric system". Thus, during the $3^{rd}$ and last 7-year

crediting period of the project activity, the combined margin $CO_2$ emission factor will be calculated and updated annually.

*Project emissions due to the consumption of electricity sourced by backup captive off-grid electricity generator (fuelled by diesel) ($PE_{EC,captive,y}$):*

By following applicable guidance of the methodological tool “Tool to calculate baseline, project and/or leakage emissions from electricity consumption” (version 1) applicable for Scenario C (with Case C.III being selected as a generic approach); project emissions from the consumption of electricity generated by the backup captive off-grid electricity generator (fuelled by diesel) are to be calculated as follows:

As the methodological tool “Tool to calculate baseline, project and/or leakage emissions from electricity consumption”, $PE_{EC,captive,y}$ is calculated as follows:

$$PE_{EC,captive,y} = EC_{PJ,captive,y} * EF_{EL,captive,y} * (1 + TDL_{captive,y}) \quad \textbf{(36)}$$

Where:

$EC_{PJ,captive,y}$ Amount of electricity sourced by the backup captive off-grid electricity generator (fuelled by diesel) and consumed by the project activity. $EC_{captive,y}$ will be measured and monitored in MWh as per the provisions of the methodological tool “Tool to calculate baseline, project and/or leakage emissions from electricity consumption”.

$TDL_{captive,y}$ Average technical transmission and distribution losses for electricity sourced by the captive electricity generator.

$EF_{EL,captive,y}$ $CO_2$ emission factor for electricity sourced by the captive off-grid electricity generator (in $tCO_2$/MWh). Like in the case of $EF_{EL,grid,y}$, $EF_{EL,captive,y}$ will be determined by following applicable guidance of the “Tool to calculate baseline, project and/or leakage emissions from electricity consumption” as follows:

> *“Where case C.III has been identified, as a conservative simple approach, the emission factor for electricity generation should be the more conservative value between the emission factor determined as per guidance for scenario A and B respectively. This means that the more conservative value should be chosen between a) the result of applying either option A1 or A2 and b) the result of applying either option B1 or B2.”*

Like in the case of the determination of $EF_{EL,grid,y}$, if applicable, the Options A.1, A.2, B.1 and/or B.2 of the methodological tool may be analysed ex-post for the determination of $EF_{EL,captive,y}$ [90].

[90] **Note:** If within a specific monitoring period along the 3rd and last 7-year crediting period of the project activity it is confirmed that the installed backup captive off-grid electricity generator (fuelled by diesel) is (as expected) not indeed used during the period in question, project emissions due to the consumption of electricity from the installed backup captive generator (fuelled by diesel) will thus directly be determined as null/zero. Under this circumstance, Case C.I (Grid Electricity) may be considered as an alternative for the ex-post determination of project emissions due to consumption of grid-sourced electricity by the project activity within such period under Scenario C (with direct application of option A.1 or A.2 of the methodological tool “Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation” (version 03.0) for the ex-post determination of $EF_{EL,grid,y}$ as established by guidance of tool for Case C.I).

***<u>Determination of leakage emissions ($LE_y$):</u>***

No leakage emissions are expected to occur. Moreover, no leakage effects are accounted for under ACM0001 (version 19.0)[91].

[91] In the view of Essencis Soluções Ambientais S.A., in the particular context of the project activity encompassing methane destruction as its unique measure, displacement of a more-GHG-intensive service (i.e. emission reductions due to generation of electricity using collected LFG as fuel) could in theory even be regarded as negative leakage emissions. Anyhow, while leakage emissions are not applicable as part of ACM0001 (version 19.0), such emissions are anyway neglected.

### B.6.2. Data and parameters fixed ex ante

| **Data/Parameter** | $OX_{top\ layer}$ |
|---|---|
| Data unit | Dimensionless |
| Description | Fraction of methane that would be oxidized in the top layer of the SWDS in the baseline |
| Source of data | Consistent with how oxidation is accounted for in the methodological tool “Emissions from solid waste disposal sites” (version 08.0) |
| Value(s) applied | 0.1 |
| Choice of data or measurement methods and procedures | Default value as per the applied CDM baseline and monitoring methodology ACM0001 - “Flaring or use of landfill gas” (version 19.0) |
| Purpose of data | Calculation of baseline emissions. |
| Additional comment | - |

| **Data/Parameter** | $GWP_{CH4}$ |
|---|---|
| Data unit | t $CO_2e$/t $CH_4$ |
| 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 values are 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 | Calculation of baseline emissions. |
| Additional comment | The applied value shall be updated according to any future COP/MOP decisions and/or decision by the CDM-EB. |

| **Data/Parameter** | $\eta_{PJ}$ |
|---|---|
| Data unit | Dimensionless |
| Description | Efficiency of the LFG capture system that will be installed in the project activity |
| Source of data | Value obtained from technical literature |
| Value(s) applied | 0.9280 |
| Choice of data or measurement methods and procedures | Value obtained from technical literature[92] and by also taking into consideration the design and operational characteristics/aspects of the UVS - Caieiras landfill plus the general construction, design and forecasted implementation of the project's LFG collection network during its 3rd and last 7-year crediting period. |
| Purpose of data | Calculation of baseline emissions |
| Additional comment | Selected value can also be represented as percentage, since 0.9280 = 92.80% |

[92] The technical paper "*Measuring landfill gas collection efficiency using surface methane concentration*" (which was published by Raymond L. Huitric and Dung Kong, from the Solid Waste Management Department of the Los Angeles County Sanitation Districts), states the following regarding LFG collection efficiency for a well-managed LFG collection system:

> *"Measuring landfill gas collection efficiency is important for gauging emission control effectiveness and energy recovery opportunities. Though researched for years, practical measures of collection efficiency are lacking. Instead, a default efficiency of 75% based on surveys of industry estimates is commonly used, for example, by the United States Environmental Protection Agency (US EPA). Though few, actual emission measurements indicate substantially higher efficiencies ranging from 85 to 98%."*

This document also mentions *"(…) landfill gas collection efficiencies should routinely reach 100%."*
Practical results, shown on table 4 of the study: Weighted average collection efficiency, show a collection efficiency of 92.8 to 96.1% on well-engineered landfills with vacuum systems to extract LFG.
The paper "*Measuring landfill gas collection efficiency using surface methane concentration*" is available at http://www.arb.ca.gov/cc/ccea/comments/april/huitric_kong.pdf

| **Data/Parameter** | $\mathbf{R_u}$ |
|---|---|
| Data unit | Pa.m$^3$/kmol.K |
| Description | Universal ideal gases constant |
| Source of data | Default value as per the methodological tool “Tool to determine the mass flow of a greenhouse gas in a gaseous stream” (version 03.0) |
| Value(s) applied | 8,314 |
| Choice of data or measurement methods and procedures | - |
| Purpose of data | Calculation of baseline emissions. |
| Additional comment | **-** |

| **Data/Parameter** | $\mathbf{MM_i}$ |
|---|---|
| Data unit | kg/kmol |
| Description | Molecular mass of greenhouse gas *i* |
| Source of data | Default values as per the methodological tool “Tool to determine the mass flow of a greenhouse gas in a gaseous stream” (version 03.0) |
| Value(s) applied | The following values of molecular mass are applicable for $CH_4$ (the only GHG which is considered): |
| Choice of data or measurement methods and procedures | - |
| Purpose of data | Calculation of baseline emissions. |
| Additional comment | - |

| Compound | Structure | Molecular mass (kg/kmol) |
|---|---|---|
| Methane | $CH_4$ | 16.04 |

| **Data/Parameter** | **$MM_k$** |
|---|---|
| Data unit | kg/kmol |
| Description | Molecular mass of gas *k* |
| Source of data | Default values as per the methodological tool “Tool to determine the mass flow of a greenhouse gas in a gaseous stream” (version 03.0) |
| Value(s) applied | For considered gases *k* that are greenhouse gases (GHGs), the values below are applied for $MM_k$.<br><br>As per the methodological tool “Tool to determine the mass flow of a greenhouse gas in a gaseous stream” (version 03.0) the following is applicable for the particular case of the project activity:<br><br>*“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 19.0) does not include any restriction to such simplification. Thus, only the volumetric fraction of gases that are greenhouse gases and are considered in related calculations ($CH_4$ in the particular case of the project activity) and the difference to 100% is just considered as pure nitrogen.<br><br>Compound: Nitrogen; Structure: $N_2$; Molecular mass (kg/kmol): 28.01 |
| Choice of data or measurement methods and procedures | - |
| Purpose of data | Calculation of baseline emissions. |
| Additional comment | - |

| **Data/Parameter** | **$MM_{H2O}$** |
|---|---|
| Data unit | kg/kmol |
| Description | Molecular mass of water |
| Source of data | Default value as per the methodological tool “Tool to determine the mass flow of a greenhouse gas in a gaseous stream” (version 03.0) |
| Value(s) applied | 18.0152 |

| | |
|---|---|
| Choice of data or measurement methods and procedures | - |
| Purpose of data | Calculation of baseline emissions. |
| Additional comment | - |

| | |
|---|---|
| **Data/Parameter** | **$P_n$** |
| Data unit | Pa |
| Description | Total pressure at normal conditions |
| Source of data | Default value as per the methodological tool “Tool to determine the mass flow of a greenhouse gas in a gaseous stream” (version 03.0) |
| Value(s) applied | 101,325 |
| Choice of data or measurement methods and procedures | - |
| Purpose of data | Calculation of baseline emissions. |
| Additional comment | - |

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

| **Data/Parameter** | $\varphi_{default}$ |
|---|---|
| Data unit | - |
| Description | Default value for the model correction factor to account for model uncertainties |
| Source of data | Default value applicable for determination of baseline emissions as per the methodological tool “Emissions from solid waste disposal sites” (version 08.0). Value applicable for humid/wet conditions as per Application A is selected (based on the climate conditions valid for the location of the project activity).<br>Source for weather condition data: http://www.bbc.com/weather |
| Value(s) applied | 0.75 |
| Choice of data or measurement methods and procedures | Determined based on default value of table 3 of the referred methodological tool as per Option 1, Application A (value applicable for humid/wet conditions). |
| Purpose of data | Calculation of baseline emissions |
| Additional comment | - |

| **Data/Parameter** | **OX** |
|---|---|
| Data unit | - |
| Description | Oxidation factor (reflecting the amount of methane from SWDS that is oxidized in the soil or other material covering the waste) |
| Source of data | Applicable default value as per the methodological tool “Emissions from solid waste disposal sites” (version 08.0) |
| Value(s) applied | 0.1 |
| Choice of data or measurement methods and procedures | - |
| Purpose of data | Calculation of baseline emissions |
| Additional comment | - |

| **Data/Parameter** | **F** |
|---|---|
| Data unit | - |
| Description | Fraction of methane in the SWDS gas (volume fraction) |
| Source of data | Applicable default value as per the methodological tool “Emissions from solid waste disposal sites” (version 08.0) |
| Value(s) applied | 0.5 |
| Choice of data or measurement methods and procedures | This factor reflects the fact that some degradable organic carbon does not degrade, or degrades very slowly, under anaerobic conditions in the considered SWDS. A default value of 0.5 is recommended by IPCC. |
| Purpose of data | Calculation of baseline emissions |
| Additional comment | - |

| **Data/Parameter** | **$DOC_{f,default}$** |
|---|---|
| Data unit | Weight fraction |
| Description | Default value for the fraction of degradable organic carbon (DOC) in MSW that decomposes in the SWDS |
| Source of data | Applicable default value as per the methodological tool “Emissions from solid waste disposal sites” (version 08.0), which refers to applicable value as per IPCC 2006 Guidelines for National Greenhouse Gas Inventories. |
| Value(s) applied | 0.5 |
| Choice of data or measurement methods and procedures | This factor reflects the fact that some degradable organic carbon does not degrade, or degrades very slowly, in the SWDS. The default value was applied as per Application A of the methodological tool “Emissions from solid waste disposal sites” (version 08.0): “*The CDM project activity mitigates methane emissions from a specific existing SWDS”.* |
| Purpose of data | Calculation of baseline emissions |
| Additional comment | Application A of the methodological tool “Emissions from solid waste disposal sites” (version 08.0) is the applicable case of the project activity. |

| **Data/Parameter** | $\mathbf{MCF_{default}}$ |
|---|---|
| Data unit | - |
| Description | Methane correction factor |
| Source of data | Value is sourced by the methodological tool “Emissions from solid waste disposal sites” (version 08.0), that refers to IPCC 2006 Guidelines for National Greenhouse Gas Inventories. |
| Value(s) applied | 1.0 |
| Choice of data or measurement methods and procedures | Value is selected as per Application A of the methodological tool, under the following conditions:<br><br>“*1.0: for anaerobic managed solid waste disposal sites. These must have controlled placement of waste (i.e., waste directed to specific deposition areas, a degree of control of scavenging and a degree of control of fires) and will include at least one of the following: (i) cover material; (ii) mechanical compacting; or (iii) leveling of the waste”*<br><br>The day-to-day MSW disposal activities at the UVS - Caieiras landfill encompasses utilization of appropriate MSW landfilling practices (covering, leveling and mechanical compacting of disposed material, etc.) as part of the operation of this landfill. The UVS - Caieiras landfill is regarded as a well-managed landfill site. |
| Purpose of data | Calculation of baseline emissions |
| Additional comment | - |

| **Data/Parameter** | $\mathbf{DOC_j}$ |
|---|---|
| Data unit | - |
| Description | Fraction of degradable organic carbon in the waste type *j* (weight fraction) |
| Source of data | Values are selected as per applicable guidance of the methodological tool “Emissions from solid waste disposal sites” (version 08.0), that refers to IPCC 2006 Guidelines for National Greenhouse Gas Inventories, (adapted from Volume 5, Tables 2.4 and 2.5). |

<table>
<tr><td>Value(s) applied</td><td>

| **Waste type *j*** | **$DOC_j$ (% wet waste)** |
|---|---|
| Wood and wood products | 43 |
| Pulp, paper and cardboard (other than sludge) | 40 |
| Food, food waste, beverages and tobacco (other than sludge) | 15 |
| Textiles | 24 |
| Garden, yard and park waste | 20 |
| Glass, plastic, metal, other inert waste | 0 |

</td></tr>
<tr><td>Choice of data or measurement methods and procedures</td><td>The selected values are based on wet waste basis (moisture concentrations in the waste streams as waste is delivered to the SWDS). The IPCC 2006 Guidelines also specifies DOC values on a dry waste basis, which refers to the moisture concentrations after complete removal of all moisture from the waste. However, this selection is not practical for the situation/practice at the UVS - Caieiras landfill.</td></tr>
<tr><td>Purpose of data</td><td>Calculation of baseline emissions</td></tr>
<tr><td>Additional comment</td><td>-</td></tr>
</table>

<table>
<tr><td>**Data/Parameter**</td><td>**$k_j$**</td></tr>
<tr><td>Data unit</td><td>1/yr</td></tr>
<tr><td>Description</td><td>Decay rate for the waste type *j*</td></tr>
<tr><td>Source of data</td><td>Values are selected as per applicable guidance of the methodological tool “Emissions from solid waste disposal sites” (version 08.0). The methodological tools refers to values as per IPCC 2006 Guidelines for National Greenhouse Gas Inventories (adapted from Volume 5, Table 3.3).</td></tr>
<tr><td>Value(s) applied</td><td>

| **Degradation speed** | **Waste type** | **$k_j$** |
|---|---|---|
| Slowly degrading | Wood, wood products, rubber and leather | 0.03 |
| | Pulp, paper and cardboard (other than sludge), textiles | 0.06 |
| Moderately Degrading | other (non-food) organic putrescible Garden, yard and park waste | 0.1 |
| Rapidly degrading | Food, food waste, sewage sludge, beverages and tobacco | 0.185 |

</td></tr>
<tr><td>Choice of data or measurement methods and procedures</td><td>Parameters are selected in accordance to the climate zone valid for the project site:<br>Mean Annual Temperature (MAT) = 19 $^oC$<br>Mean Annual Precipitation (MAP) = 1,324 mm – (wet climate).<br>Source of data for mean annual temperature (MAT) and mean annual precipitation (MAP): http://www.tempoagora.com.br</td></tr>
</table>

| | |
|---|---|
| Purpose of data | Calculation of baseline emissions |
| Additional comment | - |

| | |
|---|---|
| **Data/Parameter** | **$W_j$** |
| Data unit | - |
| Description | Weight fraction of the waste type *j* |
| Source of data | Values are selected as per applicable guidance of IPCC 2006 Guidelines for National Greenhouse Gas, Volume 5, Chapter 2, tables 2.3-2.5, MSW composition regional default values for South-America. |
| Value(s) applied | <table><tr><th>Waste type *j*</th><th>$W_j$<br>(% wet waste)</th></tr><tr><td>Wood and wood products</td><td>4.7</td></tr><tr><td>Pulp, paper and cardboard (other than sludge)</td><td>17.1</td></tr><tr><td>Food, food waste, beverages and tobacco (other than sludge)</td><td>44.9</td></tr><tr><td>Textiles</td><td>2.6</td></tr><tr><td>Garden, yard and park waste</td><td>0.0</td></tr><tr><td>Glass, plastic, metal, other inert waste</td><td>30.7</td></tr></table> |
| Choice of data or measurement methods and procedures | - |
| Purpose of data | Calculation of baseline emissions |
| Additional comment | No composition analysis for MSW disposed at the UVS - Caieiras landfill is currently available. |

| | |
|---|---|
| **Data/Parameter** | **$SPEC_{flare}$** |
| Data unit | Temperature - °C<br>Flow rate or heat flux – kg/h or $Nm^3/h$<br>Maintenance schedule - number of days |
| Description | Manufacturer's flare specifications for temperature, flow rate and maintenance schedule |
| Source of data | Flare manufacturer[93] |

[93] The designer and manufacturer for Flare 1, Flare 2, Flare 3 and Flare 4 is "BTS - Termodinâmica de Sistemas Ltda.", which is a flaring equipment manufacturer based in Brazil.

| | |
|---|---|
| Value(s) applied | Flare 1, Flare 2, Flare 3 and Flare 4[94]: |

| **SPEC$_{flare, Flare 1}$**<br>**SPEC$_{flare, Flare 2}$**<br>**SPEC$_{flare, Flare 3}$** | **Min.** | **Max.** |
|---|---|---|
| Operational LFG flow (for continuous operation) (after the occurred performance of service intervention on 08/06/2015)[95]: | 650 $Nm^3/h$ | 7,500 $Nm^3/h$ |
| Required temperature of the exhaust gas of the flare (to ensure LFG destruction (combustion) under high $CH_4$ destruction efficiency): | 500 °C | 1,200 °C |
| Required minimum frequency for inspection and maintenance service (incl. inspection in the conditions of the flare isolation ceramics revetment material): | Min. every 6 months | |
| Required/recommended minimum frequency for replacement of the flare isolation ceramics revetment material: | After 10 years of regular and appropriate operation | |

[94] Values applicable for Flare 1, Flare 2, Flare 3 and Flare 4 (as per the currently applicable configuration) are selected based on technical information/specifications details for the flares as provided by equipment manufacturer. The project participant Essencis Soluções Ambientais S.A. acknowledges and highlights that additional high temperature enclosed flare(s) may be installed during the 3rd and last 7-year crediting period in order to accommodate projected potential increase in the amount of LFG to be collected by the project activity (as estimated in the emission reduction calculation spreadsheet which is enclosed to this PDD). Installation of additional flare(s) is in accordance to the previously defined project design conceptualization (which indeed considered gradual installation of additional flares within the project lifetime in order to address forecasted increase in LFG collection by the project activity). It is important to note that this is the practice for this type of project activity). Whenever installation of additional flares occurs or is confirmed to occur, information made available in different sections of this PDD (which outline specifications and/or operational requirements and conditions for the flares) will be updated accordingly as per applicable procedures and guidance to address post-registration changes.

[95] As outlined in Section A.3 under "*Box – 2a Performed service intervention in each one of the installed 4 high temperature enclosed flares in early June/2015 for addressing detected undesirable and abnormal intermittent/sporadic vibration + noise problems in the flares (resulting in higher nameplate LFG flaring capacity for each flare)*", a service intervention was performed in each one of the installed 4 high temperature enclosed flares on 08/06/2015 in order to address/solve previously detected undesirable and abnormal intermittent/sporadic vibration + noise problems in all flares. The performed service intervention work included redesign of the LFG burner unit in each flare (through the replacement of the previously existent 5 LFG injectors in the burner unit by 5 new and slightly larger injectors (with slightly higher firing capacity)) + related inspection/testing/commissioning services. The performed service intervention successfully addressed the previously detected vibration + noise problems in the flares. By making use of slightly larger LFG injectors in the burner unit of each one of the flares, the performed service intervention also resulted in slight increase of the recommended technical maximum flow of LFG to be sent to each one of the flares. These changes in the specification of the flares after the performance of the service intervention was confirmed by the flares' designer and manufacturer "BTS - Termodinâmica de Sistemas Ltda." as follows:

- for each installed flare, the nameplate minimum LFG flaring capacity (for continuous operation) remains being 650 $Nm^3/h$ (as recommended by the flares' designer and manufacturer),
- for each installed flare, the nameplate maximum LFG flaring capacity (for continuous operation) after the performed service intervention was confirmed by the flares designer and manufacturer "BTS - Termodinâmica de Sistemas Ltda." as being changed to 7,500 $Nm^3/h$ (with the previously recommended/nameplate value of 6,500 $Nm^3/h$ not any longer being valid).

While also being assumed and previously successfully addressed as an occurred permanent change in the project design, the flare specification change resulted from the performed service intervention is acknowledged as not promoting any adverse impact over the overall function of the flares. The occurred service intervention in the flares was previously addressed as a permanent post-registration change in the project design (since the specifications of the flares are modified) which was successfully approved by the CDM EB under reference PRC-0171-003.

| $SPEC_{flare, Flare 4}$ | Min. | Max. |
|---|---|---|
| LFG flow (for continuous operation): | 650 Nm$^3$/h | 7,500 Nm$^3$/h |
| Required temperature of the exhaust gas of the flare (to ensure LFG destruction (combustion) under high CH4 destruction efficiency): | 500 ºC | 1,200 ºC |
| Required minimum frequency for inspection service (incl. inspection in the conditions of the flare isolation ceramics revetment material): | every 6 months | |
| Required/recommended minimum frequency for replacement of the flare isolation ceramics revetment material: | after 10 years of regular and appropriate operation | |

| | |
|---|---|
| Choice of data or measurement methods and procedures | 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 3$^{rd}$ and last 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,<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. |
| Purpose of data | Data is used as a reference for later ex-post determination of values of flare efficiency ($\eta_{flare,m}$) for each individual high temperature enclosed flare in the context of determination of baseline emissions[96]. |
| Additional comment | All flare specification and operation details/requirements are based on information provided by the equipment manufacturer. |

[96] 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 enclosed flares are considered in the context of the determination of baseline emissions (although ACM0001 (version 19.0) refers to the term “project emissions from flaring”.

| **Data/Parameter** | **$EF_{EL,captive,y}$** |
|---|---|
| Data unit | $tCO_2/MWh$ |
| Description | $CO_2$ emission factor for electricity sourced by the captive off-grid electricity generators |
| Source of data | Applicable default as per the methodological tool “Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation” (version 03.0) (by following option B2 of the underlying methodological tool). |
| Value(s) applied | 1.3 |
| Choice of data or measurement methods and procedures | Data is determined as per applicable guidance of the methodological tool “Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation” (version 03.0). |
| Purpose of data | Calculation of project emissions (due to the consumption of electricity by the project activity). |
| Additional comment | The ex-ante determined default value for $EF_{EL,captive,y}$ is to be used for the determination of project emissions due to the consumption of electricity by the project activity ($PE_{EC,y}$) while applying option B.2 as per Scenario C.III of the methodological tool “Tool to calculate baseline, project and/or leakage emissions from electricity consumption”. |

| **Data/Parameter** | **$EF_{EL,grid,y}$** |
|---|---|
| Data unit | $tCO_2/MWh$ |
| Description | $CO_2$ emission factor for grid-sourced electricity in year *y* |
| Source of data | Applicable conservative default value as per the methodological tool "Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation" (version 03.0) (by following option A.2 of the underlying methodological tool). |
| Value(s) applied | 1.3 |
| Choice of data or measurement methods and procedures | Data is determined as per applicable guidance of the methodological tool "Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation" (version 03.0). |
| Purpose of data | Calculation of project emissions (due to the consumption of electricity by the project activity). |
| Additional comment | The ex-ante determined default value for $EF_{EL,grid,y}$ is to be used for the determination of project emissions due to the consumption of electricity by the project activity ($PE_{EC,y}$) while applying option A.2 as per Scenario C.III of the methodological tool "Tool to calculate baseline, project and/or leakage emissions from electricity consumption". |

| | |
|---|---|
| **Data/Parameter** | $w_{BM}$ |
| Data unit | % |
| Description | Weighting of build margin emissions factor |
| Source of data | Applicable default value as per the methodological tool “Tool to calculate the emission factor for an electricity system” (version 07.0) |
| Value(s) applied | 0.75 (75%) during the 2nd 7-year crediting period |
| Choice of data or measurement methods and procedures | The applicable value for the 3rd crediting period of a CDM project activity as per the methodological tool “Tool to calculate the emission factor for an electricity system” (version 07.0) is selected. |
| Purpose of data | Data is used for determination of project emissions due to the consumption of electricity by the project activity. |
| Additional comment | The ex-ante determined default value for $w_{BM}$ is to be used for the determination of project emissions due to the consumption of electricity by the project activity ($PE_{EC,y}$) while applying option A.1 as per Scenario C.III of the methodological tool “Tool to calculate baseline, project and/or leakage emissions from electricity consumption”. |

| | |
|---|---|
| **Data/Parameter** | $w_{OM}$ |
| Data unit | % |
| Description | Weighting of operating margin emissions factor |
| Source of data | Applicable default value as per the methodological tool “Tool to calculate the emission factor for an electricity system” (version 07.0) |
| Value(s) applied | 0.25 (25%) during the 3rd and last 7-year crediting period |
| Choice of data or measurement methods and procedures | The applicable value for the 3rd crediting period of a CDM project activity as per the methodological tool “Tool to calculate the emission factor for an electricity system” (version 07.0) is selected. |
| Purpose of data | Data is used for determination of project emissions due to the consumption of electricity by the project activity. |
| Additional comment | The ex-ante determined default value for $w_{OM}$ is to be used for the determination of project emissions due to the consumption of electricity by the project activity ($PE_{EC,y}$) while applying option A.1 as per Scenario C.III of the methodological tool “Tool to calculate baseline, project and/or leakage emissions from electricity consumption”. |

| **Data/Parameter** | **$EF_{grid,BM,y}$** |
|---|---|
| Data unit | $tCO_2$/MWh |
| Description | Build margin $CO_2$ emission factor in year *y* |
| Source of data | The value previously determined for the currently expired 2nd 7-year crediting period is also used for the 3rd and last 7-year crediting period of the project activity. The previously selected value valid for all years encompassed by the currently expired 2nd 7-year crediting period of the project activity is the value calculated by the DNA of Brazil and valid for year 2012 ($EF_{grid,BM,2012}$).<br>Data is made available online:<br>http://www.mctic.gov.br/mctic/opencms/textogeral/emissao_despacho.html |
| Value(s) applied | 0.2010 |
| Choice of data or measurement methods and procedures | Data is determined as per applicable guidance of the methodological tool “Tool to calculate the emission factor for an electricity system” (version 07.0). |
| Purpose of data | Data will be used for the determination of project emissions (due to the consumption of electricity by the project activity). |
| Additional comment | The ex-ante determined default value for $EF_{grid,BM,y}$ is to be used for the determination of project emissions due to the consumption of electricity by the project activity ($PE_{EC,y}$) while applying option A.1 as per Scenario C.III of the methodological tool “Tool to calculate baseline, project and/or leakage emissions from electricity consumption”. |

### B.6.3. Ex ante calculation of emission reductions

>>
As presented in Section B.6.1, while emission reductions to be achieved by the project activity during its 3rd and last 7-year crediting period are determined as the difference between baseline emissions ($BE_y$) and project emissions ($PE_y$), as established by ACM0001 (version 19.0), the following relevant equations and conditions are applied for the ex-ante estimation of emission reductions to be achieved by the project activity during the period:

*Determination of ex-ante estimates for baseline emissions ($BE_y$):*

While the project activity encompasses methane destruction (through collection and combustion of LFG in high temperature enclosed flares and in a set of internal combustion gas engines) as its unique GHG abatement measure, by following the applicable methodological approaches and assumptions + ex-ante determined values (as presented in Section B.6.1 and B.6.2 respectively), baseline emissions ($BE_y$) are thus determined as follows:

$BE_y = BE_{CH4,y}$

Where:
$BE_{CH4,y}$ Baseline emissions of methane from the SWDS in year y ($tCO_2e/yr$)

*Determination of $BE_{CH4,y}$:*

$BE_{CH4,y}$ is 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 that would be oxidized in the top layer of the SWDS in the baseline. $OX_{top\_layer}$ is ex-ante determined as 0.1. See Section B.6.2 for further details.

$F_{CH4,BL,y}$ Amount of methane that would have been captured and destroyed in the baseline scenario (absence of the CDM project activity). $F_{CH4,BL,y}$ is determined as being equivalent to 20% of $F_{CH4,PJ,y}$ ($F_{CH4,BL,y} = 0.2 * F_{CH4,PJ,capt,y}$). See Section B.6.1 for further details.

$GWP_{CH4}$ Global warming potential of $CH_4$ ($tCO_2e/t\ CH_4$). $GWP_{CH4}$ is ex-ante determined as 25.

$F_{CH4,PJ,y}$ Amount of methane in the LFG which is combusted in the installed flares and/or in the set of internal combustion gas engines in year y ($tCH_4/yr$). In the particular context of the ex-ante estimation of emission reductions to be achieved by the project activity, as established by ACM0001 (version 19.0), $F_{CH4,PJ,y}$ is determined (in $tCH_4$/year) as follows:

*Determination of ex-ante estimations of $F_{CH4,PJ,y}$:*

$$F_{CH4,PJ,y} = \eta_{PJ} * BE_{CH4,SWDS,y} / GWP_{CH4}$$

Where:

$\eta_{PJ}$ Efficiency of the LFG capture system that will be installed in the project activity. $\eta_{PJ}$ is ex-ante determined as 0.9280. See Section B.6.2 for further details.

$GWP_{CH4}$ Global warming potential of $CH_4$ ($tCO_2e/tCH_4$). $GWP_{CH4}$ is ex-ante determined as 25. See Section B.6.2 for further details.

$BE_{CH4,SWDS,y}$ Amount of methane in the LFG that is generated from the SWDS in the baseline scenario in year *y* (in $tCO_2e/yr$). $BE_{CH4,SWDS,y}$ is estimated as follows:

$$BE_{CH4,SWDS,y} = \varphi_y * (1 - f_y) * GWP_{CH4} * (1 - OX) * \frac{16}{12} * F * DOC_f * MCF * \sum_{x=1}^{y} \sum_j W_{j,x} * DOC_j * e^{-k(y-x)} * (1 - e^{-kj})$$

For the determination of $BE_{CH4,SWDS,y}$, the ex-ante determined values for all parameters in the formulae above as well as historical and forecasts of MSW disposal at the UVS – Caieiras landfill are applied. See Section B.6.2 for details about such ex-ante determined values for such parameters.

A calculation spreadsheet including ex-ante estimates of emission reduction to be achieved by the project activity is enclosed to this PDD. This calculation spreadsheet includes all required related calculations for the ex-ante estimation of $BE_{CH4,y}$ and $BE_{EC,y}$ of the project activity during its 3rd and last 7-year crediting period.

The ex-ante estimation of $BE_y = BE_{CH4,y}$ is thus summarized as follows:

| | Estimation of $BE_{CH4,SWDS,y}$ ($tCO_2e$) | Estimation of $F_{CH4,PJ,Y}$ ($tCH_4$) | Estimation of $F_{CH4,BL,y}$ ($tCH_4$) | Estimation of $BE_{CH4,y}$ = Baseline emissions ($BE_y$) ($tCO_2e$) |
|---|---|---|---|---|
| Year | $BE_{CH4,SWDS,y} = \varphi (1-f) * GWP_{CH4} * (1-OX) * 16/12 * F * DOC_f * MCF * \Sigma\Sigma w_{j,x} * DOC_j * e^{-kj(y-x)} * (1-e^{-kj})$ | $F_{CH4,PJ,y} = n_{PJ} * BE_{CH4,SWDS,y} / GWP_{CH4}$ | $F_{CH4,BL,y} = 0.2 * F_{CH4,PJ,capt,y}$ | $BE_y = BE_{CH4,y} = ((1 - OX_{top\_layer}) * F_{CH4,PJ,y} - F_{CH4,BL,y}) * GWP_{CH4}$ |
| 2020 | 2,131,549 | 59,667 | 11,933 | 1,044,166 |
| 2021 | 2,218,988 | 82,369 | 16,474 | 1,441,455 |
| 2022 | 2,304,492 | 85,543 | 17,109 | 1,496,998 |
| 2023 | 2,388,442 | 88,659 | 17,732 | 1,551,532 |
| 2024 | 2,471,168 | 91,730 | 18,346 | 1,605,271 |
| 2025 | 2,552,953 | 94,766 | 18,953 | 1,658,398 |
| 2026 | 2,634,047 | 97,776 | 19,555 | 1,711,077 |
| 2027 | 2,714,667 | 24,847 | 4,969 | 434,823 |
| **Total** | **19,416,306** | **625,355** | **125,071** | **10,943,719** |

**Note:** Above reported values of $BE_{CH4,SWDS,y}$ for years 2020 and 2027 are valid for the entire years regardless of the starting and ending dates of the crediting period (from 31/03/2020 to 30/03/2027 respectively). All other values applicable for years 2020 and 2027 ($F_{CH4,PJ,y}$, $F_{CH4,BL,y}$ , $BE_y = BE_{CH4,y}$) are valid for the 276-day and 90-day fractions of these years which are encompassed by the 3rd and last 7-year crediting period of the project activity: from 31/03/2020 to 31/12/2020 and from 01/01/2027 to 30/03/2027 respectively. It is relevant to note that, as reflected in related calculations, year 2020 is leap year (bissextile year) including 366 days. Estimates of baseline emissions for the 276-day share of the crediting period within year 2020 are thus calculated based on the ratio 276/366.

*Determination of ex-ante estimations for project emissions ($PE_y$):*

As outlined in Section B.6.1, the sources of project emissions to be considered in the context of the determination of emission reductions to be achieved by the project activity are those due to the consumption of both electricity[97] and LPG by the project activity. The related ex-ante estimations of the corresponding project emissions are determined as follows:

*Determination of ex-ante estimations of project emissions due to consumption of grid electricity by the project activity ($PE_{EC,grid,y}$):*

By following the applicable methodological approaches and assumptions + ex-ante determined values presented in Section B.6.1 and B.6.2 respectively, $PE_{EC,grid,y}$ is determined as follows:

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

Where:

$PE_{EC,grid,y}$ Project emissions due to consumption of grid sourced electricity by the project activity in year *y* (in $tCO_2$/yr).

$EC_{PJ,grid,y}$ Quantity of grid sourced electricity consumed by the project activity in year *y* (in MWh). $EC_{PJ,grid,y}$ is estimated as being 4,966.92 MWh per year. Further details are included in Section B.7.1. This value is assumed based on the installed nominal power output for the main electrical equipment currently installed as part of the project activity (e.g installed centrifugal blowers + ancilary equipement) plus 5% for ancillary equipment (and also by assuming that such equipment will work continuously (24 hours a day) under full power during the whole 3rd and last 7-year crediting period of the project activity[98]).

$TDL_{grid,y}$ Average technical transmission and/or distribution losses for grid sourced electricity consumed by the project activity in year *y.* For the particular case of estimates of $PE_{EC,grid,y}$, $TDL_{,grid,y}$ is selected as 20%. Further details are included in Section B.7.1.

$EF_{EL,grid,y}$ $CO_2$ emission factor for grid-sourced electricity in year y (in $tCO_2$/MWh). Regardless of the non-expected utilization of the installed backup captive off-grid electricity generator (fuelled by diesel) as part of the ex-ante estimates of emission reductions, $EF_{EL,grid,y}$ is estimated as being the most conservative value between the emission factor determined as per guidance for scenario A.1, A.2, B.1 and B.2. (through the application of either option A1 or A2 and either option B.1 or B.2.).
While as per Option A.2 and B.2 $EF_{EL,grid,y}$ is directly determined as 1.3 $tCO_2$/MWh (applicable conservative default value of the methodological tool "Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation"), the following is applicable for Option A.1 (determination of the combined margin (CM) emission factor ($EF_{grid,CM,y}$) as per the methodological tool "Tool to calculate the emission factor for an electricity system" (version 07.0) and

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[97] In the particular context of ex-ante estimation of emission reductions to be achieved by the project activity within its 3rd and last 7-year crediting period, it is assumed that only grid-sourced electricity is consumed by the project activity. While a backup captive off-grid electricity generator (fuelled by diesel and with 700 kVA of nameplate installed capacity) is installed within the geographical limits of the UVS – Caieiras landfill since July/2016, this backup captive off-grid generator has not used at least during the latest 3 years and it is thus not expected to be used (at least within relevant time periods) within the 3rd and last crediting period of the project activity.

[98] It is important to note that additional power consuming equipment (e.g. additional centrifugal blowers) may be installed as part of the project activity in order to accommodate projected increment in the quantity of LFG to be collected and destroyed by the project activity. In this sense, the conservative approach hereby assumed for estimating $EC_{PJ,grid,y}$ during the 3rd and last 7-year crediting period of the project activity (equipment continuously operating under full power) is appropriate (and under a certain level incorporates an increase in grid electricity consumption by the project activity that may occur).

Option B.1 ($CO_2$ emissions for the fossil fuel diesel consumed by the installed backup captive off-grid electricity generator as well as based on the ration between the amount of fuel consumed by such generator and amount of generated electricity during the time period *t*):

*Estimates as per Option A.1:*

By following procedure and guidance described in Section B.6.1, the combined margin $CO_2$ emission factor ($EF_{grid,CM,y}$) for the elecricity grid of Brazil (SIN grid) is estimated 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 determined as 25% (0.25). See Section B.6.2 for further details. |
| $w_{BM}$ | Weighting of build margin emissions factor. $w_{BM}$ is ex-ante determined as 75% (0.75). See Section B.6.2 for further details. |
| $EF_{grid,BM,y}$ | Build margin $CO_2$ emission factor in year y. The build margin $CO_2$ emission factor for the national electricity grid of Brazil is ex-ante determined as the value applicable for year 2012 (as determined and published by the DNA of Brazil). Thus, in the particular case of the project activity, $EF_{grid,BM,y}$ = $EF_{grid,BM,2012}$ is ex-ante determined as 0.2010 $tCO_2$/MWh. Further details are available online at the website of the DNA of Brazil and in Section B.6.2[99]. |
| $EF_{grid,OM,y}$ | Operating margin $CO_2$ emission factor in year *y* (in $tCO_2$/MWh). In the particular case of the project activity, $EF_{grid,OM,y}$ = $EF_{grid,OM-DD,y}$.<br><br>*Operational Margin CO2 emission factor (dispatch analysis calculation method ($EF_{grid,OM-DD,y}$):*<br>In the particular context of ex-ante estimations of emission reductions to be achieved by the project activity, the adopted value for $EF_{grid,OM-DD,y}$ is the value published by the DNA of as being the calculated value which is valid for year 2019 (the latest year for which values are available at the time of the completion of the this PDD): |

[99] Details about the determination of the $CO_2$ Emission Factors for the national electricity grid of Brazil (according to the methodological tool: "Tool to calculate the emission factor for an electricity system (version 07.0 and previous versions) are made available online:

http://www.mctic.gov.br/mctic/opencms/textogeral/emissao_despacho.html

Operating Margin Emission Factor of Brazilian Integrated Electric System for year 2019 (dispatch analysis calculation method)

| Operating Margin Emission Factor, year 2019 $CO_2$ Emission Factor ($tCO_2$/MWh) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| 0.3540 | 0.5573 | 0.5075 | 0.5095 | 0.4794 | 0.4175 | 0.5914 | 0.5312 | 0.5606 | 0.5370 | 0.5720 | 0.5997 |

The average value of $EF_{grid,OM\text{-}DD,2019}$ is thus calculated as 0.5181 $tCO_2$/MWh. Values of $EF_{grid,OM\text{-}DD,2019}$ are determined and reported by the DNA of Brazil. Further details are available online at the website of the DNA of Brazil.

$EF_{grid,CM,y}$ is thus calculated as follows:

$EF_{grid,CM,y} = w_{OM} * EF_{grid,OM,y} + w_{BM} * EF_{grid,BM,y} = 0.25 * 0.5181 + 0.75 * 0.2010 = 0.2803$ $tCO_2$/MWh (where related calculations are summarized in the emission reduction calculation spreadsheet enclosed to this PDD).

It is important to note that, as a simplification (only in the particular context of the ex-ante estimation of project emissions to be promoted by the project activity during the 2nd 7-year crediting period), it is assumed that the calculated combined margin grid emission factor ($EF_{grid,CM,y}$) based on the value of $EF_{grid,OM\text{-}DD,2019}$ (valid for year 2019) and the value of $EF_{grid,BM,2012}$ is used for the determination of ex-ante estimates of emission reductions for all years encompassed by the 3rd and last 7-year crediting period of the project activity (regardless of the fact that annual values for the operating margin $CO_2$ emission factor ($EF_{grid,OM,y}$) are to be ex-post determined every year, thus potentially affecting the value to be calculated for $EF_{grid,CM,y}$ for each individual year encompassed by the crediting period). This simplification is anyway under conformance with applicable CDM rules[100].

[100] In the context of ex-ante estimations of project emissions due to consumption of grid electricity by the project activity, it is reasonable to consider as a simplification that major changes in the average and marginal $CO_2$ intensity for electricity generated at the national electricity grid of Brazil are not expected to occur during the 3rd and last 7-year crediting period of the project activity due to the following reason:

- As per official information published by the Brazilian Government, "*(…) According to national government's Power Expansion Plan (PEP) for 2011-2012, published by Brazil's Power Energy Research Company (EPE), the government is forecasting the percentage of capacity supplied by hydroelectricity to be reduced from 72.4% (the combined numbers of domestically-produced and imported from neighbouring countries) to 67%, while increasing the percentage of power produced by natural gas to 15%, as a direct result of the recent large oil and gas finds in Brazil. Other renewable energy sources such as small hydro, wind and biomass plants are forecasted to increase to 16% of the country's energy supply by 2020*" (http://export.gov/brazil/static/9.%20Electrical%20Power%20and%20Renewable%20Energy%20Industries_Latest_eg_br_054746.pdf).
  Thus, no significant changes in the average and marginal $CO_2$ intensity of electricity generation in Brazil is expected to occur by considering the high predominance of use of renewable energy sources for the generation of grid sourced electricity in Brazil in recent years.
- Although Essencis Soluções Ambientais S.A. acknowledges that, in the particular case of Brazil, calculated annual values for the $CO_2$ Combined Margin emission factor for the National Electricity Grid of Brazil is somehow heavy influenced by unpredictable aspects such as rain patterns, level of dams in large hydropower plants, capacity factors for non-conventional renewable energy generation facilities (e.g. wind and biomass power plants, etc.), the above-quoted information represents, under a certain limit, a credible reasons for assuming a fixed value for $EF_{grid,CM}$ in the context of the ex-ante estimations of emission reductions to be achieved by the project activity during its 3rd and last 7-year crediting period.

Information related to the determination of the combined margin $CO_2$ emission factor for the national electricity grid of Brazil is made available in the website/web portal of the DNA of Brazil[101].

*Estimates as per Option B.1.:*

The following formulae is applied for the estimates of $EL_{grid,y}$ as per Option B.1:

$$EF_{EL,grid,y} = \frac{FC_{Diesel,t} \times NCV_{Diesel} \times EF_{CO2,Diesel}}{EG_{Diesel\text{-}generator}}$$

Where:

| | |
|---|---|
| $FC_{Diesel,t}$ | Amount of fossil fuel diesel consumed by the installed backup captive off-grid electricity generator during the time period t (where t = 1 year). $FC_{Diesel,t}$ is estimated as 1,018,219 kg by taking into account the specific fuel consumption value for the installed equipment (as declared by equipment manufacturer) and the value of annual amount of electricity estimated to be consumed by the project activity. |
| $NCV_{Diesel}$ | Net calorific value for fossil fuel diesel. $NCV_{Diesel}$ is calculated as being 43.3 TJ/Gg. |
| $EF_{CO2,Diesel}$ | $CO_2$ emission factor of fuel diesel. $EF_{CO2,Diesel}$ is calculated as 79,200 kg/TJ |
| $EG_{Diesel\text{-}generator,y}$ | Amount of electricity generered by the installed backup Captive off-grid electricity generator during the period t (MWh). $EG_{Diesel\text{-}generator,y}$ is assumed as being 4966.92 MWh per year. |

As calculated in the spreadsheet enclosed to this PDD, $EL_{grid,y}$ as per Option B.1 is determined as being 0.7031 $tCO_2$/MWh. The spreadsheet also includes additonal sources for main assumptions.

While the most conservative value (highest value) among Options A.1, A.2, B.1 and B.2 is 1.3 $tCO_2$/MWh, this value is thus applied in the particular context of the ex-ante estimates of emission reduction for the whole 2nd 7-year crediting period.

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- Regardless of the assumption of a fixed value for $EF_{grid,CM}$ in the context of the ex-ante estimations of emission reductions to be achieved by the project activity during the 3rd and last 7-year crediting period (only in the context of ex-ante estimation of emission reductions), as highlighted in Section B.6.1, the $CO_2$ combined emission factor for the national electricity grid of Brazil will be annually calculated ex-post.
- The ex-ante estimated values for annual project emissions due to consumption of grid electricity represent (in nominal terms) a very low fraction of estimated total annual emission reductions to be achieved by the project activity.

[101] Calculation of $CO_2$ emission factor for the National Electricity Grid of Brazil: Data source is available online: http://www.mctic.gov.br/mctic/opencms/textogeral/emissao_despacho.html

*Determination of ex-ante estimations of project emissions due to consumption of electricity sourced by the backup captive off grid electricity generators fuelled by diesel by the project activity ($PE_{EC,captive,y}$):*

The captive off-grid backup electricity generator (fuelled by diesel) are expected to be used only for emergency purposes (whenever supply of grid electricity to the project activity is temporarily interrupted). Thus, in the particular context of ex-ante estimates of emission reductions to be achieved by the project activity, there is no estimated amount of electricity to be generated by this generator nor estimated amount of fossil fuel diesel to be consumed by the generator.

Project emissions due to the consumption of electricity sourced by such fossil-fuel electricity generator are thus estimated as zero (null) in the particular context of ex-ante estimates of emission reductions to be achieved by the project activity. It is however crucial to note that such related project emissions will be determined ex-post along the crediting period (based on applicable monitoring and calculation requirements as presented in Section B.6.1) and will thus be accounted for the ex-post determination of emission reductions.

*Determination of ex-ante estimations of project emissions due to consumption of LPG by the project activity ($PE_{LPG,y}$):*

In the particular context of ex-ante estimates of emission reductions to be achieved by the project activity within its 3rd and last 7-year crediting period, consumption of LFG is estimated on 75 kg (0.750 ton) per year. $FC_{LPG,y}$ is thus estimated to be 0.750 ton of LPG per year. This value is assumed by taking into consideration the reported and verified LPG consumption figures as part of the latest periodic verifications for the project activity within the currently expired 2nd crediting period (monitoring period from 01/07/2019 to 31/12/2019) and by also taking into account operational aspects of the project activity during such period.

Ex-ante estimations of total project emissions for the project activity during its 3rd and last 7-year crediting period are thus summarized as follows:

| **$PE_y$** | Electricity consumed from the grid (MWh) | Electricity supplied by the captive diesel backup generator (MWh) | Project emissions due to electricity consumption ($tCO_2e$) | LPG consumed by the project activity (ton) | Project emissions due to LPG consumption by the project activity ($tCO_2$)[102] | Total Project emissions promoted the project activity - PEy ($tCO_2e$) |
|---|---|---|---|---|---|---|
| Year | $EC_{PJ,grid,y}$ | $EC_{PJ,captive,y}$ | $PE_{EC,y} = (EC_{PJ,grid,y} * EF_{EL,grid,y} * (1+TDL_{grid,y,import})) + (EC_{PJ,captive,y} * EF_{EL,captive,y} * (1 + TDL_{captive,y}))$ | $FC_{LPG,y}$ | $PE_{LPG,y} = FC_{LPG,y} * NCV_{LPG,y} * EF_{CO2,LPG,y}$ | $PE_y = PE_{EC,y} + PE_{LPG,y}$ |
| 2020 | 3,746 | 0 | 5,843 | 0.566 | 1.83 | 5,845 |
| 2021 | 4,967 | 0 | 7,748 | 0.750 | 2.42 | 7,751 |
| 2022 | 4,967 | 0 | 7,748 | 0.750 | 2.42 | 7,751 |
| 2023 | 4,967 | 0 | 7,748 | 0.750 | 2.42 | 7,751 |
| 2024 | 4,967 | 0 | 7,748 | 0.750 | 2.42 | 7,751 |
| 2025 | 4,967 | 0 | 7,748 | 0.750 | 2.42 | 7,751 |
| 2026 | 4,967 | 0 | 7,748 | 0.750 | 2.42 | 7,751 |
| 2027 | 1,225 | 0 | 1,911 | 0.185 | 0.60 | 1,911 |
| **Total** | **34,772** | **0** | **54,244** | **6.0** | **17** | **54,261** |

**Note:** Values of $EC_{PJ,grid,y}$ and $PE_{EC,y}$ applicable for years 2020 and 2027 are valid for the 90-day and 276-day fractions of these years which are encompassed by the 3rd and last 7-year crediting period of the project activity: periods from 31/03/2020 to 31/12/2020 and from 01/01/2027 to 30/03/2027 respectively. It is relevant to note that, as reflected in related calculations, year 2020 is leap year (bissextile year) including 366 days. Estimates of project emissions for 276-day share of the crediting period within year 2020 are thus calculated based on the ratio 276/366.

*Summarized ex-ante estimations of emission reductions ($ER_y$):*

By taking into account the above summarized values for baseline and project emissions, the ex-ante estimations of the emission reductions for the project activity along its 3rd and last 7-year crediting period are summarized as follows:

[102] The estimated annual values for project emissions due to LPG consumption by the project activity are rounded (in order to avoid fractions of estimated emission reductions in $tCO_2$ being reported). Figures with 2 decimals are reported in the emission reduction calculation spreadsheet which is enclosed to the PDD.

| Emission reductions ($tCO_2e$) | |
|---|---|
| Year | *Emission reductions* = $ER_y$ - $PE_y$ |
| 2020 | 1,038,321 |
| 2021 | 1,433,704 |
| 2022 | 1,489,247 |
| 2023 | 1,543,781 |
| 2024 | 1,597,520 |
| 2025 | 1,650,648 |
| 2026 | 1,703,326 |
| 2027 | 432,912 |
| **Total** | **10,889,458** |
| Annual average | 1,555,637 |

**Note:** Values applicable for years 2020 and 2027 are valid for the 276-day and 90-day fractions of these years which are encompassed by the 3rd and last 7-year crediting period: from 31/03/2020 to 31/12/2020 and from 01/01/2027 to 30/03/2027 respectively. It is relevant to note that, as reflected in related calculations, year 2020 is leap year (bissextile year) including 366 days. Estimates of emission reductions for the 276-day share of crediting period within year 2020 are thus calculated based on the ratio 276/366.

Details about all ex-ante determined parameters which are used for the ex-ante estimations of emissions reductions are included in the previous section. An emission reduction calculation spreadsheet with all related calculations for the ex-ante estimations of emission reductions to be achieved by the project activity during its 3rd and last crediting period is enclosed to this PDD.

### B.6.4. Summary of ex ante estimates of emission reductions

| Year | Baseline emissions ($t\ CO_2e$) | Project emissions ($t\ CO_2e$) | Leakage ($t\ CO_2e$) | Emission reductions ($t\ CO_2e$) |
|---|---|---|---|---|
| 2020 | 1,044,166 | 5,845 | 0 | 1,038,321 |
| 2021 | 1,441,455 | 7,751 | 0 | 1,433,704 |
| 2022 | 1,496,998 | 7,751 | 0 | 1,489,247 |
| 2023 | 1,551,532 | 7,751 | 0 | 1,543,781 |
| 2024 | 1,605,271 | 7,751 | 0 | 1,597,520 |
| 2025 | 1,658,398 | 7,751 | 0 | 1,650,648 |
| 2026 | 1,711,077 | 7,751 | 0 | 1,703,326 |
| 2027 | 434,823 | 1,911 | 0 | 432,912 |
| **Total** | **10,943,719** | **54,261** | 0 | **10,889,458** |
| **Total number of crediting years** | 7 | | | |
| **Annual average over the crediting period** | 1,563,388 | 7,752 | 0 | 1,555,637 |

**Note:** Values of $ER_{,y}$ applicable for years 2020 and 2027 are valid for the 276-day and 90-day fractions of these years which are encompassed by the 3rd and last 7-year crediting period: from 31/03/2020 to 31/12/2020 and from 01/01/2027 to 30/03/2027 respectively. It is relevant to note that, as reflected in related calculations, year 2020 is leap year (bissextile year) including 366 days. Estimates of emission reductions for the 276-day share of the crediting period within year 2020 are thus calculated based on the ratio 276/366.

## B.7. Monitoring plan

### B.7.1. Data and parameters to be monitored

| Data/Parameter | Management of SWDS |
|---|---|
| Data unit | Dimensionless |
| Description | Management of the SWDS |
| Source of data | Monitoring performed by the project participants and/or appointed 3rd party.<br>The design and operational conditions of the solid waste disposal site (SWDS) UVS - Caieiras landfill will be annually monitored on the basis of different sources, including *inter alia*:<br>- Original construction and operational design of the UVS – Caieiras;<br>- Technical specifications and requirements for the management of the UVS - Caieiras landfill;<br>- Applicable local or national regulations dealing with management and operation of existing landfills.<br>Any occurred or planned relevant change in terms of management of the UVS - Caieiras landfill will be reported and justified. |
| Value(s) applied | No estimated value is required for the determination of ex-ante estimation of emission reduction to be achieved by the project activity during its 3rd and last 7-year crediting period.<br>Baseline emissions of methane from the SWDS ($BE_{CH4,y}$) are ex-ante estimated by estimating the amount of methane which is destroyed by the project activity through combustion of collected LFG in project's methane destruction devices in year *y* ($F_{CH4,PJ,y} = F_{CH4,flared,y} + F_{CH4,EL,y}$) as a function of ex-ante estimated values for efficiency of the LFG capture system that is currently installed as part of the project activity ($\eta_{PJ}$) as well as ex-ante estimations for the amount of methane in the LFG that is generated from the SWDS in the baseline scenario in year *y* ($BE_{CH4,SWDS,y}$) by applying applicable guidance of the methodological tool "Emissions from solid waste disposal sites" (version 08.0) and considering aspects/characteristics of the landfill. |
| Measurement methods and procedures | Original construction and operational design of the UVS - Caieiras landfill should be confirmed as not being modified during the 3rd and last 7-year crediting period of the project activity. This is to ensure that no practice aiming to increase methane generation in the landfill has been occurring after the implementation of the project activity. As required by ACM0001 (version 19.0), any change in the management of the UVS – Caieiras landfill after the implementation of the project activity should be justified by referring to technical or regulatory specifications. |
| Monitoring frequency | Annually. |
| QA/QC procedures | Not applicable. |
| Purpose of data | Calculation of baseline emissions. |
| Additional comment | - |

| **Data/Parameter** | **$V_{t,wb,j}$** |
|---|---|
| Data 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 internal combustion gas engine and LFG delivery pipeline to each flare). |
| Source of data | Measurements/monitoring performed by the project participants.<br>Measured as part of the operation of the project activity by applying appropriate LFG flow meters. |
| Value(s) applied | No estimated value is required for the determination of ex-ante estimation of emission reduction to be achieved by the project activity during its 3rd and last 7-year crediting period.<br>Baseline emissions of methane from the SWDS ($BE_{CH4,y}$) are ex-ante estimated by estimating the amount of methane which is destroyed by the project activity through combustion of collected LFG in project's methane destruction devices in year *y* ($F_{CH4,PJ,y} = F_{CH4,flared,y} + F_{CH4,EL,y}$) as a function of ex-ante estimated values for efficiency of the LFG capture system that is currently installed as part of the project activity ($\eta_{PJ}$) as well as ex-ante estimations for the amount of methane in the LFG that is generated from the SWDS in the baseline scenario in year *y* ($BE_{CH4,SWDS,y}$) by applying applicable guidance of the methodological tool "Emissions from solid waste disposal sites" (version 08.0) and considering aspects/characteristics of the landfill. |
| Measurement methods and procedures | Volumetric flow measurement of collected LFG should always refer to the actual LFG absolute pressure and LFG temperature. Use of measuring instrument/equipment with recordable electronic signal (analogical or digital) is assumed. |
| Monitoring frequency | Continuous measurements will be recorded and reported with an every-minute frequency. |
| QA/QC procedures | Periodic calibration events for the LFG flow meters will be performed by using a reference primary device provided by a third party independent accredited calibration laboratory. Calibration events will be performed in a frequency as per instrument specifications and/or instrument manufacturer's recommendations.<br><br>Monitoring equipment/instrument(s) will be subject to a regular maintenance and testing regime in accordance to appropriate national / international standards/requirements and/or best practice.<br>Spare instrument(s) may be kept. |
| Purpose of data | Calculation of baseline emissions. |
| Additional comment | This parameter will be monitored in case Options B or C of the "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" (version 03.0) are applied for the determination of $F_{CH4,flared,y.}$ and $F_{CH4,EL,y}$. |

| **Data/Parameter** | $V_{t,db,j}$ |
|---|---|
| Data unit | m³ dry gas/h |
| Description | Volumetric flow of LFG stream in time interval *t* on a dry basis for *j* (where *j* is the LFG delivery pipeline to each internal combustion gas engine and LFG delivery pipeline to each flare) |
| Source of data | Measurements/monitoring performed by the project participants.<br>Measured as part of the operation of the project activity by applying appropriate LFG flow meters. |
| Value(s) applied | No estimated value is required for the determination of ex-ante estimation of emission reduction to be achieved by the project activity during its 3rd and last 7-year crediting period.<br>Baseline emissions of methane from the SWDS ($BE_{CH4,y}$) are ex-ante estimated by estimating the amount of methane which is destroyed by the project activity through combustion of collected LFG in project's methane destruction devices in year *y* ($F_{CH4,PJ,y} = F_{CH4,flared,y} + F_{CH4,EL,y}$) as a function of ex-ante estimated values for efficiency of the LFG capture system that is currently installed as part of the project activity ($\eta_{PJ}$) as well as ex-ante estimations for the amount of methane in the LFG that is generated from the SWDS in the baseline scenario in year *y* ($BE_{CH4,SWDS,y}$) by applying applicable guidance of the methodological tool "Emissions from solid waste disposal sites" (version 08.0) and considering aspects/characteristics of the landfill. |
| Measurement methods and procedures | Volumetric flow measurement of collected LFG should always refer to the actual LFG absolute pressure and LFG temperature. Calculated based on the wet basis LFG flow measurement plus water concentration measurement.<br>Use of measuring instrument/equipment with recordable electronic signal (analogical or digital) is assumed. |
| Monitoring frequency | Continuous measurements will be recorded and reported with an every-minute frequency. |
| QA/QC procedures | Periodic calibration events for the LFG flow meter(s) will be performed by using a reference primary device provided by a third party independent accredited calibration laboratory. Calibration events will be performed in a frequency as per instrument specifications and/or instrument manufacturer's recommendations.<br><br>Monitoring equipment/instrument(s) will be subject to a regular maintenance and testing regime in accordance to appropriate national / international standards/requirements and/or best practice.<br>Spare instrument(s) may be kept. |
| Purpose of data | Calculation of baseline emissions. |
| Additional comment | This parameter will be monitored in case Option A of the "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" (version 03.0) is applied for the determination of $F_{CH4,flared,y}$ and $F_{CH4,EL,y}$. |

| **Data/Parameter** | **$v_{CH4,t,db,j}$** |
|---|---|
| Data unit | $m^3CH_4/m^3$ dry gas |
| Description | Volumetric fraction of $CH_4$ in the collected LFG in time interval *t* on a dry basis for *j* (where *j* is the LFG delivery pipeline to each internal combustion gas engine and LFG delivery pipeline to each flare)[103] |
| Source of data | Measurements/monitoring performed by the project participants.<br>Measured as part of the operation of the project activity by applying an appropriate continuous $CH_4$ content gas analyzer. |
| Value(s) applied | No estimated value is required for the determination of ex-ante estimation of emission reduction to be achieved by the project activity during its 3rd and last 7-year crediting period.<br>Baseline emissions of methane from the SWDS ($BE_{CH4,y}$) are ex-ante estimated by estimating the amount of methane which is destroyed by the project activity through combustion of collected LFG in project's methane destruction devices in year *y* ($F_{CH4,PJ,y} = F_{CH4,flared,y} + F_{CH4,EL,y}$) as a function of ex-ante estimated values for efficiency of the LFG capture system that is currently installed as part of the project activity ($\eta_{PJ}$) as well as ex-ante estimations for the amount of methane in the LFG that is generated from the SWDS in the baseline scenario in year *y* ($BE_{CH4,SWDS,y}$) by applying applicable guidance of the methodological tool "Emissions from solid waste disposal sites" (version 08.0) and considering aspects/characteristics of the landfill. |
| Measurement methods and procedures | Measurements to be performed by appropriate continuous gas analyzer(s) operating in dry-basis. Volumetric flow measurement should always refer to the actual pressure and temperature.<br>Use of measuring instrument/equipment with recordable electronic signal (analogical or digital) is assumed. |
| Monitoring frequency | Continuous measurements will be recorded and reported with an every-minute frequency. |
| QA/QC procedures | Periodic calibration events in the continuous $CH_4$ content gas analyzer(s) will be performed by utilization of calibration span gas with certified $CH_4$ content (for span checking/adjustment). Utilization of an inert calibration gas (e.g. $N_2$) will also occur (for span checking/adjustment). All calibration gases (span gases) must have a certificate provided by the gas supplier and must be under their validity period.<br><br>Periodic calibration events will be performed in a frequency as per instrument specifications and/or instrument manufacturer's recommendations.<br><br>Monitoring equipment/instrument(s) will be subject to a regular maintenance and testing regime in accordance to appropriate national / international standards/requirements and/or best practice.<br>Spare instrument(s) may be kept. |
| Purpose of data | Calculation of baseline emissions. |

[103] By taking into account the design of the project activity, a unique instrument may be appropriately positioned/installed at the LFG delivery pipeline serving all methane destruction devices of the project activity and used to perform continuous measurements of volumetric fraction of $CH_4$.

| | |
|---|---|
| Additional comment | This parameter will be monitored in case Option B of the “Tool to determine the mass flow of a greenhouse gas in a gaseous stream” (version 03.0) is applied for the determination of $F_{CH4,flared,y}$ and $F_{CH4,EL,y}$.<br>This parameter may be monitored in case Options A or D of the “Tool to determine the mass flow of a greenhouse gas in a gaseous stream” (version 03.0) are applied instead. |

| **Data/Parameter** | $v_{CH4,t,wb,j}$ |
|---|---|
| Data 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 for *j* (where *j* is the LFG delivery pipeline to each internal combustion gas engine and LFG delivery pipeline to each flare)[104] |
| Source of data | Measurements/monitoring performed by the project participants.<br>Measured as part of the operation of the project activity by applying appropriate continuous $CH_4$ content gas analyzer(s). |
| Value(s) applied | No estimated value is required for the determination of ex-ante estimation of emission reduction to be achieved by the project activity during its 3rd and last 7-year crediting period.<br>Baseline emissions of methane from the SWDS ($BE_{CH4,y}$) are ex-ante estimated by estimating the amount of methane which is destroyed by the project activity through combustion of collected LFG in project’s methane destruction devices in year *y* ($F_{CH4,PJ,y} = F_{CH4,flared,y} + F_{CH4,EL,y}$) as a function of ex-ante estimated values for efficiency of the LFG capture system that is currently installed as part of the project activity ($\eta_{PJ}$) as well as ex-ante estimations for the amount of methane in the LFG that is generated from the SWDS in the baseline scenario in year *y* ($BE_{CH4,SWDS,y}$) by applying applicable guidance of the methodological tool “Emissions from solid waste disposal sites” (version 08.0) and considering aspects/characteristics of the landfill. |
| Measurement methods and procedures | Measurements to be continuously performed by appropriate gas analyzer(s) operating in wet-basis. Volumetric flow measurement should always refer to the actual pressure and temperature. (calculated based on the dry basis analysis plus water concentration measurement or continuous in-situ analyzer(s)).<br>Use of measuring instrument/equipment with recordable electronic signal (analogical or digital) is assumed. |
| Monitoring frequency | Continuous measurements will be recorded and reported with an every-minute frequency. |
| QA/QC procedures | Periodic calibration events in the continuous $CH_4$ content gas analyzer(s) will be performed by utilization of calibration span gas with certified $CH_4$ content (for span checking/adjustment). Utilization of an inert calibration gas (e.g. $N_2$) will also occur (for span checking/adjustment). All calibration gases (span gases) must have a certificate provided by the gas supplier and must be under their validity period.<br><br>Periodic calibration events will be performed in a frequency as per instrument specifications and/or instrument manufacturer’s recommendations.<br><br>Monitoring equipment/instrument(s) will be subject to a regular maintenance and testing regime in accordance to appropriate national / international |

[104] By taking into account the design of the project activity, a unique instrument may be appropriately positioned/installed at the LFG delivery pipeline serving all methane destruction devices of the project activity and used to perform continuous measurements of volumetric fraction of $CH_4$.

| | |
|---|---|
| | standards/requirements and/or best practice.<br>Spare instrument(s) may be kept. |
| Purpose of data | Calculation of baseline emissions. |
| Additional comment | This parameter will be monitored in case Option C of the methodological tool “Tool to determine the mass flow of a greenhouse gas in a gaseous stream” (version 03.0) is applied for the determination of $F_{CH4,flared,y}$. and $F_{CH4,EL,y}$. This parameter may be monitored in case Options A or D of the methodological tool are applied instead. |

| **Data/Parameter** | $\mathbf{M_{t,db,j}}$ |
|---|---|
| Data unit | kg/h |
| Description | Mass flow of the LFG stream in time interval *t* on dry basis for *j* (where *j* is the LFG delivery pipeline to each internal combustion gas engine and LFG delivery pipeline to each one of the flares) |
| Source of data | Measurements/monitoring performed by the project participants.<br>Measured as part of the operation of the project activity by applying appropriate LFG flow meters. |
| Value(s) applied | No estimated value is required for the determination of ex-ante estimation of emission reduction to be achieved by the project activity during its 3rd and last 7-year crediting period.<br>Baseline emissions of methane from the SWDS ($BE_{CH4,y}$) are ex-ante estimated by estimating the amount of methane which is destroyed by the project activity through combustion of collected LFG in project’s methane destruction devices in year *y* ($F_{CH4,PJ,y} = F_{CH4,flared,y} + F_{CH4,EL,y}$) as a function of ex-ante estimated values for efficiency of the LFG capture system that is currently installed as part of the project activity ($\eta_{PJ}$) as well as ex-ante estimations for the amount of methane in the LFG that is generated from the SWDS in the baseline scenario in year *y* ($BE_{CH4,SWDS,y}$) by applying applicable guidance of the methodological tool “Emissions from solid waste disposal sites” (version 08.0) and considering aspects/characteristics of the landfill. |
| Measurement methods and procedures | Continuous measurements to be performed by applying appropriate flow meter operating in dry-basis. Mass flow measurement should always refer to the actual pressure and temperature (calculated based on the wet basis flow measurement plus water concentration measurement).<br>Instruments with recordable electronic signal (analogical or digital) are required. |
| Monitoring frequency | Continuous measurements will be recorded and reported with an every-minute frequency. |
| QA/QC procedures | Periodic calibration events for the LFG flow meter(s) will be performed by using a reference primary device provided by a third party independent accredited calibration laboratory. Calibration events will be performed in a frequency as per instrument specifications and/or instrument manufacturer’s recommendations.<br><br>Monitoring equipment/instrument(s) will be subject to a regular maintenance and testing regime in accordance to appropriate national / international standards/requirements and/or best practice.<br>Spare instrument(s) may be kept. |

| | |
|---|---|
| Purpose of data | Calculation of baseline emissions. |
| Additional comment | This parameter will be monitored only in case Option D of the “Tool to determine the mass flow of a greenhouse gas in a gaseous stream” (version 03.0) is applied for the determination of $F_{CH4,flared,y}$ and $F_{CH4,EL,y}$. |

| **Data/Parameter** | $\mathbf{T_t}$ |
|---|---|
| Data unit | K[105] |
| Description | Temperature of the LFG stream in time interval *t* |
| Source of data | Measurements/monitoring performed by the project participants.<br>Measured as part of the operation of the project activity by applying appropriate LFG temperature sensor. |
| Value(s) applied | No estimated value is required for the determination of ex-ante estimation of emission reduction to be achieved by the project activity during its 3rd and last 7-year crediting period.<br>Baseline emissions of methane from the SWDS ($BE_{CH4,y}$) are ex-ante estimated by estimating the amount of methane which is destroyed by the project activity through combustion of collected LFG in project’s methane destruction devices in year *y* ($F_{CH4,PJ,y} = F_{CH4,flared,y} + F_{CH4,EL,y}$) as a function of ex-ante estimated values for efficiency of the LFG capture system that is currently installed as part of the project activity ($\eta_{PJ}$) as well as ex-ante estimations for the amount of methane in the LFG that is generated from the SWDS in the baseline scenario in year *y* ($BE_{CH4,SWDS,y}$) by applying applicable guidance of the methodological tool “Emissions from solid waste disposal sites” (version 08.0) and considering aspects/characteristics of the landfill. |
| Measurement methods and procedures | Measured to determine the density of methane $\rho_{CH4}$. No separate monitoring of LFG temperature is necessary when using LFG flow meters that automatically measure temperature and pressure, expressing LFG volumes in normalized cubic meters (by considering standard temperature and pressure (STP) conditions).<br><br>Instruments with recordable electronic signal (analogical or digital) are required. |
| Monitoring frequency | Continuous measurements will be recorded and reported with an every-minute frequency. |
| QA/QC procedures | Periodic calibration events will be performed in the LFG temperature sensor by a third party independent accredited calibration laboratory in a frequency as per instrument specifications and/or instrument manufacturer’s recommendations.<br><br>Monitoring equipment/instrument(s) will be subject to a regular maintenance and testing regime in accordance to appropriate national / international standards/requirements and/or best practice.<br>Spare instrument(s) may be kept. |
| Purpose of data | Calculation of baseline emissions. |

[105] Measurements for $T_t$ will be recorded and reported in ºC. Recorded/reported data will be converted to Kelvin in order to also being recorded/reported in K.

| | |
|---|---|
| Additional comment | In case of measurements for the applicable LFG flow parameter are automatically converted and recorded in normalized cubic meters (by considering standard temperature and pressure (STP) conditions), monitoring of this parameter may not be required except if the applicability condition related to the gaseous stream flow temperature being below 60ºC is adopted. Under this circumstance, this parameter shall be monitored continuously to assure the applicability condition is indeed met. |

| **Data/Parameter** | **$P_t$** |
|---|---|
| Data unit | Pa[106] |
| Description | Pressure of the LFG stream in time interval *t* |
| Source of data | Measurements/monitoring performed by the project participants.<br>Measured as part of the operation of the project activity by applying appropriate LFG pressure sensor. |
| Value(s) applied | No estimated value is required for the determination of ex-ante estimation of emission reduction to be achieved by the project activity during its 3rd and last 7-year crediting period.<br>Baseline emissions of methane from the SWDS ($BE_{CH4,y}$) are ex-ante estimated by estimating the amount of methane which is destroyed by the project activity through combustion of collected LFG in project's methane destruction devices in year *y* ($F_{CH4,PJ,y} = F_{CH4,flared,y} + F_{CH4,EL,y}$) as a function of ex-ante estimated values for efficiency of the LFG capture system that is currently installed as part of the project activity ($\eta_{PJ}$) as well as ex-ante estimations for the amount of methane in the LFG that is generated from the SWDS in the baseline scenario in year *y* ($BE_{CH4,SWDS,y}$) by applying applicable guidance of the methodological tool "Emissions from solid waste disposal sites" (version 08.0) and considering aspects/characteristics of the landfill. |
| Measurement methods and procedures | Measured to determine the density of methane $\rho_{CH4}$. No separate monitoring of LFG pressure is necessary when using LFG flow meters that automatically measure temperature and pressure, expressing LFG volumes in normalized cubic meters (by considering standard temperature and pressure (STP) conditions).<br><br>Instruments with recordable electronic signal (analogical or digital) are required. |
| Monitoring frequency | Continuous measurements will be recorded and reported with an every-minute frequency. |
| QA/QC procedures | Periodic calibration events will be performed in the LFG pressure sensor by a third party independent accredited calibration laboratory in a frequency as per instrument specifications and/or instrument manufacturer's recommendations.<br><br>Monitoring equipment/instrument(s) will be subject to a regular maintenance and testing regime in accordance to appropriate national / international standards/requirements and/or best practice.<br>Spare instrument(s) may be kept. |
| Purpose of data | Calculation of baseline emissions. |

[106] Depending on installed measurement instrument, measurements for $P_t$ will be recorded and reported in mbar. Recorded/reported data will be converted into Pascal in order to be also recorded and reported in Pa.

| | |
|---|---|
| Additional comment | - |

| **Data/Parameter** | $p_{H20,t,Sat}$ |
|---|---|
| Data 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* |
| Source of data | Data as per the literature "*Fundamentals of Classical Thermodynamics*"; Authors: Gordon J. Van Wylen, Richard E. Sonntag and Borgnakke; 4º Edition 1994. Published by John Wiley & Sons, Inc. |
| Value(s) applied | No estimated value is required for the determination of ex-ante estimation of emission reduction to be achieved by the project activity during its 3rd and last 7-year crediting period.<br>Baseline emissions of methane from the SWDS ($BE_{CH4,y}$) are ex-ante estimated by estimating the amount of methane which is destroyed by the project activity through combustion of collected LFG in project's methane destruction devices in year *y* ($F_{CH4,PJ,y} = F_{CH4,flared,y} + F_{CH4,EL,y}$) as a function of ex-ante estimated values for efficiency of the LFG capture system that is currently installed as part of the project activity ($\eta_{PJ}$) as well as ex-ante estimations for the amount of methane in the LFG that is generated from the SWDS in the baseline scenario in year *y* ($BE_{CH4,SWDS,y}$) by applying applicable guidance of the methodological tool "Emissions from solid waste disposal sites" (version 08.0) and considering aspects/characteristics of the landfill. |
| Measurement methods and procedures | This parameter is solely a function of the LFG stream temperature $T_t$ and can be found at above-referenced literature for a total pressure equal to 101,325 Pa. |
| Monitoring frequency | - |
| QA/QC procedures | - |
| Purpose of data | Data will be used for the determination of baseline emissions. |
| Additional comment | - |

| **Data/Parameter** | $EC_{PJ,grid,y}$ |
|---|---|
| Data unit | MWh |
| Description | Amount of grid electricity consumed by the project activity during the year *y* |
| Source of data | Measured as part of the operation of the project activity by applying appropriate electricity meter(s). |
| Value(s) applied | It is estimated that the project activity will consume 4,967 MWh of grid sourced electricity per year during its 3rd and last 7-year crediting period.<br>In the context of the ex-ante estimation of emission reductions to be achieved by the project activity during its 3rd and last 7-year crediting period, it is considered that the project's electricity demand will be met entirely by imports of grid-sourced electricity. |

| | |
|---|---|
| | |
| Measurement methods and procedures | Authorized electricity meter(s). Measurement records will be cross-checked against available electricity consumption receipts/invoices issued by the local electricity distribution company. The parameter $EC_{PJ,y}$ is equivalent to the parameter $EG_{EC,y}$ as indicated in ACM0001 (version 19.0). |
| Monitoring frequency | Continuous measurements will be aggregated automatically. Accumulated measurement records will be reported at least once a week. |
| QA/QC procedures | Periodic calibration events will be performed in a frequency as per instrument specifications and/or instrument manufacturer's recommendations.<br><br>Monitoring equipment/instrument(s) will be subject to a regular maintenance and testing regime in accordance to appropriate national / international standards/requirements and/or best practice.<br>Spare instrument(s) may be kept. |
| Purpose of data | Calculation of project emissions. |
| Additional comment | The values considered in the context of the ex-ante estimation of emission reductions were selected based on the nameplate power output for the installed centrifugal blowers. The installed centrifugal blowers are the most electricity intensive equipment of the project activity). Additional 5% in the estimated value for electricity consumption is considered in order to address the potential electricity consumption of other less electricity intensive equipment (i.e ancillary equipment). Also as a conservative assumption, it is considered that the project activity will operate 24 hours a day during its 3rd and last 7-year crediting period.<br>Measurement records will be cross-checked against available receipts/invoices/reports for imports and/or purchase of grid-sourced electricity.<br><br>As justified in Box 2c in Section A.3, electricity sourced by the grid-connected electricity generation infrastructure fuelled by LFG and located within the geographical limits of the UVS – Caieiras landfill and consumed by the project activity will be regarded and accounted as consumption of grid-sourced electricity. |

| **Data/Parameter** | $\mathbf{EF_{grid,OM,y} = EF_{grid,OM\text{-}DD,y}}$ |
|---|---|
| Data 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*. |
| Source of data | Data will be determined as per applicable guidance for dispatch data analysis operating margin $CO_2$ emission factor of the methodological tool "Tool to calculate the emission factor for an electricity system" (version 07.0).<br><br>The selected value considered for all years encompassed by the 3rd and last 7-year crediting period of the project activity in the context of the ex-ante estimation of emission reductions represents the value calculated by the DNA of Brazil and valid for year 2019 (the most recent value available).<br>Data is made available online:<br>http://www.mctic.gov.br/mctic/opencms/textogeral/emissao_despacho.html |
| Value(s) applied | 0.5181 |

| | |
|---|---|
| Measurement methods and procedures | Data will be determined as per applicable guidance for dispatch data analysis operating margin $CO_2$ emission factor of the methodological tool “Tool to calculate the emission factor for an electricity system” (version 07.0). |
| Monitoring frequency | Yearly. |
| QA/QC procedures | - |
| Purpose of data | Calculation of project emissions |
| Additional comment | - |

| **Data/Parameter** | **$Op_{j,h}$** |
|---|---|
| Data unit | - |
| Description | Operation of the equipment that consumes LFG (i.e. set of internal combustion gas engines (as additional/alternative methane destruction devices)). |
| Source of data | Measured as part of the operation of the project activity. |
| Value(s) applied | No estimated value is required for the determination of ex-ante estimation of emission reduction to be achieved by the project activity during its 3rd and last 7-year crediting period. Baseline emissions of methane from the SWDS ($BE_{CH4,y}$) are ex-ante estimated by estimating the amount of methane which is destroyed by the project activity through combustion of collected LFG in project’s methane destruction devices in year *y* ($F_{CH4,PJ,y} = F_{CH4,flared,y} + F_{CH4,EL,y}$) as a function of ex-ante estimated values for efficiency of the LFG capture system that is currently installed as part of the project activity ($\eta_{PJ}$) as well as ex-ante estimations for the amount of methane in the LFG that is generated from the SWDS in the baseline scenario in year *y* ($BE_{CH4,SWDS,y}$) by applying applicable guidance of the methodological tool “Emissions from solid waste disposal sites” (version 08.0) and considering aspects/characteristics of the landfill. |
| Measurement methods and procedures | As established by ACM0001 (version 19.0), for each equipment unit *j (*internal combustion gas engine*)* promoting utilization of LFG, it will be monitored whether the equipment is operating in hour *h* by monitoring any one or more of the following three parameters:<br>(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;<br>(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>$O_{pj,h} = 0$ when:<br><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.*<br><br>Otherwise, $O_{pj,h} = 1$ |

| | |
|---|---|
| Monitoring frequency | Hourly |
| QA/QC procedures | Calculation of baseline emissions. |
| Purpose of data | In the particular case of the project activity the only equipment that consumes LFG (and for which the monitoring parameter $Op_{j,h}$ is applicable to) are the internal combustion gas engines (additional/alternative destruction methane devices). As per ACM0001 (version 19.0), the monitoring parameter $Op_{j,h}$ is not applicable to the project's high temperature enclosed flares. |
| Additional comment | - |

| **Data/Parameter** | $\mathbf{F_{CH4,EG,t}}$ |
|---|---|
| Data unit | kg |
| Description | Mass flow of methane in the exhaust gas of the flare on a dry basis at reference conditions in the time period *t* |
| Source of data | Measurements undertaken by a third party accredited entity for each operational flare |
| Value(s) applied | No estimated value is required for the determination of ex-ante estimation of emission reduction to be achieved by the project activity during its 3rd and last 7-year crediting period.<br>Baseline emissions of methane from the SWDS ($BE_{CH4,y}$) are ex-ante estimated by estimating the amount of methane which is destroyed by the project activity through combustion of collected LFG in project's methane destruction devices in year *y* ($F_{CH4,PJ,y} = F_{CH4,flared,y} + F_{CH4,EL,y}$) as a function of ex-ante estimated values for efficiency of the LFG capture system that is currently installed as part of the project activity ($\eta_{PJ}$) as well as ex-ante estimations for the amount of methane in the LFG that is generated from the SWDS in the baseline scenario in year *y* ($BE_{CH4,SWDS,y}$) by applying applicable guidance of the methodological tool "Emissions from solid waste disposal sites" (version 08.0) and considering aspects/characteristics of the landfill. |
| Measurement methods and procedures | Measure the mass flow of methane in the exhaust gas of each operational flare according to an appropriate national or international standard (such as the UK's Technical Guidance LFTGN05 or a similar standard).<br>The time period *t* over which the mass flow is measured must be at least one hour.<br>The average flow rate to the flare during the time period *t* must be greater than the average flow rate observed for the previous six months. |
| Monitoring frequency | Biannual |
| QA/QC procedures | QA/QC procedures are to be applied by the entity responsible for performing the related measurements as per requirements of the applied standard.<br><br>Periodic calibration events in the applied instruments will be performed by a third party independent accredited calibration laboratory (in a frequency as per instrument specifications and/or instrument manufacturer's recommendations).<br><br>Monitoring equipment/instrument(s) will be subject to a regular maintenance and testing regime in accordance to appropriate national / international standards/requirements and/or best practice.<br>Spare instrument(s) may be kept. |

| | |
|---|---|
| Purpose of data | Calculation of baseline emissions[107]. |
| Additional comment | Monitoring of this parameter is required in the case of enclosed flares and if the project participants select Option B.1 to determine flare efficiency. |

| **Data/Parameter** | $\mathbf{T_{EG,m}}$ |
|---|---|
| Data unit | ºC |
| Description | Temperature in the exhaust gas of the enclosed flare in minute *m* |
| Source of data | Measurements performed for each operational flare by the project participants |
| Value(s) applied | No estimated value is required for the determination of ex-ante estimation of emission reduction to be achieved by the project activity during its 3rd and last 7-year crediting period.<br>Baseline emissions of methane from the SWDS ($BE_{CH4,y}$) are ex-ante estimated by estimating the amount of methane which is destroyed by the project activity through combustion of collected LFG in project's methane destruction devices in year *y* ($F_{CH4,PJ,y} = F_{CH4,flared,y} + F_{CH4,EL,y}$) as a function of ex-ante estimated values for efficiency of the LFG capture system that is currently installed as part of the project activity ($\eta_{PJ}$) as well as ex-ante estimations for the amount of methane in the LFG that is generated from the SWDS in the baseline scenario in year *y* ($BE_{CH4,SWDS,y}$) by applying applicable guidance of the methodological tool "Emissions from solid waste disposal sites" (version 08.0) and considering aspects/characteristics of the landfill. |
| Measurement methods and procedures | Measure the temperature of the exhaust gas of each operational high temperature enclosed flare by appropriate temperature measurement equipment (e.g. thermocouples). Measurements outside the operational temperature specified/recommended by the manufacturer may indicate that one or more flares is/are not functioning correctly and may require maintenance.<br><br>Flare manufacturers must provide suitable monitoring ports for the monitoring of the temperature of the exhaust gas of the flare. These would normally be expected to be in the middle third of the flare.<br><br>Where more than one measurement port for temperature of the exhaust gas of the flare is fitted to the flare, the flare manufacturer must provide written instructions detailing the conditions under which each location shall be used and the port most suitable for monitoring the operation of the flare according to manufacturer's specifications for temperature[108]. |
| Monitoring frequency | Continuous measurements will be recorded and reported with a least every minute frequency. |
| QA/QC procedures | Temperature measurement equipment should be replaced or calibrated in accordance with their maintenance schedule. |

[107] It is relevant to note that, as shown in Section B.6.1., as per the applied methodological approach, monitoring records of $F_{CH4,EG,t}$ are used for the determination of project emissions from flaring ($PE_{flare,y}$), of which are accounted for the determination of baseline emissions (and not used for the determination of project emissions despite of being termed as "project emissions" from flaring).

[108] In the particular case of the currently installed high temperature enclosed flares as part of the project activity, there is only one individual measuring instrument (e.g. thermocouple) located in the upper section of each flare. Anyway, in case additional flares with more than one measurement port (for temperature of the exhaust gas of the flare) are installed within the 3rd and last 7-year crediting period, the requirement applicable for flares with more than one measurement port for temperature of the exhaust gas will thus be considered.

| | |
|---|---|
| Purpose of data | Calculation of baseline emissions. |
| Additional comment | Unexpected changes such as a sudden increase/drop in temperature can occur for different reasons. As part of the monitoring procedure, these events will be noted in the site records along with any corrective action that was implemented to correct the issue.<br>Measurements are required to determine if manufacturer's flare specifications for operating temperature are met.<br><br>Periodic calibration events will be performed in the instruments by a third party independent accredited calibration laboratory in a frequency as per instrument specifications and/or instrument manufacturer's recommendations.<br><br>Monitoring equipment/instrument(s) will be subject to a regular maintenance and testing regime in accordance to appropriate national / international standards/requirements and/or best practice.<br>Spare instrument(s) may be kept. |

| **Data/Parameter** | **Flame$_m$** |
|---|---|
| Data unit | Flame status "*on*" or flame status "*off*" |
| Description | Flame detection of flare in the minute *m* |
| Source of data | Measurements/monitoring for each operational flare performed by the project participants. Whenever, flame is detected in the flare, flame status "*on*" is attributed. Whenever, flame is not detected in the flare, flame status "*off*" is attributed. |
| Value(s) applied | No estimated value is required for the determination of ex-ante estimation of emission reduction to be achieved by the project activity during its 3$^{rd}$ and last 7-year crediting period.<br>Baseline emissions of methane from the SWDS ($BE_{CH4,y}$) are ex-ante estimated by estimating the amount of methane which is destroyed by the project activity through combustion of collected LFG in project's methane destruction devices in year *y* ($F_{CH4,PJ,y} = F_{CH4,flared,y} + F_{CH4,EL,y}$) as a function of ex-ante estimated values for efficiency of the LFG capture system that is currently installed as part of the project activity ($\eta_{PJ}$) as well as ex-ante estimations for the amount of methane in the LFG that is generated from the SWDS in the baseline scenario in year *y* ($BE_{CH4,SWDS,y}$) by applying applicable guidance of the methodological tool "Emissions from solid waste disposal sites" (version 08.0) and considering aspects/characteristics of the landfill. |
| Measurement methods and procedures | Measure for each operational flare using a fixed installation optical flame detector: Ultra Violet detector or Infra-red or both. |
| Monitoring frequency | Once per minute. |
| QA/QC procedures | Equipment shall be maintained and calibrated in accordance with manufacturer's recommendations. |
| Purpose of data | Calculation of baseline emissions. |
| Additional comment | Applicable to all flares. The condition will be regularly monitored for each individual high temperature enclosed flare.<br><br>Periodic calibration events will be performed in the instruments by a third party |

| | |
|---|---|
| | independent accredited calibration laboratory in a frequency as per instrument specifications and/or instrument manufacturer's recommendations.<br><br>Monitoring equipment/instrument(s) will be subject to a regular maintenance and testing regime in accordance to appropriate national / international standards/requirements and/or best practice.<br>Spare instrument(s) may be kept. |

| **Data/Parameter** | **$Maintenance_y$** |
|---|---|
| Data unit | Calendar dates |
| Description | Maintenance events completed in year *y* as monitored by the project participants. |
| Source of data | Measurements/monitoring performed by the project participants. |
| Value(s) applied | No estimated value is required for the determination of ex-ante estimation of emission reduction to be achieved by the project activity during its 3rd and last 7-year crediting period.<br>Baseline emissions of methane from the SWDS ($BE_{CH4,y}$) are ex-ante estimated by estimating the amount of methane which is destroyed by the project activity through combustion of collected LFG in project's methane destruction devices in year *y* ($F_{CH4,PJ,y} = F_{CH4,flared,y} + F_{CH4,EL,y}$) as a function of ex-ante estimated values for efficiency of the LFG capture system that is currently installed as part of the project activity ($\eta_{PJ}$) as well as ex-ante estimations for the amount of methane in the LFG that is generated from the SWDS in the baseline scenario in year *y* ($BE_{CH4,SWDS,y}$) by applying applicable guidance of the methodological tool "Emissions from solid waste disposal sites" (version 08.0) and considering aspects/characteristics of the landfill. |
| Measurement methods and procedures | Record the date that maintenance events were completed in year *y*. Records of maintenance logs must include all aspects of the maintenance including the details of the person(s) undertaking the work, parts replaced, or needing to be replaced, source of replacement parts, serial numbers and calibration certificates. |
| Monitoring frequency | Annual |
| QA/QC procedures | Records must be kept in a maintenance log for two years beyond the life of the flare. |
| Purpose of data | Calculation of baseline emissions. |
| Additional comment | Monitoring of this parameter is required for the case of enclosed flares and the project participant selects Option B to determine flare efficiency.<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 ($SPEC_{flare}$). |

| Data/Parameter | $FC_{LPG,y}$ |
|---|---|
| Data unit | ton |
| Description | Quantity of LPG consumed by the project activity in year *y* |
| Source of data | Monitoring based on measurements performed by applying weight scale |
| Value(s) applied | It is estimated that 750 kg (0.750 ton) of LPG will be consumed by the project activity per year during the 2nd 7-year crediting period[109]. |
| Measurement methods and procedures | Recording of measurements of LPG consumed by project activity in year *y* by using appropriate mass meter (weight scale). |
| Monitoring frequency | Continuous measurements of quantity of LPG by the project activity will be monitored with frequency not lower than once a month. |
| QA/QC procedures | LPG purchasing receipts may be used for crosschecking of valid measurement records. |
| Purpose of data | Calculation of project emissions. |
| Additional comment | Periodic calibration events will be performed in the mass meters by a third party independent accredited calibration laboratory in a frequency as per instrument specifications and/or instrument manufacturer's recommendations.<br><br>Instruments will be subject to a regular maintenance and testing regime in accordance to appropriate national/international standards/requirements and/or best practice.<br>Spare instrument(s) may be kept. |

[109] The 0.750 ton of LPG per year value is assumed by taking into consideration the reported and verified LPG consumption figures as part of the latest periodic verifications for the project activity within the currently expired 2nd crediting period (monitoring period from 01/07/2019 to 31/12/2019) and by also taking into account operational aspects of the project activity during such period.

| **Data/Parameter** | **$NCV_{LPG,y}$** |
|---|---|
| Data unit | GJ/ton LPG |
| Description | Net calorific value of the fuel LPG in year y |
| Source of data | Value provided by the fuel supplier in invoices, regional or national default values or IPCC default values (at upper limit of uncertainty at 95% confidence interval as provided in Table 1.2 of Chapter 1 of Vol. 2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories[110]).<br><br>For the ex-ante estimation of emission reductions to be achieved by the project activity during its 3rd and last 7-year crediting period, the value is selected as reported in the Brazilian Energetic Balance Report, year 2019 (Table VIII.9 – Specific Mass and Heating Values – 2018[111]) |
| Value(s) applied | 49.20 |
| Measurement methods and procedures | - |
| Monitoring frequency | In case values are provided by the fuel supplier in invoices, the applied weighted average annual value will be determined based on provided related information in the context of each individual fuel delivery event.<br><br>In case regional or national default values or IPCC default values are considered an every year monitoring frequency is applied. |
| QA/QC procedures | Both values provided by the fuel supplier in invoices as well as regional or national default values will be confirmed to be within the uncertainty range of the IPCC default values (as provided in Table 1.2, Vol. 2 of the 2006 IPCC Guidelines).<br>If the considered values fall below this range, additional information and/or justification will be collected and will be used to justify the outcome. The laboratory (ies) sourcing related measurements or analysis will be confirmed to have ISO17025 accreditation (or it will be justified that it/they can comply with similar quality standards). |
| Purpose of data | Calculation of project emissions. |
| Additional comment | If the LPG supplier does provide related NCV values and $CO_2$ emission factor for the delivered fuel on the invoice and these two values are based on measurements for this specific fuel, this source will be used for the determination of values for the monitoring parameter $NCV_{LPG,y}$.. In case, another source(s) for the values is/are applied, regional or national default values or IPCC default values will thus be considered. |

[110] Any future related revision of the IPCC Guidelines will be taken into account.

[111] The Brazilian Energetic Balance Report – 2019 (Relatório Balanço Energético Nacional (BEN) – 2019) is the latest report and it is based on data for year 2018. This official governmental report was published by the entity Empresa de Pesquisa Energética (EPE) and is available online:

http://www.epe.gov.br/sites-pt/publicacoes-dados-abertos/publicacoes/PublicacoesArquivos/publicacao-377/topico-470/Relat%C3%B3rio%20S%C3%ADntese%20BEN%202019%20Ano%20Base%202018.pdf

| **Data/Parameter** | **$EF_{CO2,LPG,y}$** |
|---|---|
| Data unit | $tCO_2/GJ$ |
| Description | $CO_2$ emission factor of fuel LPG in year *y* |
| Source of data | Value provided by the fuel supplier in invoices, regional or national default values or IPCC default values (at upper limit of uncertainty at 95% confidence interval as provided in Table 1.4 of Chapter 1 of Vol. 2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories)[112]. Appropriate net calorific value (NCV) for LPG may be used for converting energy basis data into mass basis data.<br><br>For the ex-ante estimation of emission reductions to be achieved by the project activity during its 3rd and last 7-year crediting period, the value is selected as per 2006 IPCC Guidelines on National GHG Inventories (applicable value at upper limit of uncertainty at 95% confidence interval as provided in Table 1.4 of Chapter 1 of Vol. 2 (Energy)). |
| Value(s) applied | 0.0656 |
| Measurement methods and procedures | - |
| Monitoring frequency | In case values are provided by the fuel supplier in invoices, the applied weighted average annual value will be determined based on provided related information in the context of each individual fuel delivery event.<br><br>In case regional or national default values or IPCC default values are considered an every year monitoring frequency is applied. |
| QA/QC procedures | Both values provided by the fuel supplier in invoices as well as regional or national default values will be confirmed to be within the uncertainty range of the IPCC default values (as per 2006 IPCC Guidelines on National GHG Inventories - applicable value at upper limit of uncertainty at 95% confidence interval as provided in Table 1.4 of Chapter 1 of Vol. 2 (Energy).). If the considered values fall below this range, additional information and/or justification will be collected and will be used to justify the outcome. |
| Purpose of data | Calculation of project emissions. |
| Additional comment | If the LPG supplier does provide related NCV values and $CO_2$ emission factor for the delivered fuel on the invoice and these two values are based on measurements for this specific fuel, this source will be used for the determination of values for the monitoring parameter $NCV_{LPG,y}$.. In case, another source(s) for the values is/are applied, regional or national default values or IPCC default values will thus be considered. |

[112] Any future revision of the IPCC Guidelines will be taken into account.

| **Data/Parameter** | $EG_{Diesel\text{-}Generator,y} = EC_{PJ,captive,y}$ |
|---|---|
| Data unit | MWh |
| Description | Quantity of electricity generated by captive diesel backup generator during the year *y*<br><br>Quantity of electricity consumed from captive diesel backup generator during the year *y* |
| Source of data | Measurements by the project participants. |
| Value(s) applied | No estimated value is considered for the determination of ex-ante estimation of emission reductions to be achieved by the project activity during its 3rd and last 7-year crediting period. In the particular context of the ex-ante estimation of emission reductions to be achieved by the project activity during its 3rd and last 7-year crediting period, it is considered that the project's electricity demand will be met entirely by imports of grid-sourced electricity. The installed backup off-grid electricity generator is expected to be used only during emergency situations (interruption of the supply of grid-sourced electricity to the project activity). |
| Measurement methods and procedures | Use appropriate electricity meters. |
| Monitoring frequency | Measurements will be aggregated manually or automatically. Accumulated measurement records will be reported at with at least every-month frequency. |
| QA/QC procedures | Periodic calibration events will be performed in a frequency as per instrument specifications and/or instrument manufacturer's recommendations.<br><br>Monitoring equipment/instrument(s) will be subject to a regular maintenance and testing regime in accordance to appropriate national / international standards/requirements and/or best practice.<br>Spare instrument(s) may be kept. |
| Purpose of data | Calculation of project emissions. |
| Additional comment | The captive off-grid backup electricity generator (fuelled by diesel) is used only for emergency purposes. Thus, in the context of ex-ante estimates of emission reductions to be achieved by the project activity, there is no estimated amount of electricity to be generated this generator and/or amount of fossil fuel diesel to be consumed by the generators either. Project emissions due to the consumption of electricity sourced by this generator are thus estimated as zero (null) in the context of ex-ante estimates of emission reductions to be achieved by the project activity. However, such project emissions will be determined ex-post along the crediting period (based on applicable monitoring and calculation requirements as presented in Section B.6.1) and will be accounted for the determination of emission reductions.<br><br>It is important to note that, while all electricity generated by the backup captive off-grid electricity generator (fuelled by Diesel) will be consumed by the project activity, $EG_{Diesel\text{-}Generator,y} = EC_{PJ,captive,y}$. |

| **Data/Parameter** | **$FC_{Diesel,y}$** |
|---|---|
| Data unit | Liters |
| Description | Quantity of fuel diesel combusted by the captive off-grid electricity generator |
| Source of data | Measurements by the project participants. |
| Value(s) applied | No estimated value is required for the determination of ex-ante estimation of emission reduction to be achieved by the project activity during the 3rd and last 7-year crediting period of the project activity as the installed backup off-grid electricity generator is expected to be used only during emergency situations (and thus not considered to be used as part of the determination of ex-ante estimates of emission reductions). |
| Measurement methods and procedures | Measurements using flow meters or volume or mass meter(s). As an alternative measurements will be based on records of an integrated electronic system of the generator, which shows the percentage of stored fuel<br><br>Monitoring will be made weekly, recording the operating hours and the percentage of fuel load of equipment, considering specific fuel consumption specified by the equipment manufacturer. |
| Monitoring frequency | Measurements will be aggregated manually or automatically. Accumulated measurement records will be reported at with at least once a week. |
| QA/QC procedures | Periodic calibration events will be performed in a frequency as per instrument specifications and/or instrument manufacturer’s recommendations.<br><br>Instrument(s) will be subject to a regular maintenance and testing regime in accordance to appropriate national / international standards/requirements and/or best practice. |
| Purpose of data | Calculation of project emissions. |
| Additional comment | The captive off-grid backup electricity generator (fuelled by diesel) is used only for emergency purposes. Thus, in the context of ex-ante estimates of emission reductions to be achieved by the project activity, there is no estimated amount of electricity to be generated this generator neither amount of fossil fuel diesel to be consumed by the generators. Project emissions due to the consumption of electricity sourced by this generator are thus estimated as zero (null) in the context of ex-ante estimates of emission reductions to be achieved by the project activity.<br>However, such project emissions will be determined ex-post along the crediting period (based on applicable monitoring and calculation requirements as presented in Section B.6.1) and will be accounted for the determination of emission reductions. |

| **Data/Parameter** | **$NCV_{Diesel,y}$** |
|---|---|
| Data unit | GJ/liters |
| Description | Net calorific value of the fuel diesel in year y |
| Source of data | Value provided by the fuel supplier in invoices, regional or national default values or IPCC default values (at upper limit of uncertainty at 95% confidence interval as provided in Table 1.2 of Chapter 1 of Vol. 2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories[113]). |
| Value(s) applied | No estimated value is required for the determination of ex-ante estimation of emission reduction to be achieved by the project activity during its 3rd and last 7-year crediting period as the installed backup off-grid electricity generator is expected to be used only during emergency situations. |
| Measurement methods and procedures | - |
| Monitoring frequency | In case values are provided by the fuel supplier in invoices, the applied weighted average annual value will be determined based on provided related information in the context of each individual fuel delivery event.<br><br>In case regional or national default values or IPCC default values are considered an every year monitoring frequency is applied. |
| QA/QC procedures | Both values provided by the fuel supplier in invoices as well as regional or national default values will be confirmed to be within the uncertainty range of the IPCC default values (as provided in Table 1.2, Vol. 2 of the 2006 IPCC Guidelines). If the considered values fall below this range, additional information and/or justification will be collected and will be used to justify the outcome. The laboratory(ies) sourcing related measurements or analysis will be confirmed to have ISO17025 accreditation (or it will be justified that it/they can comply with similar quality standards). |
| Purpose of data | Calculation of project emissions. |
| Additional comment | - |

[113] Any future revision of the IPCC Guidelines will be taken into account

| **Data/Parameter** | **$EF_{CO2,Diesel,y}$** |
|---|---|
| Data unit | $tCO_2/GJ$ |
| Description | $CO_2$ emission factor of fuel diesel in year *y* |
| Source of data | Value provided by the fuel supplier in invoices, regional or national default values or IPCC default values (at upper limit of uncertainty at 95% confidence interval as provided in Table 1.4 of Chapter 1 of Vol. 2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories)[114]. |
| Value(s) applied | No estimated value is required for the determination of ex-ante estimation of emission reduction to be achieved by the project activity during its 3rd and last 7-year crediting period as the installed backup off-grid electricity generator is expected to be used only during emergency situations. |
| Measurement methods and procedures | - |
| Monitoring frequency | In case values are provided by the fuel supplier in invoices, the applied weighted average annual value will be determined based on provided related information in the context of each individual fuel delivery event.<br><br>In case regional or national default values or IPCC default values are considered an every year monitoring frequency is applied. |
| QA/QC procedures | Both values provided by the fuel supplier in invoices as well as regional or national default values will be confirmed to be within the uncertainty range of the IPCC default values (as per 2006 IPCC Guidelines on National GHG Inventories - applicable value at upper limit of uncertainty at 95% confidence interval as provided in Table 1.4 of Chapter 1 of Vol. 2 (Energy).). If the considered values fall below this range, additional information and/or justification will be collected and will be used to justify the outcome. |
| Purpose of data | Calculation of project emissions. |
| Additional comment | - |

| **Data/Parameter** | **$TDL_{grid,y}$** |
|---|---|
| Data unit | - |
| Description | Average technical transmission and distribution losses for grid sourced electricity consumed by the project activity. |
| Source of data | Use of recent, accurate and reliable data available within the host country or selection of applicable default value as per Option C.III of the methodological tool “Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation” (version 03.0) or use of recent, accurate and reliable data available within the host country. |

[114] Any future revision of the IPCC Guidelines will be taken into account.

| | |
|---|---|
| Value(s) applied | 20% |
| Measurement methods and procedures | Value should be estimated for the distribution and transmission networks of the electricity grid of the same voltage as the connection where the proposed CDM project activity is connected to. The technical distribution losses in the grid should not contain other types of grid losses (e.g. commercial losses/theft).<br>The distribution losses can either be calculated by the project participants or be based on references from utilities, network operators or other official documentation. |
| Monitoring frequency | Annually. In the absence of data from the relevant year, most recent figures should be used, but not older than 5 years. |
| QA/QC procedures | - |
| Purpose of data | Data is used for determination of project emissions (due to consumption of grid-sourced electricity by the project activity). |
| Additional comment | - |

| **Data/Parameter** | **$TDL_{captive,y}$** |
|---|---|
| Data unit | - |
| Description | Average technical transmission and distribution losses for electricity sourced by the captive electricity generator. |
| Source of data | Use of recent, accurate and reliable data available within the host country or selection of the applicable default value valid for Option C.III as per the methodological tool “Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation” (version 03.0).<br>For the ex-ante estimates of emission reductions, the default value is applied. |
| Value(s) applied | No estimated value is considered for the determination of ex-ante estimation of emission reductions to be achieved by the project activity during its 3rd and last 7-year crediting period. In the particular context of the ex-ante estimation of emission reductions to be achieved by the project activity during its 3rd and last 7-year crediting period, it is considered that the project’s electricity demand will be met entirely by imports of grid-sourced electricity. The installed backup off-grid electricity generator is expected to be used only during emergency situations (interruption of the supply of grid-sourced electricity to the project activity). |
| Measurement methods and procedures | Value should be estimated for the distribution and transmission networks of the electricity grid of the same voltage as the connection where the proposed CDM project activity is connected to. Value can either be calculated by the project participants or be based on relevant references. |
| Monitoring frequency | Annually. In the absence of data from the relevant year, most recent figures should be used, but not older than 5 years. |
| QA/QC procedures | - |
| Purpose of data | Data is used for determination of project emissions (due to consumption of grid-sourced electricity by the project activity). |

| | |
|---|---|
| Additional comment | - |

| **Data/Parameter** | **Status of biogas destruction device** |
|---|---|
| Data unit | - |
| Description | Operational status of biogas destruction device(s) |
| Source of data | Not applicable. |
| Value(s) applied | Not applicable. |
| Measurement methods and procedures | Monitoring and documenting may be undertaken through monitoring of the operation of the flare(s) (by means of s flame detector in each flare) and the operation of the internal combustion gas engines (by means of direct monitoring of operation status for each engine) in order to demonstrate the actual destruction of methane in such installed biogas destruction devices.<br>Emission reductions will not accrue for periods in which the underlying destruction device(s) (high temperature enclosed flare(s) and/or internal combustion gas engine(s)) is/are not operational. |
| Monitoring frequency | Continuous measurements will be recorded and reported with a least every minute frequency. |
| QA/QC procedures | Not applicable. |
| Purpose of data | Calculation of baseline emissions. |
| Additional comment | Monitoring records for the monitoring parameter “Flame detection of flare in the minute *m*” ($Flame_m$) will be considered for the installed flares.<br><br>Monitoring records for the monitoring parameter “Operation of the equipment that consumes LFG (i.e. set of internal combustion gas engines (as additional/alternative methane destruction devices))” ($Op_{j,h}$) will be considered for the internal combustion gas engines. |

### B.7.2. Sampling plan

>>

Not applicable.

### B.7.3. Other elements of monitoring plan

>>

*General monitoring:*
The following instruments/equipment will be used to monitor required data along the 3rd and last 7-year crediting period of the project activity (depending on the applied measurement options and calculation approaches - to be chosen ex-post)[115]:

| Instrument or Source of data | Measurement option | | Data monitored | |
|---|---|---|---|---|
| Appropriate volumetric or mass flow meters<br><br>(one individual LFG flow meter for each operational high temperature enclosed flare and for each internal combustion gas engine, with separated measurement data being recorded and reported for each one of these methane destruction devices) | A | Volume flow – dry basis; Volumetric fraction dry or wet basis | $\mathbf{V_{t,db,j}}$ | Volumetric flow of LFG stream *j* in time interval *t* on a dry basis (in $m^3$ dry gas/h).<br>*j* = LFG delivery pipeline to each operative high temperature enclosed flare and/or to each operative internal combustion gas engine (i.e. each installed methane destruction device). |
| | B | Volume flow – wet basis; Volumetric fraction dry basis | $\mathbf{V_{t,wb,j}}$ | Volumetric flow of LFG stream *j* in time interval *t* on a wet basis (in $m^3$ dry gas/h).<br>*j* = LFG delivery pipeline to each operative high temperature enclosed flare and/or to each operative internal combustion gas engine (i.e. each installed methane destruction device). |
| | C | Volume flow – wet basis; Volumetric fraction wet basis | $\mathbf{V_{t,wb,j}}$ | Volumetric flow of LFG stream *j* in time interval *t* on a wet basis (in $m^3$ wet gas/h).<br>*j* = LFG delivery pipeline to each operative high temperature enclosed flare and/or to each operative internal combustion gas engine (i.e. each installed methane destruction device). |
| | D | Mass flow – dry basis; Volumetric fraction dry or wet basis | $\mathbf{M_{t,db,j}}$ | Mass flow of LFG stream *j* in time interval *t* on a dry basis (in kg/h).<br>*j* = LFG delivery pipeline to each operative high temperature enclosed flare and/or to each operative internal combustion gas engine (i.e. each installed methane destruction device). |
| Continuous $CH_4$ content gas analyser unit | - | | $\mathbf{v_{CH4,t,db/wb,j}}$ | Volumetric fraction of methane on the LFG stream directed to the flares and/or to the internal combustion gas engines in a time interval *t* on a dry or wet basis (in $m^3$ $CH_4$/$m^3$ dry or wet gas) |
| LFG pressure sensor | **-** | | $\mathbf{P_t}$ | Pressure of the LFG stream directed to the |

[115] Measurement options defined in the "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" (version 03.0) when referring to "*Adequate volumetric or mass flow meter(s)*" and defined in the methodological tool Project emissions from flaring" (version 03.0) in other cases.

Different measurement options are indeed defined in the "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" (version 03.0) when referring to "Adequate volumetric or mass flow meter (s)". The applicable guidance of the methodological tool "Project emissions from flaring" (version 03.0) also refers to different measurement and calculation options.

| Instrument or Source of data | Measurement option | Data monitored | |
|---|---|---|---|
| | | | flares and/or to the internal combustion gas engines in time interval *t* (in Pa or mbar)<br><br>Note: **$P_t$** may not be monitored when using LFG flow meters that automatically consider and measures LFG temperature and LFG pressure, thus expressing LFG volumetric or mass flows in normalised units. |
| LFG temperature sensor | - | **$T_t$** | Temperature of the LFG stream directed to the flares and/or to the internal combustion gas engines in time interval *t* (in K or ºC)<br><br>Note: **$T_t$** may not be monitored when using LFG flow meters that automatically consider and measures LFG temperature and LFG pressure, thus expressing LFG volumetric or mass flows in normalised units. |
| Not based on measurements. Monitoring performed in the context of operation/monitoring for the project activity (based on calculations) | - | **$p_{H20,t,Sat}$** | Saturation pressure of $H_2O$ at temperature $T_t$ in time interval *t*<br>This parameter is solely a function of the LFG stream temperature $T_t$ and can be found at referenced literature. |
| Electricity meters | | **$EC_{PJ,y} =$ $EC_{grid,y}$** | Amount of grid electricity consumed by the project activity in year *y* (in MWh) |
| | | **$EG_{Diesel\text{-}Generator,y}$ / $EC_{PJ,captive,y}$** | Quantity of electricity generated by / consumed from captive diesel backup generator during the year *y* (in MWh) |
| Not based on measurements. Monitoring performed in the context of operation/monitoring for the project activity (based on calculations) | - | **$EF_{grid,OM,y} =$ $EF_{grid,OM\text{-}DD,y}$** | Operation margin $CO_2$ emission factor in year *y* = Dispatch data analysis operating margin $CO_2$ emission factor in year *y.* (in $tCO_2$/MWh).<br>Data will be determined as per applicable guidance for dispatch data analysis operating margin $CO_2$ emission factor of the methodological tool "Tool to calculate the emission factor for an electricity system" (version 07.0). |
| Mass/weight scale | | **$FC_{LPG,y}$** | Amount of LPG consumed by the project activity in year *y* (in ton) |
| | **Calculation approach (option) 1 or 3** | **$FC_{Diesel,y}$** | Quantity of fuel Diesel combusted by the captive off-grid electricity generator (in liters) |
| Not based on measurements performed in the | - | **Management of SWDS** | Management of SWDS<br>The design and operational conditions of the |

| Instrument or Source of data | Measurement option | Data monitored | |
|---|---|---|---|
| context of operation/monitoring for the project activity | | | landfill will be annually monitored on the basis of different sources, including *inter alia*:<br>- Original design of the landfill;<br>- Technical specifications for the management of the landfill;<br>- Applicable local or national regulations |
| Meter or equipment electronics. | **-** | **$Op_{j,h}$** | Operation of the equipment that consumes LFG (internal combustion gas engines).<br>For each internal combustion gas engine *j* combusting LFG (destroying methane), it will be continuously monitored whether the equipment is operating in hour *h* by monitoring any one the following sub-parameters/conditions:<br>- Amount of electricity generated in hour *h*<br>- Operational status of the engine-generator set during each hour *h*. |
| Not based on measurements Monitoring performed in the context of operation/monitoring for the project activity (based on calculations) | **-** | **$NCV_{LPG,y}$** | Net calorific value of the fuel LPG in year y (in GJ/ton LPG). Data will be determined as per applicable guidance of the methodological tool “Tool to calculate project or leakage $CO_2$ emissions from fossil fuel combustion” (version 03.0). |
| Not based on measurements Monitoring performed in the context of operation/monitoring for the project activity (based on calculations) | **Calculation approach (option) 1 or 3** | **$NCV_{Diesel,y}$** | Net calorific value of the fuel Diesel in year y (in GJ/ton LPG). Data will be determined as per applicable guidance of the methodological tool “Tool to calculate project or leakage $CO_2$ emissions from fossil fuel combustion” (version 03.0). |
| Not based on measurements Monitoring performed in the context of operation/monitoring for the project activity (based on calculations) | | **$EF_{CO2,LPG,y}$** | $CO_2$ emission factor of fuel LPG in year *y* (in $tCO_2$/GJ). Data will be determined as per applicable guidance of the methodological “Tool to calculate project or leakage $CO_2$ emissions from fossil fuel combustion” (version 03.0). |

| Instrument or Source of data | Measurement option | Data monitored | |
|---|---|---|---|
| Not based on measurements Monitoring performed in the context of operation/monitoring for the project activity (based on calculations) | **Approach 1 or 3** | **$EF_{CO2,Diesel,y}$** | $CO_2$ emission factor of fuel Diesel in year *y* (in $tCO_2$/GJ). Data will be determined as per applicable guidance of the methodological tool "Tool to calculate project or leakage $CO_2$ emissions from fossil fuel combustion" (version 03.0). |
| Measurements undertaken by a third party accredited entity | **B.1** | **$F_{CH4,EG,t}$** | Mass flow of methane in the exhaust gas of the flare on a dry basis at reference conditions in the time period *t* (kg)<br>For each one of the installed high temperature enclosed flare, it will be measured the mass flow of methane in the exhaust gas according to an appropriate national or international standard (e.g. UKs Technical Guidance LFTGN05).<br>The time period *t* over which the mass flow is measured must be at least one hour.<br>The average flow rate to the flare during the time period *t* must be greater than the average flow rate observed for the previous six months.<br>Monitoring of this parameter is only required in the case the project participants select Option B.1 to determine the efficiency values for the high temperature enclosed flares. |
| Thermocouples | **A or B.1** | **$T_{EG,m}$** | Temperature in the exhaust gas of the enclosed flare in minute *m* (ºC)<br>For each one of the installed high temperature enclosed flare, it will be continuously measured the temperature of the exhaust gas through use of appropriate temperature measurement instrument (e.g. thermocouples). Measurements outside the operational temperature specified by the flare manufacturer may indicate that the flare is not functioning correctly and may require maintenance or repair work.<br>For each flare, the temperature of the exhaust gas in each flare have to be measured in a suitable monitoring port. In high temperature enclosed flares, monitoring ports are normally expected to be located within the middle third of the flare.<br>In case more than one temperature port is fitted to the high temperature enclosed flare, the flare manufacturer must provide written instructions detailing the conditions under which each location shall be used and the port most suitable for monitoring the operation of the flare according to |

| Instrument or Source of data | Measurement option | Data monitored | |
|---|---|---|---|
| | | | manufacturer's specifications for temperature of exhaust gas. The 4 high temperature enclosed flares currently installed as part of the project activity only have one monitoring port for temperature of the exhaust gas.<br>Measurements are required to determine if manufacturer's flare specifications for operating temperature are met. |
| Optical flame detector (using ultra violet or infra-red technology or both | **A or B.1** | **$Flame_m$** | Flame detection of flare in the minute *m* (Flame "*on*" or Flame "*off*")<br>For each installed high temperature enclosed flare, continuous monitoring of flame detection through use of appropriate installation (e.g. optical flame detector (using ultra violet or infra-red technology or both). |
| Records from the project participants gathered as part of the operation of the project activity. | **B.1** | **$Maintenance_y$** | Maintenance events completed in year *y* (Calendar dates) for each one of the high temperature enclosed flare combusting LFG.<br>For each installed high temperature enclosed flare, record the date when maintenance events are performed in year *y*. Records of maintenance logs will include all aspects of the maintenance including the details of the person(s) undertaking the work, parts replaced/repaired, or needing to be replaced, source of replacement parts, serial numbers and related calibration certificates. |
| Not based on measurements | **Calculated or application of default value** | **$TDL_{grid,y}$ / $TDL_{captive,y}$** | Use of recent, accurate and reliable data available within the host country or selection of the applicable default value as per the methodological tool "Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation" (version 03.0). |
| Project participants | **-** | **Status of biogas destruction device** | Operational status of biogas destruction device<br>The same procedures as adopted for monitoring parameter $Flame_m$ (in the case of the flares) and for parameter $Op_{j,h}$ (in the case of internal combustion gas engines). For installed high temperature enclosed flares), continuous monitoring of flame detection through use of appropriate installation (e.g. optical flame detector (using ultra violet or infrared technology or both).<br>For installed internal combustion gas engines, continuous monitoring of operational status signal in each engine. |

During the 3rd and last 7-year crediting period of the project activity, all continuously measured LFG related parameters as well as measurements related to the exhaust gas of the flares (temperature in the exhaust gas of the flares) and parameters related to flare operational conditions (i.e. status of methane destruction devices) will all be recorded electronically via an appropriate data logger / data acquisition system (to be located within the site boundary).
The data logger / data acquisition system will have the capability to record all data in a safe and reliable manner (thus ensuring the required data reliability and validity). Data recording and reporting frequency for these parameters will be at least every one minute.

Records of electricity consumed by the project activity will also be recorded electronically via an appropriate data logger / data control / data acquisition system (to be located within the site boundary). Data from invoices of purchased grid-sourced electricity (issued by local electricity transmission/commercialization company) may also be used as cross-checking. Moreover, records of electricity generated by the backup captive off-grid electricity generator (fueled by diesel) may also be regularly recorded (depending on the approach applied for the determination of project emissions from consumption of electricity source by such backup electricity generator).

During the 3rd and last 7-year crediting period of the project activity, records of quantity of LPG eventually consumed by the project activity will be aggregated manually or automatically (depending on the specifications of related measurement instrument to be applied). Accumulated related measurement records will be reported at with an at least every-month frequency. Data from related eventual LPG purchasing receipts or invoices (to be issued by local LPG distribution company) will also be used as cross-checking.

By the use of appropriate software application, recorded monitoring data will be regularly retrieved, aggregated and reported in order to be considered in the context of calculations of emission reduction achieved by the project activity.

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

During the 3rd and last 7-year crediting period, all monitoring data will be recorded and backed-up in a central database. As per the applicable monitoring procedure, data records will be summarized into emission reduction calculations prior to each periodic CDM verification. All data recorded by the data logger / data acquisition system will be made available to the Designated Operational Entities (DOEs) responsible for each periodic verification. This will ensure that data integrity and reliability for related monitoring data.

As per the monitoring procedure adopted by Essencis Soluções Ambientais S.A., access to monitoring data will be restricted and controlled. All monitoring records will be kept archived until at least two years after the end of the crediting period or at least two years after the last issuance of CER’s for the project activity, whichever occurs later.

It will be the responsibility of the appointed monitoring team manager to ensure that all monitoring data is properly measured and recorded as part of operation of the project activity.

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

*Maintenance and calibration for monitoring instruments/equipment and project's equipment/components in general:*
During the 3rd and last 7-year crediting period of the project activity, all maintenance service and routines will include all preventive and corrective actions necessary for ensuring good functioning of all project related equipment, such as:

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

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

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

*Project's operational and management structure:*
An appropriate project's operational and management structure will be made available as part of the operation of the project activity during its 3rd and last 7-year crediting period.

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

a) General competence development about LFG generation and collection;
b) Review of equipment operational principles and captors;
c) Maintenance and calibration requirements for project's related equipment;
d) Procedures for monitoring data gathering and handling;
e) Emergency and safety procedures;
f) General competence development about methane destruction through combustion of LFG in high temperature enclosed flares;
g) General competence development about methane destruction through combustion of LFG in internal combustion gas engines.

The monitoring plan will be implemented and operationalized during the 3rd and last 7-year crediting period of the project activity by reflecting the best practice in terms of monitoring efforts for LFG collection and destruction project based initiatives under de CDM.

*Monitoring of the management of the landfill:*
As required by ACM0001 (version 19.0), the design and operational conditions of the UVS – Caieiras landfill during the 3rd and last 7-year crediting period of the project activity will be monitored on the basis of different sources, including *inter alia*:

- Original design of the landfill;
- Technical specifications for the management of the UVS – Caieiras landfill;
- Applicable local or national regulations

During the 3rd and last 7-year crediting period of the project activity, original operational design of the landfill should be confirmed not to be modified in order to ensure that no practice to increase methane generation at the landfill have been occurring, when compared to the landfill management and operation condition prior to implementation of the project activity. As required by ACM0001

(version 19.0), any change in the management of the landfill after the implementation of the project activity should be justified by referring to technical or regulatory specifications and impacts of such changes in the determination of baseline emissions should in this case be taken into account appropriately. Such monitoring requirement will be used for the determination/confirmation of baseline emissions and/or confirmation of the project's implementation as described in the PDD (in terms of operation and management conditions of the landfill from which LFG is combusted). Further monitoring details are included in Section B.7.1 (under parameter "Management of SWDS").

## SECTION C. Start date, crediting period type and duration

### C.1. Start date of project activity

>>

At the time the CDM project activity "Caieiras landfill gas emission reduction" was validated and registered as a CDM project activity (during period encompassing years 2005 and 2006), the start date of the project was selected and indicated in the PDD valid for the 1st 7-year crediting period as being "*March 2006*".

### C.2. Expected operational lifetime of project activity

>>

The expected operational lifetime for both the project's infrastructure is at least 20 years. However, the lifetime of equipment of such project components may even exceed 20 years if required service and maintenance is appropriately performed (as per recommendation and requirements set by equipment manufacturers/suppliers).

While the project activity (under its previous design) started its continuous operations (as part of its 1st crediting period) in February/2007[116], thus the remaining operational lifetime for the project's LFG collection and destruction infrastructure potentially exceeds 7 years in April/2020 (after being operated for more than 13 years).

### C.3. Crediting period of project activity

#### C.3.1. Type of crediting period

>>

While the project activity applies 7-year renewable crediting period option, this PDD is thus valid for its 3rd and last 7-year crediting period.

#### C.3.2. Start date of crediting period

>>

The 3rd and last 7-year crediting period of the project activity starts on 31/03/2020.

#### C.3.3. Duration of crediting period

>>

7-year (renewable)

[116] The starting of regular and continuous operation of the project activity in February/2007 is reported and assessed in the documentation for the occurred 1st verification for the project activity (Monitoring Report and Verification Report). These documents are available on-line:

http://cdm.unfccc.int/Projects/DB/DNV-CUK1134509951.62/iProcess/SGS-UKL1195228146.42/view

# SECTION D. Environmental impacts

## D.1. Analysis of environmental impacts

>>
Information about the analysis of the environmental impacts for the project activity (under its previous design configuration) and related validation assessment by the responsible DOE are all presented in the latest version of its PDD valid for the currently expired 1st 7-year crediting period of the project activity (PDD version 4, dated 10/01/2013) + Validation Report for the project activity (dated 12/12/2005).

Regarding methane destruction through combustion of LFG in internal combustion gas engines since July/2016, such additional/alternative methane destruction devices were installed and have operated since July/2016 conformance with requirements established in the environmental licensing process of no. 29/00794/09 within the competent environmental authority “Companhia de Tecnologia de Saneamento Ambiental” (CETESB) an valid operational environmental permit[117].

## D.2. Environmental impact assessment

>>
Information about the analysis of the environmental impacts for the project activity (under its previous design configuration) and related validation assessment by the DOE are presented in the latest version of the PDD valid for the currently expired 1st 7-year crediting period of the project activity (PDD version 4, dated 10/01/2013) + Validation Report for the project activity (dated 12/12/2005).

Regarding the occurred and yet to occur (planned) implementation and starting of operation of the set of internal combustion gas engines under its 3 implementation phases (as additional and additional/alternative methane destruction devices for the project activity) with starting of operations occurring in year 2016 and forecasted to occur in years 2021 and 2022 as an expansion of the previously implemented project activity), no Environmental Impact Assessment (EIA) was required by the competent environmental authority CETESB.

# SECTION E. Local stakeholder consultation

## E.1. Modalities for local stakeholder consultation

>>
Information about previously occurred solicitation of comments from local stakeholders (including received comments) and related validation assessment by the DOE are presented in the latest version of the PDD valid for the currently expired 1st 7-year crediting period of the project activity (PDD version 4, dated 10/01/2013) + Validation Report for the project activity (dated 12/12/2005).

[117] The operational environmental permit for grid-connected electricity generation infrastructure fuelled by LFG and located within the geographical limits of the UVS – Caieiras landfill (Permit no. 29000393 for the enterprise “*TERMOVERDE CAIEIRAS LTDA.”*) is included in list made available at the website of the environmental agency CESTESB and valid for enterprises/projects which were granted with an operational permit in March/2016 and for which development of EIA was not required. Information available online:

http://www.cetesb.sp.gov.br/wp-content/uploads/sites/11/2015/06/Licen%C3%A7as-Concedidas-Mar%C3%A7o-2016-3.pdf

Operational environmental permit 29000393 is also available for download at the document searching engine at the website of CETESB (http://licenciamento.cetesb.sp.gov.br/cetesb/processo_consulta.asp)

As per applicable CDM rules, no additional local CDM stakeholder consultation was required for the previously initiated implementation of the electricity generation infrastructure (for which the set of internal combustion gas engines represents major components). No additional stakeholder meeting was required by the competent local environmental authority CETESB in the context of the previously occurred environmental licencing for such electricity generation infrastructure (under its 1st implementation phase) either.

### E.2. Summary of comments received

>>
Information about solicitation of comments from local stakeholders (including received comments) and related validation assessment by the DOE are presented in the latest version of the PDD valid for the currently expired 1st 7-year crediting period of the project activity (PDD version 4, dated 10/01/2013) + Validation Report for the project activity (dated 12/12/2005).

### E.3. Consideration of comments received

>>
Information about the previously occurred solicitation and consideration of comments from local stakeholders (including received comments) and related validation assessment by the DOE are presented in the latest version of the PDD valid for the currently expired 1st 7-year crediting period of the project activity (PDD version 4, dated 10/01/2013) + Validation Report for the project activity (dated 12/12/2005).

## SECTION F. Approval and authorization

>>
The project activity has been previously granted with Letter of Acceptance (LoA) (dated 24/11/2005) by the Designated National Authority (DNA) of the host party Brazil. Copy of such LoA and related assessment details are made available at the project page at UNFCCC's CDM website and in the Validation Report for the project activity[118]. Host Country Approval from Brazil confirmed the voluntary participation of Essencis Soluções Ambientais S.A. as project participant in the CDM project activity. It is clearly stated in LoA issued by the DNA of Brazil that the project activity is considered to contribute towards Sustainable Development in Brazil. This is also assessed and reported in the Validation Report for the project activity (dated 12/12/2005).

More recently in year 2014, the Annex I country Norway also became a Party for the project activity. LoA from Annex I Party Norway was issued by the DNA of Norway on 25/09/2014. This LoA authorizes and approves Nordic Environment Finance Corporation as project participant.

[118] The project webpage at UNFCCC's CDM website (information valid for the currently expired 1st 7-year crediting period of the project activity): https://cdm.unfccc.int/Projects/DB/DNV-CUK1134509951.62/view?cp=1

# Appendix 1. Contact information of project participants

| | |
|---|---|
| **Organization name** | Essencis Soluções Ambientais S.A. |
| **Country** | Brazil |
| **Address** | Rodovia dos Bandeirantes, km 33<br>07803-970<br>Caieiras – SP<br>Brazil |
| **Telephone** | +55 11 4442 8057 |
| **Fax** | - |
| **E-mail** | eazzari@essencis.com.br |
| **Website** | www.essencis.com.br |
| **Contact person** | Mr. Eduardo Azzari |

| | |
|---|---|
| **Organization name** | Nordic Environment Finance Corporation |
| **Country** | Norway |
| **Address** | Fabianinkatu 34 – 241<br>FI-00171<br>Helsinki, Finland |
| **Telephone** | +358 10 618 0664 |
| **Fax** | +358 10 618 0664 |
| **E-mail** | helle.lindegaard@nefco.fi |
| **Website** | www.nefco.org |
| **Contact person** | Ms. Helle Lindegaard |

# Appendix 2. Affirmation regarding public funding

Not applicable. The implementation and operation of the project do not involve any kind of public funding from Parties included in Annex I.

# Appendix 3. Applicability of methodologies and standardized baselines

Information about the applicability of selected methodology is presented in Section B.2.

## Appendix 4. Further background information on ex ante calculation of emission reductions

All information about the ex-ante calculation of emission reductions are summarized in Section B.6.3. An emission reduction calculation spreadsheet includes all calculations of figures which are indicated in Section B.6.3. This spreadsheet is enclosed to this PDD.

# Appendix 5. Further background information on monitoring plan

All information about the design and operation of the monitoring plan are presented in Section B.7.1. and B.7.3.

## Appendix 6. Summary report of comments received from local stakeholders

Information about solicitation of comments from local stakeholders (including received comments) and related validation assessment by the DOE are presented in the latest version of the PDD valid for the currently expired 1st 7-year crediting period (PDD version 4, dated 10/01/2013) + Validation Report for the project activity (dated 12/12/2005).

# Appendix 7. Summary of post-registration changes

This initial version of the PDD valid for the 3rd and last 7-year crediting period of the project activity does not encompass post-registration changes.

- - - - -

**Document information**

| *Version* | *Date* | *Description* |
|---|---|---|
| 11.0 | 31 May 2019 | Revision to:<br>• Ensure consistency with version 02.0 of the "CDM project standard for project activities" (CDM-EB93-A04-STAN);<br>• Make editorial improvements. |
| 10.1 | 28 June 2017 | Revision to make editorial improvement. |
| 10.0 | 7 June 2017 | Revision to:<br>• Improve consistency with the "CDM project standard for project activities" and with the PoA-DD and CPA-DD forms;<br>• Make editorial improvement. |

| *Version* | *Date* | *Description* |
|---|---|---|
| 09.0 | 24 May 2017 | Revision to:<br>• Ensure consistency with the "CDM project standard for project activities" (CDM-EB93-A04-STAN) (version 01.0);<br>• Incorporate the "Project design document form for small-scale CDM project activities" (CDM-SSC-PDD-FORM);<br>• Make editorial improvement. |
| 08.0 | 22 July 2016 | EB 90, Annex 1<br>Revision to include provisions related to automatically additional project activities. |
| 07.0 | 15 April 2016 | Revision to ensure consistency with the "Standard: Applicability of sectoral scopes" (CDM-EB88-A04-STAN) (version 01.0). |
| 06.0 | 9 March 2015 | Revision to:<br>• Include provisions related to statement on erroneous inclusion of a CPA;<br>• Include provisions related to delayed submission of a monitoring plan;<br>• Provisions related to local stakeholder consultation;<br>• Provisions related to the Host Party;<br>• Make editorial improvement. |
| 05.0 | 25 June 2014 | Revision to:<br>• Include the Attachment: Instructions for filling out the project design document form for CDM project activities (these instructions supersede the "Guidelines for completing the project design document form" (Version 01.0));<br>• Include provisions related to standardized baselines;<br>• Add contact information on a responsible person(s)/ entity(ies) for the application of the methodology (ies) to the project activity in B.7.4 and Appendix 1;<br>• Change the reference number from F-CDM-PDD to CDM-PDD-FORM;<br>• Make editorial improvement. |
| 04.1 | 11 April 2012 | Editorial revision to change version 02 line in history box from Annex 06 to Annex 06b. |
| 04.0 | 13 March 2012 | Revision required to ensure consistency with the "Guidelines for completing the project design document form for CDM project activities" (EB 66, Annex 8). |
| 03.0 | 26 July 2006 | EB 25, Annex 15 |
| 02.0 | 14 June 2004 | EB 14, Annex 06b |
| 01.0 | 03 August 2002 | EB 05, Paragraph 12<br>Initial adoption. |

Decision Class: Regulatory
Document Type: Form
Business Function: Registration
Keywords: project activities, project design document