Project design document form
(Version 10.1)

BASIC INFORMATION	
Title of the project activity	Caieiras landfill gas emission reduction
Scale of the project activity	☒ Large-scale ☐ Small-scale
Version number of the PDD	9.0
Completion date of the PDD	20/07/2018
Project participants	Essencis Soluções Ambientais S.A. Nordic Environment Finance Corporation
Host Party	Brazil
Applied methodologies and standardized baselines	ACM0001 - “Flaring or use of landfill gas” (version 13.0.0)
Sectoral scopes linked to the applied methodologies	Sectoral Scope: 13 - Waste handling and disposal
Estimated amount of annual average GHG emission reductions	1,199,180 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].

[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 one of the post-registration permanent changes in the project design that are addressed in this revised version of the PDD. 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) is the other permanent post-registration change in the project design that is addressed in this revised version of the PDD.

While the post-registration changes encompassed by this revised version of the PDD are summarized in Appendix 7, section A.3 includes details for the destruction of methane in a set of internal combustion gas engines (since July 2016) which are regarded as additional/alternative methane destruction devices for the project activity encompassing methane destruction as its unique GHG abatement/mitigation measure.

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 includes in Box 2.c the rationale and justification for the 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).

No promotion of quantitative increase of methane destruction is expected to occur with combustion of LFG also occurring in the set of internal combustion gas engines (as additional/alternative methane destruction devices) since July/2016:

The set of internal combustion gas engines represents additional/alternative methane destruction devices for the project activity. In the absence of their installation and starting of operations as permanent change in the project design, all LFG collected by the project activity would remain be combusted in the previously installed set of 4 high temperature enclosed flares under the project scenario. As also explained and justified in Section A.3, Box 2c, the project activity (under its revised design configuration) is not expected to promote or result in any quantitative increase in terms of methane destruction either. By taking into account (i) the total combined LFG flaring capacity of the set of 4 high temperature enclosed flares previously (installed as part of the project activity), (ii) the nameplate LFG consumption range of later installed and yet to be installed internal combustion gas engines and (iii) the operational pattern of the project activity; it is demonstrated in Section A.3 that the later occurred and yet to occur gradual/phased installation of such internal combustion gas engines (as additional/alternative methane destruction devices) is not expected to promote collection and destruction of methane (as part of the operation of the project activity) in a level beyond what would be technically possible to occur in the absence of such gas engines along the project's remaining lifetime.

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 under its revised design configuration 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 the remaining share of its 2nd 7-year crediting period.

The only type of GHG mitigation action encompassed by the CDM project activity "Caieiras landfill gas emission reduction" remains being 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

[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 2nd 7-year crediting period 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. In case of occurrence of permanent change of the number of available and operational flares, this will be opportunely addressed as per applicable guidance for addressing post-registration changes in the project design. It is also relevant to note that installed flares became temporarily not under operation due to the 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 April 2016 (with the project activity operating under reduced activity level during the period) as further explained in Section A.3.

[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.

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 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 are expected to occur in year 2020);
- 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

[5] Monitoring of the operational status/conditions of the set of internal combustion gas engines that consumes 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.

[7] In May/2018, there was no horizontal LFG collection well/trench yet implemented as part of the project activity.

[8] In May/2018 there were 4 high temperature enclosed flares installed and under operation as part of the project activity. The number of operational high temperature enclosed flares may permanently or temporarily change during the 2nd 7-year renewable crediting period. 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 installed high temperature enclosed flares are included in Section A.3.

[9] As per the 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 2019 and 2020 (after the occurred commissioning and starting of operations of its 1st implementation phase occurred in July/2016 and encompassing 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 implementation schedule for the internal combustion gas engines are included in Section A.3.

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 2nd 7-year crediting period (under the project's revised design):
For the 2nd 7-year renewable crediting period, 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 passive and conventional LFG venting/combustion drains in 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 passive and conventional venting/combustion drains.

GHG emission reductions to be achieved by the project activity during the 2nd 7-year crediting period:
By promoting permanent and real destruction of methane, the project activity (under its revised design configuration) is expected to promote total combined GHG emission reductions of 7,553,194 tCO_2e during the 2nd 7-year crediting period. This value is equivalent to average annual GHG emission reductions of 1,199,180 tCO_2e/year.

Environmental and climate change positive aspects of the project activity (under its revised design configuration):
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.

[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).

[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 along the 2nd 7-year crediting period) for address safety and odor concerns is further explained in Section B.6.1 under Step A.2.

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 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[13]:

- 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:

[13] The correctness of the project's geographical coordinates were confirmed by using a portable GPS navigator during the on-site visit performed by the Designated Operational Entity (DOE) responsible for the validation assessment for the renewal of the crediting period. The reported project's geographical coordinates are slightly different than the ones previously reported in the latest version of the PDD valid for the 1st 7-year crediting period (PDD version 4, dated 10/01/2013).

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

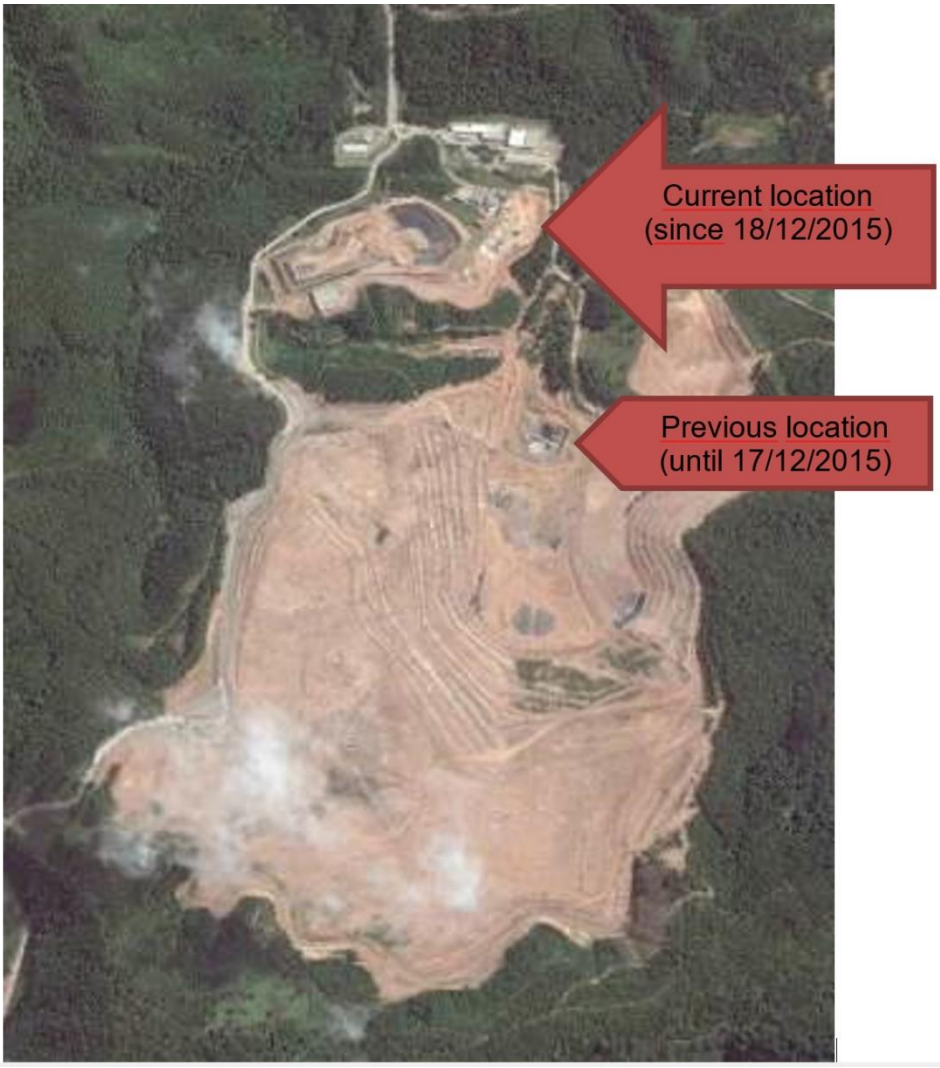

Figure 1 - Aerial view of the location of the UVS - Caieiras landfill

(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[14])

[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 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 will converted in 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))[15]

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

[15] 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 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)[16], 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[17].

  - 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[18], 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).

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[16] 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)."*

[17] 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.

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

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.

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[19].

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 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 passive and conventional LFG venting/combustion drains being used in the landfill's MSW disposal area to allow sporadic passive combustion of LFG[20] (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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[19] The 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 1st crediting period 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) under UNFCCC 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 approved by the CDM-EB on 27/05/2013.

[20] As further explained and justified in Section B.6.1 under Step A.2, 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 2nd 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 2nd 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 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[21].

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 and passive 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 the 2nd 7-year renewable 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 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 2nd 7-year renewable 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 2nd 7-year renewable crediting period of the project activity either. As required by the applied baseline and monitoring methodology ACM0001 (version 13.0.0), the occurrence or planning of any change in the management of the UVS - Caieiras landfill during the time period to be encompassed by the 2nd 7-year renewable crediting period 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 13.0.0) 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 LFG (methane destruction devices), etc.). In summary, the project technology is environmentally safe and sound.

[21] 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 2nd 7-year crediting period) are presented included in Section B.6.1 under Step A.2.

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 2nd 7-year crediting period[22]).

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 2nd 7-year renewable crediting period when compared to the currently existing project's configuration[23].
While the project's LFG collection and flaring infrastructure started its continuous operations (as part of its 1st crediting period) in February/2007[24], thus the remaining operational lifetime for related equipment potentially exceeds 10 years in May/2018.

While ACM0001 (version 13.0.0) requires ex-post monitoring whether equipment combusting LFG operates under compliance with operational requirements and/or recommendations as set by

[22] Continuous monitoring of the flare status with every minute recording of the status signal of flame detectors in each individual flare represents a later implemented monitoring improvement in order to make the project's monitoring system under compliance with monitoring requirements of ACM0001 (version 13.0.0) and applicable methodological tools. Other improvements of the project's monitoring infrastructure also occurred in order to fully meet the monitoring requirements of ACM0001 (version 13.0.0) and applicable methodological tools. Such requirements are outlined in Section B.7.

[23] 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 the 2nd 7-year crediting period (e.g. additional high temperature flare(s), additional centrifugal blowers, etc.).

[24] 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

equipment manufacturer, the main operational characteristics and specifications of high temperature enclosed flares[25] [26] are defined as follows:

[25] 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 13.0.0) 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 2nd 7-year crediting period. 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 13.0.0) and applicable methodological tools.

[26] The project participant Essencis Soluções Ambientais S.A. acknowledges that additional high temperature enclosed flares may be installed during the 2nd 7-year crediting period 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). 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 13 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.

LFG combustion flaring equipment	Characteristics/specifications
Flare 1 Flare 2 Flare 3[27]	Manufacturer: BTS - Termodinâmica de Sistemas Ltda. Model: n/a Order Number: 10.196/05 (Flare 1), 10.287/08 (Flare 2), 10.408/11 (Flare 3) Serial Number (S/N): n/a High: 16,000 mm Diameter: 3,500 mm Number of injectors: 5 (with new re-designed injectors being installed on 08/06/2015) Min. LFG flaring capacity (for continuous operation): 650 Nm^3/h Max. LFG flaring capacity (for continuous operation): <u>*Flare 2 and Flare 3:*</u> - 6,500 Nm^3/h (up to 08/06/2015 08:59 AM, with previously installed LFG injectors) - 7,500 Nm^3/h (since 08/06/2015 09:00 AM, after installation of new and larger LFG injectors)[28] - <u>*Flare 1:*</u> - 6,500 Nm^3/h (up to 08/06/2015 01:59 PM, with previously installed LFG injectors) - 7,500 Nm^3/h (since 08/06/2015 02:00 PM, after installation of new and larger LFG injectors Min. CH_4 destruction efficiency: 99.5% Required min. temperature of the exhaust gas of the flare (to ensure LFG destruction under high CH_4 destruction efficiency): 500 ^oC Required max. temperature of the exhaust gas of the flare (to ensure LFG destruction under high CH_4 destruction efficiency): 1,200 ^oC Required frequency for inspection service (incl. inspection in the conditions of the flare's isolation ceramics revetment material): every 6 months

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

[28] 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).

	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. Model: n/a Order Number: S 10.041/00 Serial Number (S/N): n/a High: 15,000 mm Diameter: 3,400 mm Number of injectors: 5 (with new re-designed injectors being installed on 08/06/2015) Min. LFG flaring capacity (for continuous operation): 650 Nm^3/h Max. LFG flaring capacity (for continuous operation): - 6,500 Nm^3/h (up to 08/06/2015 01:59 PM, with previously installed LFG injectors) - 7,500 Nm^3/h (since 08/06/2015 02:00 PM, after installation of new and larger LFG injectors Min. CH_4 destruction efficiency: 99.5% Required min. temperature of the exhaust gas of the flare (to ensure LFG destruction under high CH_4 destruction efficiency): 500 ^oC Required max. temperature of the exhaust gas of the flare (to ensure LFG destruction under high CH_4 destruction efficiency): 1,200 ^oC Required frequency for inspection service (incl. inspection in the conditions of the flare's isolation ceramics revetment material): every 6 months 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) [29].

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)[30]). 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.

[29] 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.

[30] 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.

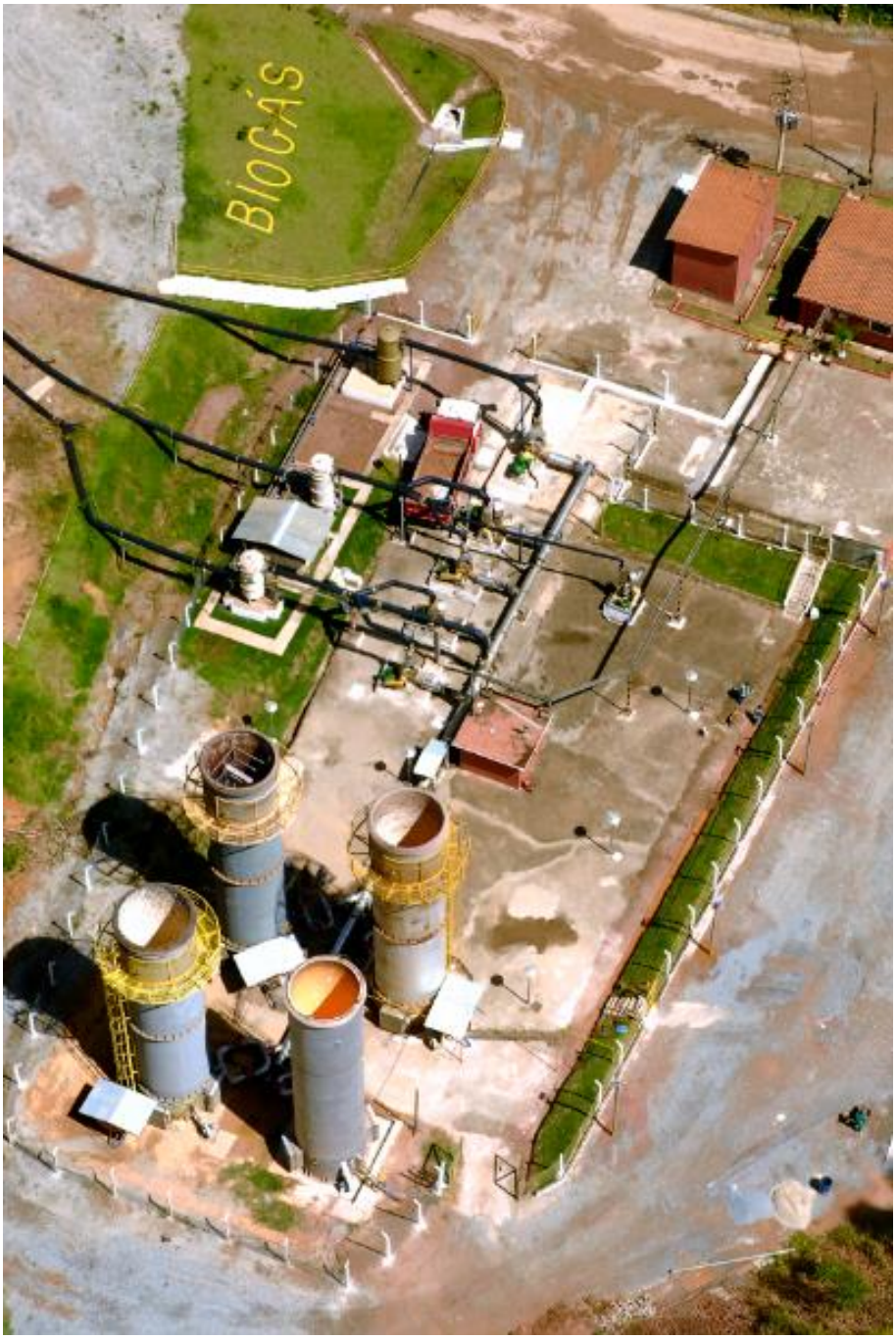

Figure 4 – View of the project's LFG flaring infrastructure currently equipped with 4 high temperature enclosed flares in its previous location (under operation until 17/12/2015)

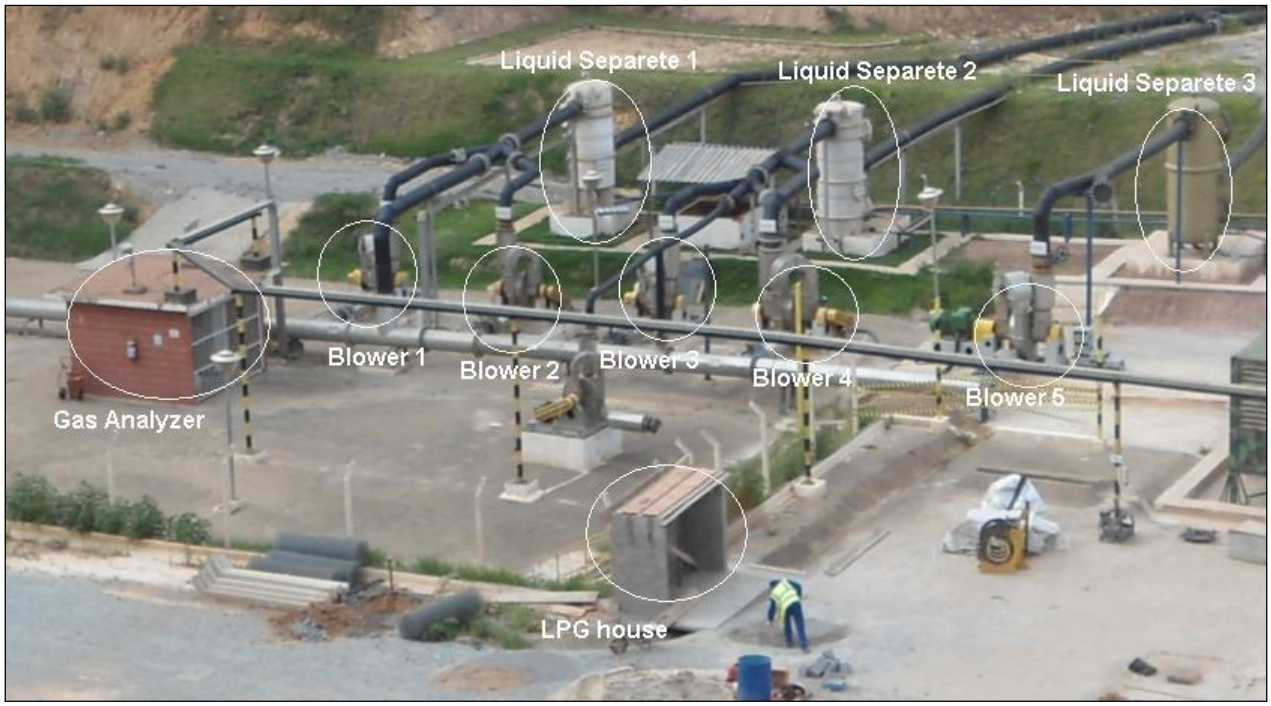

Figure 5 – Partial view of the project's LFG flaring infrastructure in its previous location (under operation until 17/12/2015)
(view of the main LFG pipeline, location of the CH_4 content gas analyzer unit (marked as "*Gas Analyzer*", centrifugal blowers (marked as "*Blower 1*", …, "*Blower 5*"), liquid 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)[31]

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/April/2016 (with the project activity operating under reduced activity level during the period)

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, 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.

[31] 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.

This decision was in line with the previously conceived and approved operational plan for the landfill[32]. 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)).

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)

[32] 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 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.).

After occurred disassembly 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 remaining share of 2nd 7-year crediting period for the project activity 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):

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 on 08/06/2015. 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[33]. 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 is acknowledged as not promoting any adverse impact over the previously assessed and demonstrated additionality of the project activity either. The change does not adversely affects the application of the CDM baseline and monitoring methodology ACM0001 (version 13.0.0) + applicable methodological tools either. Finally, the previously defined scale of the project activity (registered as large-scale project activity) is not adversely impacted either.

[33] This change was previously successfully addressed as a permanent change in the project design.

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

During the period from July/2016 to July/2017, 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.).

By May/2018, about 80 units of collecting well of the whole project's LFG collection infrastructure had their damaged, worn and/or not anymore functional top manifolds replaced by the new units with improved design &construction. Further manifold replacement work is planned to be eventually performed for the remaining project's LFG collection wells at the UVS - Caieiras landfill along the remaining share of the 2nd 7-year crediting period.

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.

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).

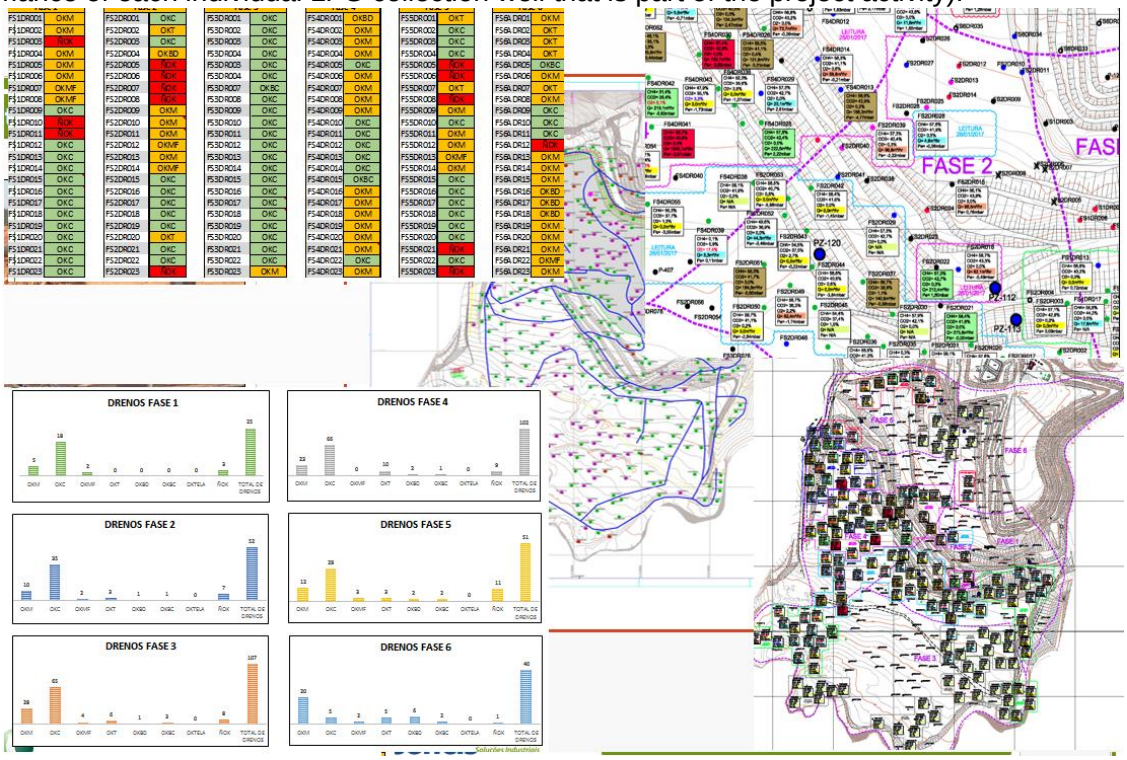

Figure 11 - Use of better designed electronic format mapping for all LFG wells of the project activity (with more frequent and more detailed/reliable data recording and updating of the operational status/performance of each individual LFG collection well).

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.

Destruction of methane in a set of internal combustion gas engines (since July 2016):

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].

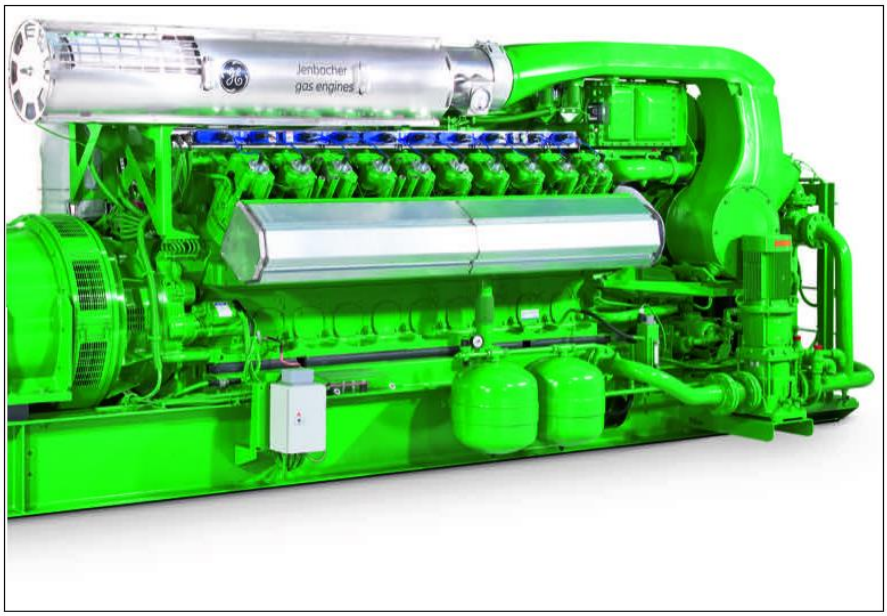

Figure 12: View of the internal combustion gas engine (regarded as additional/alternative methane destruction devices for the project activity). This engine is the major component of each one of the type 4, G-420 series engine-generator set manufactured by GE Jenbacher GmbH & Co OHG

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 13.0.0) 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.

[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.

[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

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 2020, 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 represents 27 additional/alternative methane destruction devices operating as part of the project activity by year 2020.

In May/2018, 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.

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.

Upon the forecasted conclusion of implementation phases 2 and 3 of the grid-connected electricity generation infrastructure by years 2019 and 2020 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 2019
- 2 additional and identical engine-generator sets are expected to be under operation in year 2020).

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 2019 and 2020 (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 May/2018)

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	2019	4 (addition of 5.6 MW of installed capacity)	35.0 MW
Phase 3	2020	2 (addition of 2.8 MW of installed capacity)	37.8 MW

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.

Box 2c – Rationale for non-inclusion of electricity generation as additional GHG abatement 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)

As part of the operation of the project activity under its revised design configuration, the project activity does not encompass electricity generation as an additional GHG abatement measure and it thus remains having methane destruction as its unique GHG abatement measure. Therefore, no emission reductions associated to generation of electricity using collected LFG as renewable energy source will be accounted and/or claimed by project activity. Furthermore, as explained and justified below, the project activity under its current design configuration is not expected to encompass any quantitative increase in terms of methane destruction either.

Rationale for the non-inclusion of electricity generation (from renewable energy source) as additional measure for the project activity:

The decision of non-including electricity generation using LFG (as renewable energy source) as an additional GHG abatement measure for the project activity is due to the following reasons/aspects[37]:

- As further explained in the Section A.3, both the timeline for the conclusion of the implementation of Phase 1 for of the grid-connected electricity generation infrastructure located within the geographical limits of the UVS – Caieiras landfill and the forecasted time plan for implementation of its Phases 2 and 3 clearly denote an existent time horizon of about 9.5 years between (i) the time when the project activity (under its initial design configuration) was commissioned and started operating (February/2007) to (ii) the more recently occurred time of starting of operations of such power generation source under its phase 1 (July/2016). Furthermore, a time horizons of more than 12 and 13 years are valid when implementation phases 2 and 3 of the power generation infrastructure are considered respectively.

  In this context, by acknowledging that both the initial design conceptualization and CDM consideration for the project activity (occurred within years 2004/2005) indeed occurred more than 10 years prior of the implementation of Phase 1 of the electricity generation infrastructure, it is assumed that occurred and yet to occur capital expenditures and decision-making processes for the implementation of such power generation source using LFG as renewable energy source are not related to such previously occurred CDM consideration[38]. In summary, in the particular case of the project activity, generation of electricity using LFG as gaseous fuel represents an initiative that for which related infrastructure implementation + related decision-making process did not previously occur at the time of the occurred project's initial design conceptualization and CDM consideration (within years 2004 and 2005).

- Non-accounting of CO_2 emission reductions due to generation of electricity in the grid-connected electricity generation infrastructure (for which the set of internal combustion gas engines represents the major components) as an additional GHG abatement measure GHG abatement measure promoting is also in line and under conformance with item (d) of the Ruling note

[37] From a methodological perspective, once regarded as part of project activity, the whole grid-connected electricity generation infrastructure located within the geographical limits of the UVS – Caieiras landfill would generate electricity that, under a emission reduction methodological perspective, would displace equivalent amount of electricity that would otherwise be generated in existent grid-connected electricity generation facilities (including fossil fuel fired electricity generation facilities) (and addition of new power generation units) within the National Electricity Grid of Brazil in its absence, thus promoting permanent and real CO_2 emission reductions. This is established and under conformance with applied baseline and monitoring methodology ACM0001 (version 13.0.0). In fact, as further analysed in Section B.5, currently (May/2018), as per available UNFCCC CDM records, there were 56 initiatives registered/under validation as CDM project activities and 1 initiative registered as a Programme of Activities (PoA) that promote LFG collection, destruction and/or utilization in the host-country Brazil. Among all those 56 LFG collection and destruction/utilization registered CDM project activities, 29 of them includes utilization of LFG as gaseous fuel for electricity generation.

[38] 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)."*

"Rationale for rejection of PRC-0171-004" (CDM-PA0171-RULE01)[39]. The Ruling note CDM-PA0171-RULE01 was recently issued by the CDM-EB on 01/03/2018 as an outcome of the rejection by the CDM-EB of a previously submitted request of approval of post-registration changes for the project activity in September/2017 (incl. the occurred and yet to occur implementation of the electricity generation infrastructure in question as a permanent change in project design that represented addition of new GHG abatement measure). This particular Ruling note establishes the following in its item (d):

> *"The PP/DOE may wish to submit a post registration change to reflect the actual implementation of the project activity and continue claiming CERs from the landfill gas (LFG) capture and destruction (…)"*

By following the content of the above-quoted text from the ruling note CDM-PA0171-RULE01, destruction of methane through combustion of LFG in both the set of the high temperature enclosed flares and the set of internal combustion gas engines (with gradual/phased implementation schedule), (with both sets being regarded as methane destruction devices for the project activity) is thus regarded as being the only measure encompassed by the project activity. In this context, the set of internal combustion gas engines represents additional/alternative methane destruction devices which are added as part of the project activity as a permanent change in its design. Such permanent change in the design of the project activity does not represent any extension/addition of GHG measures and/or technologies[40].

[39] The Ruling note "Rationale for rejection of PRC-0171-004" (CDM-PA0171-RULE01) is available online: https://cdm.unfccc.int/filestorage/e/x/t/extfile-20180305165234555-postreg_rule19.pdf/postreg_rule19.pdf?t=QXZ8cDh6N2tqfDB9edaTjbTW6wqRFMp0liYX

A phone call was conducted with members of the Secretariat by representative of Essencis Soluções Ambientais S.A. on 27/03/2018 in order to have clarifications on the ruling CDM-PA0171-RULE01 being provided by the CDM Secretariat as per applicable CDM rules. During the phone call, the members of the CDM Secretariat clarified and confirmed that the project participants and the validating DOE could submit a revised PDD and a Validation Opinion Report requesting approval of post-registration changes by claiming methane destruction through combustion of collected LFG in both the set of flares and set of internal combustion gas engines as part of the project activity as its unique GHG abatement measure.

[40] The CDM definition of measure and technology are summarized below:

"Measure (for emission reduction activities): Measure is a broad class of greenhouse gas (GHG) emission reduction activities that possess common features. A project activity can include single or multiple measures. The reason to divide the project activity into multiple measures is that the baseline for the output generated by measure may change depending upon the measures. Four types of measures are currently covered in the guidelines:

- *(i) Fuel and/or feedstock switch (example: switch from naphtha to natural gas, or switch from limestone to gypsum in cement clinker production);*
- *(ii) Switch of technology with or without change of energy source (example: energy efficiency improvements, power generation based on renewable energy);*
- *(iii) GHG destruction (example: landfill gas flaring, incineration of HFC23 gas vented from HCFC22 production unit);*
- *(iv) GHG formation avoidance (example: use of biomass that would have been left to decay in a solid waste disposal site resulting in the formation and emission of methane, for energy generation.*

Technology: equipment or conversion process used for the production of goods or provision of services. Two different project activities/CPAs are considered to be using the same technology(ies) if they:

- *(i) Provide the same kind of output and use the same kind of equipment and conversion process; or*
- *(ii) Undertake the same course of action that results in the same kind of effect (e.g. two projects using the same management practice such as fuel switching); (…)"*

In the context of definition of technology, the following definition of output is relevant (with destruction of methane *per se* not being assumed as representing a good or a service).

"Output: goods or services with comparable quality, properties, and application areas (e.g. clinker, lighting, residential cooking, waste disposal, steam produced, electricity produced)."

- In the particular context of the only GHG abatement measure encompassed by the project activity (methane destruction), the destruction of a measured amount of this powerful GHG through combustion of LFG in a set of high temperature enclosed flares and/or through combustion of LFG in a set of internal combustion gas engines (with both process being performed under efficient and controlled conditions) promote comparable/identical effects in terms of mitigation of GHG emissions. It is also relevant to note that, as explained below, no quantitative increase of methane destruction is expected to occur with combustion of LFG also occurring in the set of internal combustion gas engines (as additional/alternative methane destruction devices) since July/2016.

By taking into account the above-summarized aspects, non-accounting and non-claiming of related CO_2 emissions associated with generation of electricity by the infrastructure (for which the set of internal combustion gas engines represents major components) and remain considering methane destruction (due to combustion of collected LFG in the project's methane destruction devices) as the unique GHG abatement measure for the project activity are under conformance with applicable CDM rules and principles applicable for post-registration changes in the design of CDM project activities [41].

By encompassing methane destruction occurring through combustion of collected LFG under efficient and controlled manner in both the project's high temperature enclosed flares and in the set of internal combustion gas engines, the project activity remains representing one of the largest CDM project activity promoting methane destruction ever implemented in South America and one of the largest project activities under such category ever implemented worldwide.

Non-claiming 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) through submission of a new project activity under the CDM (or under any other voluntary project based GHG mitigation standard/scheme):

It is relevant to note that the following is also indicated in item (e) of Ruling note CDM-PA0171-RULE01 regarding potential CO_2 emission reduction due to generation of electricity by grid-connected electricity generation infrastructure (for which the set of internal combustion gas engines represents the major components):

> *"The PP/DOE may also wish to submit a new project activity covering the power generation based on the captured LFG in accordance with corresponding procedures and standards."*

The host country project participant and project owner Essencis Soluções Ambientais S.A. has decided NOT SUBMITTING under the CDM (or even under any other voluntary project based GHG mitigation standard/scheme) a new project activity covering electricity generation that would claim/account CO_2 emission reductions due to generation of electricity using LFG as renewable energy source in a grid-connected new electricity generation facility.

[41] In May/2018 there was still no definitive CDM rules and procedures for addressing post-registration changes encompassing addition of new technologies/measures contributing to emissions reductions. However, it is relevant to note that the CDM-EB considered a concept note on changes in CDM project activity, PoAs or CPAs to be allowed as post-registration changes on its ninety-ninth meeting (EB99) with new rules being agreed. The EB99 meeting was held on 23/04/2018 to 26/04/2018. Such agreed rules applicable for permanent changes in project design encompassing increase of capacity and extension of measure/technology are yet to be included in the regulatory documents CDM Project Standard for Project Activities (CDM-PS-PA), CDM Validation and Verification Standard for Project Activities (CDM-VVS-PA) and CDM Project Cycle Procedure for Project Activities (PCP-PA). The CDM-EB has agreed the following in its EB99 meeting that,

> "(…) *in deciding the effective date of these new rules, sufficient time should be given to stakeholders to minimize adverse impacts on existing or planned post-registration changes."*

The EB99 meeting report is available online:

https://cdm.unfccc.int/filestorage/E/2/N/E2N1V4TWIYAG8HK5ZXBMRSP3Q9DF70/eb99_meeting_report.pdf?t=M2l8cDh6NmYxfDAgkGncYaetQFyg-mtr4SAM

The Concept note Changes in the CDM project activity, PoA or CPA to be allowed as post-registration changes (jointly completed by CDM Meth Panel and CDM Secretariat) is also available online:

https://cdm.unfccc.int/filestorage/O/R/Q/ORQFNC96DAW8TEK1YJS70V3MXHBG5L/eb96_propan03.pdf?t=T3d8cDh6N3o5fDChvGi3SU5QsgjevU0k9wyg

Combustion of LFG also occurring in the set of internal combustion gas engines (as additional/alternative methane destruction devices) since July/2016 will not result in quantitative increase of methane destruction by the project activity.

No quantitative increase in terms of methane destruction is promoted with combustion of LFG also occurring in the set of internal combustion gas engines (additional/alternative methane destruction devices for the project activity). By taking into account (i) the total combined LFG flaring capacity of the set of 4 high temperature enclosed flares currently installed as part of the project activity, (ii) the nameplate LFG consumption range of later installed and yet to be installed internal combustion gas engines and (iii) the operational aspects for the project activity; it is demonstrable that the installation of such gas engines as additional/alternative methane destruction devices is not expected to promote or result, as part of the operation of the project activity under its revised design configuration, collection and destruction of methane beyond the level that would otherwise be technically possible to occur in the absence of such engines.

Since July/2016, methane destruction through combustion of LFG has occurred, as a priority, in the installed set of internal combustion gas engines, with excess of LFG (amount of collected LFG exceeding the consumption of the set of gas engines) being sent for combustion in the set of high temperature enclosed flares. The project's flares are also expected to be used as backup control devices, thus limiting direct LFG emissions in the atmosphere at the UVS – Caieiras landfill whenever the internal combustion gas engines are off-line. Under events of temporary planned or unplanned interruption of operation of such engines, part of or all collected LFG may be sent for combustion in the high temperature enclosed flares. Even with all gas engines under regular operation, the stream of amount of excess LFG being sent to the flares may increase as a response to unexpected and quick quantitative variations in LFG generation at the landfill site.

In summary, under normal and typical operational conditions for the project activity (under its revised design configuration since July/2016), the largest share of LFG collected has being combusted in the set of internal combustion gas engines and the operation of the project activity is expected to be as such until the end of its 2nd 7-year crediting period.

It is relevant to note that while the currently installed set of 4 high temperature enclosed flares have total combined LFG flaring capacity of 30,000 Nm^3/h (4 flares with individual nominal LFG flaring capacity of 7,500 Nm^3/h (LFG with 50% share of CH_4)), the yet to be completely installed set of 27 internal combustion gas engines (no. of engines in which LFG will be also combusted under conclusion of implementation phase 3 of the power generation infrastructure) has an estimated total combined LFG consumption range of 16,200 Nm^3/h (by taking into account declared fuel consumption of about 600 Nm^3/h of LFG (LFG with 50% share of CH_4) for each installed / to be installed gas engine[42]).
Therefore, the estimated total and final combined LFG consumption for the set of internal combustion gas engines (under the last implementation phases of the grid-connected electricity generation infrastructure) represents about 50% less than the total combined LFG flaring capacity of the previously installed project's flares[43].

It is also crucial to note that in the absence of the more recently installed set of internal combustion gas engines, all collected LFG would remain being sent to combustion in currently installed 4 high temperature enclosed flares as part of the operation of the project activity. In the absence of such gas engines, the project participant Essencis Soluções Ambientais S.A. would remain having a strong incentive/driver and a commitment to keep on promoting, as much as possible, LFG combustion in the set of installed high temperature enclosed flares in order to sufficiently meet its CER delivery scheduled established with the project's current Annex I party since year 2014[44].

[42] GE Jenbacher GmbH & Co OHG as the manufacturer of the internal combustion gas engines which are part of the Type 4, G-420 series engine-generator set declares a typical average LFG consumption for each set of about 600 Nm^3/h of LFG (LFG with 50% share of CH_4) under full load factor. Information available online:
http://north-tec-shop.de/media/pdf/jms_420_gs_bl_b28.pdf

[43] Section A.3 includes under "*Destruction of methane in LFG flaring infrastructure*" specification details for the 4 high temperature enclosed flares currently installed as part of the project activity.

[44] In year 2014 the project activity was selected by the Norwegian Carbon Procurement Facility (NorCaP) from the Nordic Environment Finance Corporation (NEFCO) as one of the CDM project activities with guaranteed purchase of generated CERs until year 2020. Further details are available online:

https://www.nefco.org/sites/nefco.org/files/pdf-files/nefco-cff-2014_screen_spread.pdf

In summary, with collected LFG being also combusted in the set of internal combustion gas engines (that represents additional/alternative methane destruction devices for the project activity) and with electricity generation using LFG (as renewable energy source) not being included as additional measure for the project activity, the only type of GHG mitigation action (measure) encompassed by the CDM project activity "Caieiras landfill gas emission reduction" remains being methane destruction. No emission reductions due to displacement of a more-GHG-intensive service (i.e. CO_2 emission reductions due to generation of electricity using collected LFG as fuel) are thus eligible and/or claimable for the project activity. This is under full conformance with CDM rules, procedures and principles and also under conformance with item (d) of the Ruling note "Rationale for rejection of PRC-0171-004" (CDM-PA0171-RULE01).

Consumption by the project activity of 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:

While no emission reductions due to displacement of a more-GHG-intensive service (due to generation of electricity using collected LFG as fuel) are eligible and/or claimable for the project activity, for sake of conservativeness and integrity, any 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 (for which the set of internal combustion gas engines represents the major components) will always be regarded and accounted as consumption of grid-sourced electricity (with related project emissions being determined ex-post accordingly)[45].

The Emission Reduction Purchase Agreement (ERPA) signed between NEFCO and Essencis Soluções Ambientais S.A. and valid until year 2020 includes a limit in the amount of CERs to be delivered as result of operation of the project activity. Moreover, such ERPA also defines as obligation to Essencis Soluções Ambientais S.A. not deliver or commercialize CERs to any other party. Therefore, in the particular context of the signed ERPA, at least until year 2020, there is no driver or incentive for the project participant Essencis Soluções Ambientais S.A. and/or any other party to have the project activity generating CERs beyond the level that would be generated under the project previous design configuration: methane destruction occurring only in the set of 4 installed high temperature enclosed flares.

[45] 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, since leakage emissions are not applicable as part of ACM0001 (version 13.0.0), such emissions are thus neglected. Furthermore, while Essencis Soluções Ambientais S.A. has decided NOT SUBMITTING under the CDM or under any GHG offset standard/scheme a new project activity covering electricity generation that would generated CO_2 emission reductions due to generation of electricity using LFG as renewable energy source in a grid-connected new electricity generation infrastructure/facility, there is no risk of any improper/unfair net-accounting of GHG emissions.

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):

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). Right in the beginning of year 2014, Essencis Soluções Ambientais S.A. and the company Solvi Valorização Energética (SVE)[46] 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: - 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). - 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.). - 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)). - Reduction in the previously existent policy, technical requirements and market uncertainties within the Brazilian power market.

[46] 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.

	- Overall historical slight improvement in macroeconomic conditions in Brazil It is relevant to note that in year 2014, the project activity was already registered under its 2nd 7-year crediting period[47].
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. On 13/01/2015, an Engineering, Procurement and Commission (EPC) agreement was established/signed between the incorporated/registered company "Termoverde Caieiras Ltda."[48] 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. 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. The establishment of such agreement was occurred in the context of the project activity 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 : Civil construction: - Foundations for the plant control house and foundations for the 21 engine-generator sets: from Feb./2015 to Oct./2015

[47] Since at the time of the 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 the occurred renewal of the 7-year crediting period of the project activity does not include any reference to such electricity generation infrastructure.

[48] 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.

	- Construction of the power substation (incl. firefighting equipment): from Jun./2009 to Sep./2010 Electrical and power control system: - Installation of the 21 engine-generator sets + ancillary and control system (without testing/commissioning): from Jul./2015 to Oct./2015 Power substation: - Construction of power station: from Oct./2015 to Jun./2016 Testing and commissioning for the whole infrastructure: from Jun./2016 to early Jul./2016. 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. 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[49]. As outlined in an official communication issued by the Brazil's national grid operator is termed *Operador Nacional do Sistema* (ONS) [50] 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. As published in the Diário Oficial da União (DOU) of 15/07/2016 (Section 1)[51], 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.

[49] 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).

[50] 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.

[51] 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. 08/07/2016: Starting of operations of the set of internal combustion gas engines[52]. 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). *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):* 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: - 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). 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 will represent increment in its total combined installed capacity of 5.6 MW and 2.8 MW respectively) are currently expected to occur in years 2019 and 2020 respectively.

[52] 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. Copy of this Commissioning Report was made available to the DOE in charge of the validation of this revised version of the PDD.

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 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) (440 V voltage, 60 Hz frequency)
Main components	Diesel engine: Scania DC1649A Generator: WEG GTA 312AI45 B35T 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[53], 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.)[54].

[53] 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

[54] 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.

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.

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:

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[55]

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:

[55] Although the occurred pilot tests/evaluation of a portable electricity generation facility fuelled by collected LFG occurred within the 1st crediting period, Box 3 is added in the PDD valid for the 2nd 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 1st crediting period.

- 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)

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 May/2018, almost 9 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 May/2018 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 May/2018, 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 renewable 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 2nd 7-year crediting period 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 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)[56].

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

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

A.6. History of project activity

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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 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

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Not applicable.

[56] 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.

SECTION B. Application of selected methodologies and standardized baselines

B.1. Reference 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 13.0.0)
  (http://cdm.unfccc.int/methodologies/DB/EYUD9R1ZAUZ2XNZXD3HQH18OK3VWIV);

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);

- Tool to calculate baseline, project and/or leakage emissions from electricity consumption (version 1)
  (http://cdm.unfccc.int/Reference/tools/ls/meth_tool05_v01.pdf);

- Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion (version 02)
  (https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-03-v2.pdf)

- Project emissions from flaring (version 02.0.0)
  (http://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-06-v2.0.pdf);

- Tool to determine the mass flow of a greenhouse gas in a gaseous stream (version 02.0.0)
  (http://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-08-v2.0.0.pdf);

- Tool to calculate the emission factor for an electricity system (version 04.0)
  (http://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-07-v3.0.0.pdf);

- Combined tool to identify the baseline scenario and demonstrate additionality (version 06.0)
  (https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-02-v6.0.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).

- "Common practice" (version 03.1)
  (http://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-24-v1.pdf)

B.2. Applicability of methodologies and standardized baselines

>>
The approved baseline and monitoring methodology ACM0001 (version 13.0.0) 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[57]. Demonstration applicability conditions for ACM0001 (version 13.0.0) and all methodological tools referred in Section B.1 are included in the tables below:

[57] The gradual/phased implementation of set of internal combustion gas engines (as alternative methane destruction devices for the project activity) + installation of backup captive off-grid electricity generator (fuelled by diesel) as a permanent post-registration changes in the project design does not require the previously applied CDM baseline and monitoring methodology (ACM0001 (version 13.0.0)) + applicable methodological tools to be changed/updated.

Applicability Condition of CDM baseline and monitoring methodology ACM0001 – "Flaring or use of landfill gas" (version 13.0.0)	Justification
"*This methodology is applicable to project activities which:* *(a) Install a new LFG capture system in a new or existing SWDS; or* *(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:* *(i) The captured LFG was only vented or flared and not used prior to the implementation of the project activity; and* *(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 flared is available.* *(c) Flare the LFG and/or use the captured LFG in any (combination) of the following ways:* *(i) Generating electricity;* *(ii) Generating heat in a boiler, air heater or kiln (brick firing only); and/or glass melting furnace; and or* *(iii) Supplying the LFG to consumers through a natural gas distribution network.*	As per the CDM project standard for project activities (CDM-PS-PA), in the context of the previously occurred renewal of crediting period for a previously registered CDM project activity, the PDD valid for the additional new and 2nd 7-year crediting period was completed by applying the latest version of the CDM baseline and monitoring methodology at that time. The project activity was previously registered as a CDM project activity by applying the CDM baseline and monitoring methodology ACM0001 (version 2). While at the time the previous version of the registered PDD valid for the 2nd 7-year renewable crediting period of the project activity was completed, ACM0001 (version 13.0.0) was the latest valid version of ACM0001 baseline and monitoring methodology, it was thus the one to be applied in the context of the occurred renewal of crediting period for the registered CDM project activity. Furthermore, while the post-registration changes in the project design (e.g. combustion of LFG (destruction of methane) also occurring in a set of internal combustion gas engines + installation of backup captive off-grid electricity generator fuelled by diesel) do not require the application of a more recent version of ACM0001 or even other CDM baseline and monitoring methodology, ACM0001 (version 13.0.0) thus remains being applicable for the project activity. 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 passive LFG combustion system (using conventional passive LFG venting/combustion drains)[58]. The project was implemented in year 2007. In this sense, condition (b – i) of the quoted applicability criteria is met[59].

[58] 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 13.0.0), it is assumed that condition (a) is not applicable and condition (b – i) is applicable.

[59] As part of the expected implementation and operation of the project activity during the 2nd 7-year renewable 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 in the last years of the 1st 7-year crediting period. During the last years of the 1st 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 possible to

Applicability Condition of CDM baseline and monitoring methodology ACM0001 – "Flaring or use of landfill gas" (version 13.0.0)	Justification
(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). The project design encompasses collection of LFG (which is collected as part of the operation of the project activity [60]) 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 (under its revised configuration) does not encompass any other type of utilization of collected LFG. Thus, the project activity fully fulfills condition (c). As a result of the previously occurred implementation of the project activity (under the previously conceived project design), 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). While the 7-year crediting period for the project activity was successfully renewed in

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). For the 2nd 7-year crediting period, as required by ACM0001 (version 13.0.0) and applicable methodological tools, further capital investment in additional monitoring equipment and procedures were made in order to upgrade the project's currently existent LFG capture system (equipment and monitoring practice) for meeting the additional monitoring requirements of ACM0001 (version 13.0.0) (which are not requirements as per the previously applied monitoring methodology ACM0001 (version 2)). Such occurred capital investments in monitoring equipment and procedures did not aim to increase the recovery rate of LFG or change the destination of the captured LFG as part of the project design. Such occurred capital investments in additional monitoring instruments and monitoring procedures were required to meet monitoring requirements of ACM0001 (version 13.0.0) and applicable methodological tools.

[60] 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, some conventional passive LFG venting/combustion drains are still being 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 May/2018, there were about 90 conventional 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 e 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 13.0.0)	Justification
	December/2013, this situation is expected to remain the same during the remaining share of the 2nd 7-year crediting period (with the project activity under its revised design configuration). 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, the implementation and operation of the project activity per se are not expected to promote any quantitative change in waste disposal activities undertaken at the UVS - Caieiras landfill. Furthermore, no quantitative or qualitative changes in terms of waste management practices are expected to occur 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 the 2nd 7-year crediting period. Thus, the mere previously occurred implementation of the project and its continuous operation during the 2nd 7-year crediting period (under both the previous and revised design configurations) 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 (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)). 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 environmental permits for the construction and operation of this landfill), the UVS - Caieiras landfill is not expected to include any activity or initiative promoting recycling or utilization of organic fraction of waste to be disposed in this landfill (such as implementation of a large scale waste sorting or waste composting facility for example). Without any organic waste recycling activity being under operation within the limits of the UVS - Caieiras landfill, it is thus clearly not expected that the implementation of the project activity could eventually reduce organic waste recycling activities in the UVS - Caieiras landfill. The design, construction and operational aspects for the UVS - Caieiras landfill were 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

Applicability Condition of CDM baseline and monitoring methodology ACM0001 – "Flaring or use of landfill gas" (version 13.0.0)	Justification
	of operator and owner of the UVS - Caieiras landfill and regional waste management company (service provider) providing MSW disposal services for municipalities located within the Metropolitan Region of São Paulo. Furthermore, it is also crucial to take into account that 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. In this sense, the implementation and operation of the project activity thus 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 absence of the project activity at the UVS - Caieiras landfill or in the region of influence of this landfill[61]. The same is actually also applicable for recycling of inert waste material.

[61] As per the Brazilian Federal Law 12.305/10, 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 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, solid waste recycling initiatives in Brazil are still being quite limited (especially in the case of organic fraction of MSW). As outlined in the publication "*Panorama dos Resíduos Sólidos no Brasil – 2014*" (tittle translated into English language as "*Outlook of Solid Waste Sector in Brazil – year 2014"* and available online at:
http://www.abrelpe.org.br/panorama_apresentacao.cfm), 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 represents one of the most credible annual outlook and statistics source for the solid waste management in Brazil. The most recent Greenhouse Gases Emissions National Inventory (published by the Brazilian Ministry of Science, Technology, Innovation and Communications (MCTIC) in 2010 and available online at: http://sirene.mcti.gov.br/documents/1686653/1706429/228953.pdf/8e299655-2df1-4a34-84f6-59ae4d887c2f) 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 was implemented).

In year 2012 the Brazilian Ministry of City Infrastructure (through its National Secretary of Sanitation) has published the year 2010 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 – 2010*" (tittle translated into English language as "*Diagnostics of Urban Solid Waste Management - 2010*" and available online at: http://www.snis.gov.br/PaginaCarrega.php?EWRErterterTERTer=93). Like the Report "*Panorama dos Resíduos Sólidos no Brasil – 2014*", 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 (city of São Paulo and surrounding cities), all solid waste materials (organic or inert) to be eventually/potentially recycled are normally previously sorted 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 landfill or dump site) 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 sorted pulp/paper/cardboard waste materials has been considered as recyclable material (as per both available statistics and available recycling practices). Besides some particular inert waste materials with commercial value (e.g. aluminum, clean plastic material and glass), no other waste materials have been collected in order to be recycled in the region where the project activity is implemented or transported to be recycled in other region. This has also been the common 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 landfill would be expected to be collected and directed to any type of recycling facility (e.g. composting facility) after or prior its disposal in the landfill site. In fact, as established by related construction and design documents for the UVS - Caieiras landfill and also established in the Environmental Impact Assessment (EIA) previously developed for this landfill site, no waste pickers or waste sorting teams have 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 in the area either. This situation is not expected to change during the time period to be encompassed by the 2nd 7-year crediting period either.

That confirms that no relevant sorting and collection of recyclable organic material from MSW already disposed in the landfill are expected to occur regardless of the implementation of the project activity (under both baseline and project scenarios). Thus, recycling or alternative use from organic fraction of waste already disposed in the landfill are not expected to occur either (regardless of the implementation of the project activity).

Based on information and data included in the "*Diagnóstico do Manejo de Resíduos Sólidos Urbanos – 2010*"; information and data available in the "*Panorama dos Resíduos Sólidos no Brasil – 2014*" and also based on common practice for waste collection, disposal e recycling in the region of the project activity and other regions in Brazil, and by also taking into account the local 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 landfills and 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 2010 (data organized and published in year 2012)).
- It is important to note that in all regions in Brazil with existing MSW disposal activities using landfilling techniques (in landfill or dump sites) significant quality improvements in MSW disposal services are still required for the cases where waste is disposed in dump sites and not well designed/managed landfills: e.g. construction of better designed landfills and use of appropriated technics for waste compacting and covering, etc. In this sense, the UVS - Caieiras landfill represents a very well designed and 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 which is collected as MSW has been historically disposed by applying landfilling techniques.
- In all geographical regions in Brazil, relative 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 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 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 clearly do not represent any driver or incentive for promoting any change in the MSW management situation in the region where it is to be implemented (including waste recycling practices or initiatives for organic content of MSW to be disposed in landfills or dump sites).

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	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 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 public service policies in the case of Brazil (including policies, laws, regulations and programmes) and 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. In Brazil, the administrations of municipalities are the entities responsible for all MSW management services. 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

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 to be noted:

- it is clear that deliberate 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. (owner and operator of the UVS - Caieiras landfill). Aspects and actions related to deliberate promotion of any increase or even reduction of recycling of organic fraction of waste (and/or recycling of any other type of solid waste material) in the region where the project activity is implemented are to be seen as fully dependent in a last instance on public service policies (including governmental policies, laws, regulations and programmes) to be set by competent governmental authorities (under a regional and national level) and/or even by private practitioners of waste recycling activities. In Brazil, the administrations of municipalities are responsible for addressing all MSW management services. This is the case also in the geographical region of the project site. MSW collection and disposal services are normally performed by the municipality or 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) (i.e. concession of exploration rights for public services) for the provision of MSW collection and/or MSW disposal services by following directives and requirements established in such public contracts/regulations. In this context, both under the baseline and project scenarios (with or without the implementation of the project activity), Essencis Soluções Ambientais S.A is definitely not in a position to 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 even at other location in the region.
- The implementation and operation of the project-based initiative promoting methane destruction through collection of LFG and its combustion in high temperature flares and/or set of internal combustion gas engines (methane destruction devices) in 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 Section B.6.1, so far, there is still no legal restriction neither requirement for LFG gas collection and its combustion using high temperature enclosed flares and/or set of internal combustion gas engines 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. Actually, there is no applicable regulation 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 per se does not represent any driver or incentive to promote incremental disposal of organic waste stream at this particular 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 aspects and information above-presented, the project activity 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 13.0.0)	Justification
	requirements set by the municipalities from where generated MSW are to be managed. In this sense, in the position of a MSW management company operating a LFG collection and destruction initiative in the landfill it operates, Essencis Soluções Ambientais S.A. is not under a position to trigger, establish or promote any promotion of reduction or prevention of organic waste recycling in the region where it operates. Finally, the implementation and operation of the project activity (both under its previous and revised design configurations) 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 the policies and practices related to recycling of inert or organic solid waste in the region (or even outside the region) of influence of the UVS - Caieiras landfill. While the 7-year crediting period of the project activity was successfully renewed in December/2013, no change in this sense is expected to occur during the remaining share of the 2nd 7-year crediting period either (with the project activity under its revised design configuration). As outlined in Section B.6.1, so far, there is still no legal restriction or requirement for LFG gas collection and its destruction using high temperature enclosed flares or any other device/equipment in Brazil. Moreover, there is still no legal restriction neither requirement 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 LFG venting/combustion drains is identified as the baseline scenario for the project activity). Actually, there is no applicable regulation that deals 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). In this sense, under no circumstance the project activity (both under its previous and revised design configurations) *per se* potentially promote any displacement of volumes of organic waste stream from eventual treatments/utilization in an existent or hypothetical MSW recycling/utilization facilities (e.g. a MSW composting plant for example) to be disposed at the UVS - Caieiras landfill because of the implementation and continuous 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 13.0.0)	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* *(a) Release of LFG from the SWDS; and* *(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;* (i) *For electricity generation: that electricity would be generated in the grid or in captive fossil fuel fired power plants; and/or* (ii) *For heat generation: that heat would be generated using fossil fuels in equipment located within the project boundary."*	As further demonstrated in Section B.4, the most plausible baseline scenario for methane emissions remains being the release of LFG from the SWDS into the atmosphere (with minor share of generated LFG being partially destroyed in conventional LFG passive venting/combustion drains). The application of the procedure to identify the baseline scenario falls into (a). The quoted applicability condition is thus satisfactory met.
Non applicability conditions	**Justification**
(a) In combination with other approved methodologies. For instance, ACM0001 cannot be used to claim emission reductions for the 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; (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*	Neither options (a) and/or (b) occur. 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) 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). While the 7-year crediting period of the project activity was successfully renewed in December/2013, MSW disposal practices and management at the UVS - Caieiras landfill are not expected to change during the remaining share of the 2nd 7-year crediting period[62].

[62] 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 remaining share of the 2nd 7-year crediting period either (with the project activity under its

Applicability Condition of CDM baseline and monitoring methodology ACM0001 – "Flaring or use of landfill gas" (version 13.0.0)	Justification
implementation of the project activity.	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"	02.0.0	*"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.* *This tool is applicable to the flaring of flammable greenhouse gases where:* *o Methane is the component with the highest concentration in the flammable residual gas; and* *o 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).* *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.* *This methodology refers to the latest approved version of the "Tool to determine the mass flow of a greenhouse gas in a gaseous stream". The applicability conditions of this tool also apply."*	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. 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 component with the highest concentration in LFG[63]. No auxiliary fuel is required to make the flammability of LFG sufficiently enough to

revised design configuration). 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. This is confirmed in a technical document previously issued by the specialized engineering service provider and advisory/consultancy company Arquipélago Engenharia Ambiental Ltda. and also confirmed in documented declaration issued by Essencis Soluções Ambientais S.A.

[63] 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.

Methodological tool	Version	Applicability conditions	Comments
			be combusted in the project flares[64]. 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. Thus, the quoted applicability criteria defined in the methodological tool are sufficiently met.
"Tool to calculate baseline, project and/or leakage emissions from electricity consumption"	1	*"This tool provides procedures to estimate the baseline, project and/or leakage emissions associated with the consumption of electricity.* *(…)* *The tool is only applicable if one out of the following three scenarios applies to the sources of electricity consumption:* *<u>Scenario A:</u> Electricity consumption from the grid. The electricity is purchased from the grid only. Either no captive power plant is installed at the site of electricity consumption or, if any on-site captive power plant exits, it is not operating or it can physically not provide electricity to the source of electricity consumption.* *<u>Scenario B:</u> Electricity consumption from (an) off-grid fossil fuel fired captive power plant(s). One or more*	As established by ACM0001 (version 13.0.0), consumption of electricity by the project activity is to be accounted as project emissions. Under normal operational situations, electricity demand of the project activity (under its revised design configuration) is expected to be met through imports of 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)

[64] 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
		fossil fuel fired captive power plants are installed at the site of the electricity consumption source and supply the source with electricity. The captive power plant(s) is/are not connected to the electricity grid. *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 consumption source. The captive power plant(s) can provide electricity to the electricity consumption source. The captive power plant(s) is/are also connected to the electricity grid."*	will be consumed by the project activity[65]. Thus, Scenario C of the tool is applicable. In summary, the quoted applicability criteria defined in the methodological tool are sufficiently met. It is important to note that, as further explained in Section A.3, 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 2nd 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).

[65] 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
"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)."* *"The tool can be used to determine emissions for the following types of applications:* *(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);* *(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 13.0.0). Thus, the quoted applicability criteria defined in the methodological tool are sufficiently met.
"Tool to calculate the emission factor for an electricity system"	04.0	*This methodological tool determines the CO_2 emission factor for the displacement of electricity generated by power plants in an electricity system, by calculating the "combined margin" emission factor (CM) of the electricity system.* *(…)*	Project emissions due to the consumption of grid-sourced electricity by the project activity are determined by applying applicable guidance of "Tool to calculate project emissions from electricity consumption" (of which

Methodological tool	Version	Applicability conditions	Comments
		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. *(…)* *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).* *(…)* *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."*	ACM0001 version 13.0.0 refers to). The methodological tool "Tool to calculate the emission factor for an electric system" is referred to in the methodological tool "Tool to calculate project emissions from electricity consumption" for the purpose of calculating project emissions in case where a project activity consumes electricity from the grid. 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[66]. The electricity grid (to which the project activity is connected to) is not located partially or totally in an Annex I country. The relevant applicability conditions of the methodological tool are thus fully met.
"Combined tool to identify the baseline scenario and demonstrate additionality"	06.0.0	"*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"* *(…)* *For example, in the following situations a methodology could refer to this tool:* - *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*	As established by ACM0001 (version 13.0.0), this methodological tool is applied as per the methodology for the demonstration of the continuation of the baseline scenario. 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.

[66] 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 04.0 and previous versions).

Methodological tool	Version	Applicability conditions	Comments
		use of the existing equipment without any retrofits; - *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.* *In these cases, the project proponents could not implement the three alternatives in parallel but they could only implement one of them."* *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 continuation of the baseline scenario is demonstrated by applying the stepwise procedure of ACM0001 (version 13.0.0) for the determination of the baseline scenario. Baseline emissions are also determined by applying methodological approach also established by ACM0001 (version 13.0.0) and applicable methodological tools. As established by applicable CDM rules, the additionality of the project is not required to be demonstrated for the 2nd 7-year crediting period. However, due to permanent change in the project design (i.e. methane destruction also occurring on a set of internal combustion gas engines (additional/alternative methane destruction devices), this revised version of the PDD includes the stepwise approach of the "Combined tool to identify the baseline scenario and demonstrate additionality" in order to demonstrate that the previously assessed additionality of the project activity is not undermined by the post-registration change in its design. The applicability condition of the methodological tool is thus met.
"Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion"	02	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 13.0.0), 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

Methodological tool	Version	Applicability conditions	Comments
			purposes other than for electricity generation). In the particular case of the project activity Liquefied Petroleum Gas (LPG) has been used to ignite the flares. The applicability condition of the methodological tool is thus met.
"Tool to determine the mass flow of a greenhouse gas in a gaseous stream"	02.0.0	"*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 13.0.0), 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. 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.
Methodological tool "Common practice"	*03.1*	*"This methodological tool provides a step-wise approach for the conduction of the common practice analysis as referred to in methodological tool "Tool for the demonstration and assessment of additionality", the methodological tool "Combined tool to identify the baseline scenario and demonstrate additionality", or baseline and monitoring methodologies that use the common practice test for the demonstration of additionality."* *(…)* *"This methodological tool is applicable to project activities that apply the*	In the context of addressing the permanent post-registration change in the project design (methane destruction also occurring on a set of internal combustion gas engines (additional/alternative methane destruction devices) and installation of backup electricity generator), the stepwise procedure of the methodological tool "Combined tool to identify

Methodological tool	Version	Applicability conditions	Comments
		methodological tool "Tool for the demonstration and assessment of additionality", the methodological tool "Combined tool to identify the baseline scenario and demonstrate additionality", or baseline and monitoring methodologies that use the common practice test for the demonstration of additionality."	the baseline scenario and demonstrate additionality" (version 06.0.0) is applied (as required by ACM0001 (version 13.0.0) with the following purposes: - Confirmation of the identification of the baseline scenario for methane emissions for the project activity (under its revised design configuration). - Demonstrating that the previously assessed and demonstrated additionality of the project activity is not undermined by the permanent post-registration change in the project design. While common practice analysis is one of the steps of the "Combined tool to identify the baseline scenario and demonstrate additionality", applicable guidance from the methodological tool "Common practice" is thus assumed as required to be followed. The applicability condition of the methodological tool is thus met.

The permanent post-registration change in the project design, the revision of the monitoring plan and performed corrections (in information which do not affect project design) do not adversely affect the previously demonstrated compliance of the project activity with applicability requirements of ACM0001 (version 13.0.0) + applicable methodological tools.
The scale and the level of accuracy and completeness in overall monitoring of the project activity are not adversely affected by such post-registration changes either. Monitoring (including the design of the monitoring plan) and GHG calculation approaches are however improved and complemented, thus meeting related additional monitoring requirements for the project activity under its revised design.

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

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The boundary of 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[67] 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:

[67] 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).

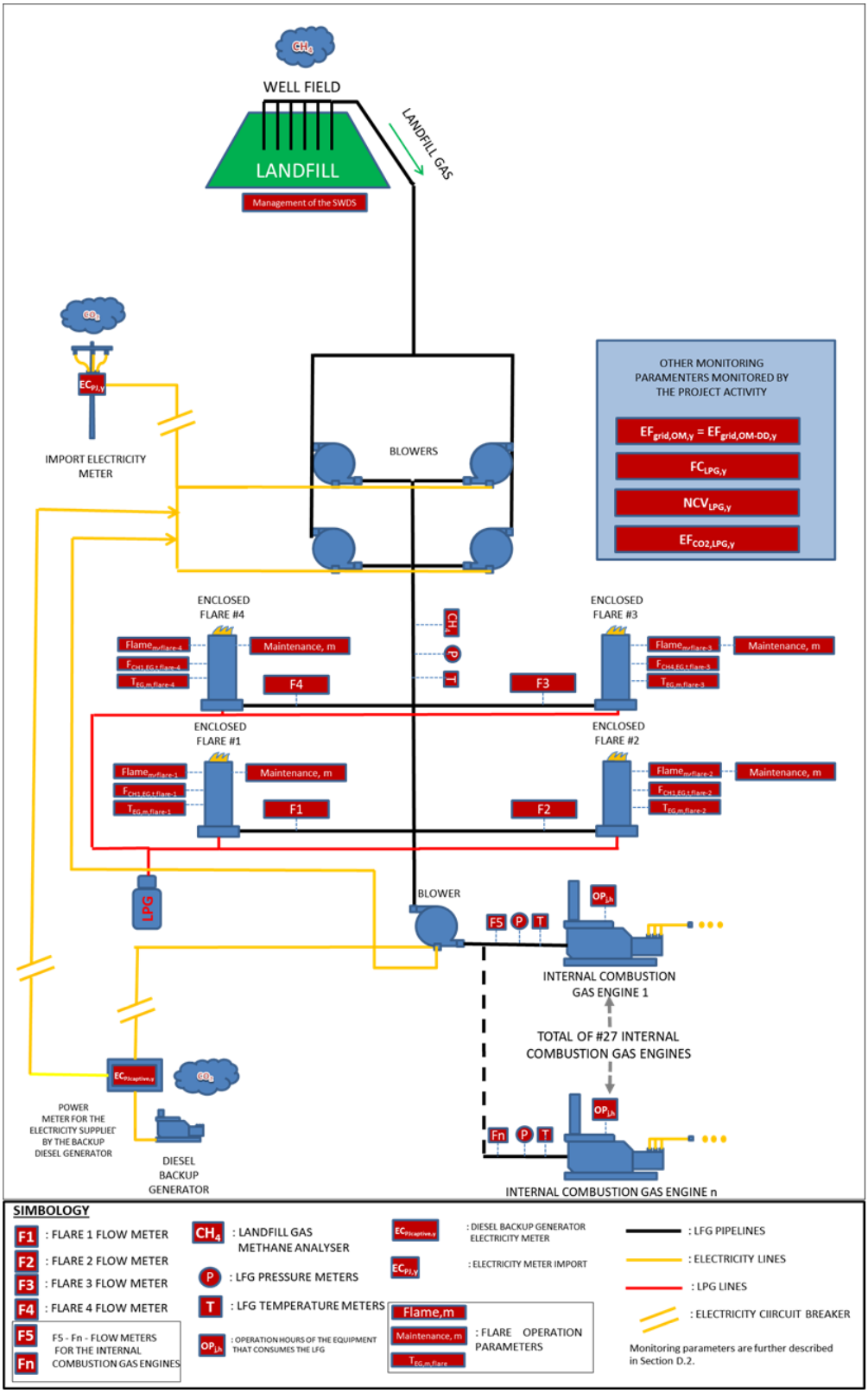

Figure 16 - Diagram summarizing the project boundary and delineating the project activity (equipment, parameters t o be monitored, and GHG included in the project boundary)[68]

[68] 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 gradual/phased implementation of the grid-connected electricity generation infrastructure fuelled by LFG and located within the geographical limits of the UVS – Caieiras landfill (forecasted to occur by year 2020).

B.4. Establishment and description of baseline scenario

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This Section includes a revised application of the previously applied 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" (version 03.0.1) in order to demonstrate the non-changing of the identification of the baseline scenario for the project activity under its revised design configuration[69].

The changes in the project design encompasses (i) combustion of LFG (destruction of methane) also occurring in a set of internal combustion gas engines (that are part of a grid-connected electricity generation infrastructure fuelled by LFG and located within the geographical limits of the UVS – Caieiras landfill since July 2016 (regarded as additional/alternative methane destruction devices for the project activity) and (ii) meeting of electricity demand for the project activity with electricity generated by a backup captive off-grid electricity generator fuelled by diesel since July 2016[70].

For completely meeting requirements for addressing post-registration changes in the design of a registered CDM project activity, this Section includes confirmation that the previously derived baseline scenario for the project activity is not changed due to its revised design configuration by following the applicable guidance and stepwise procedure of ACM0001 (version 13.0.0).

While the stepwise procedure of ACM0001 (version 13.0.0) is also included in Section B.5, this Section is thus complemented by Section B.5[71].

[69] The demonstration of the validity of the previously derived baseline scenario of emissions of methane for the project activity (under its previous design configuration) was previously performed through the 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" (version 03.0.1) as a requirement for already occurred renewal of the 7-year crediting period of the project activity (with related information details included in the previous version of the PDD valid for the 2nd 7-year crediting period).

The confirmation of the previously derived baseline scenario for the project activity under its revised design configuration (i.e. including destruction of methane through combustion of LFG in the set of internal combustion gas engines (which since July 2016 represents, at the same time, (i) 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) + meeting of electricity demand of the project activity with electricity generated by a backup captive off-grid electricity generator (fuelled by diesel)) is hereby performed in order to fulfill the requirement of applicable CDM rules and procedures for addressing post-registration changes.

The application of the "Combined tool to identify the baseline scenario and demonstrate additionality" (version 06.0) is partially included in Section B.4 in the context of the establishment/identification of the baseline scenario for the project activity (under its revised design configuration) (as part of the 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" (version 03.0.1)). The stepwise approach of such methodological tool is further applied in Section B.5 (in the context of the also performed demonstration that the previously assessed project's additionality is not undermined by the occurred permanent change in the project design). Thus, information available in Section B.4 and Section B.5 do complement each other.

[70] Detailed milestone for the starting of combustion of LFG (destruction of methane) in the set of internal combustion gas engines (as additional/alternative methane destruction devices for the project activity) is made available in Section A.3.

[71] Demonstration that the previously assessed additionality for the project activity is not undermined by the permanent change in its design is explained performed in Section B.5 (also on the basis of the application of the stepwise approach of the "Combined tool to identify the baseline scenario and demonstrate additionality"). The stepwise application of this methodological tool is included in Section B.4 and concluded in Section B.5. Thus information made available in Section B.4 also complements information made available in Section B.5 (that analysis adverse impacts of the occurred permanent post-registration change in the project design over the previously demonstrated and assessed additionality of the project activity) and *vice-versa*.

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":

In the context of the previously occurred renewal of the 7-year crediting period, 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) was previously applied.

In the context of revision of this PDD (for addressing the permanent changes in the project design), also as per applicable guidance of the CDM-PCP-PA, the previously applied 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) is thus complemented/updated[72].

In summary, the objective of applying this methodological tool is thus demonstrating the continuation and validity of the previously derived baseline scenario for methane emissions for the project activity also under its revised design configuration[73] [74].

Step 1: Assess the validity of the current baseline for the next crediting period[75]

Step 1.1: Assess compliance of the current baseline with relevant mandatory national and/or sectoral policies

Baseline scenario for emissions of methane:
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.

[72] For sake of completeness and transparency, texts available in the previous version of the PDD (PDD compiled for the renewal of the 7-year crediting period) that deals with the application 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) remains being presented in this revised version of the PDD However, part of previously available information is moved to Section B.5 in this revised version of the PDD for enhancing comprehension.

[73] As per the CDM project standard for project activities (CDM-PS-PA), adverse impacts over the previously derived baseline scenario and baseline emissions triggered by the post-registration changes in the project design are required to be analyzed as per valid/applicable methodological approach(es).

[74] It is relevant to note that since, no emission reductions associated to generation of electricity in the grid-connected electricity generation infrastructure (fuelled by renewable energy source) and under operation since July/2016 will be accounted during the remaining share of the 2nd 7-year crediting period of the project activity; baseline emissions for electricity generation are thus not assessed.

[75] While the 7-year crediting period for the project activity was previously renewed and this revised version of the PDD addresses permanent PRCs in the project design, the term "*validity of the current baseline for the next crediting period*" should be interpreted as "*validity of the previously identified baseline for the 2nd 7-year crediting period under the revised project design configuration".*

This situation currently remains prevailing[76].

Although there is still no regional or national legal requirement 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.

[76] In May/2018, there was still no legal requirement 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 May/2018 there was still no legal restriction neither legal requirement 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 is still no applicable regulation 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 about the *Regulation of the National Policy on Waste Management* is pointed out by the law firm "Tauil & Chequer Advogados" in an articles published in 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 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]

Step 1.2: 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[77]. 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 crediting period remains 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 is no change in market or regulatory characteristics/aspects (incl. legal requirements) or new market or regulatory circumstances that would demand any type of re-assessment or re-evaluation for the determination of the baseline scenario for emissions of methane at UVS - Caieiras landfill for the remaining share of the 2nd 7-year renewable crediting period.

Step 1.3: 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.

[77] 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 the 2nd 7-year renewable crediting period have significantly changed when compared assumptions as presented in the latest version of the PDD (and related emission reduction spreadsheet) valid for the 1st 7-year crediting period (PDD version 4, dated 10/01/2013). While the version of ACM0001 baseline and monitoring methodology which was previously applied in the PDD for the 1st crediting period (ACM0001, version 2) 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) applicable as per ACM0001 (version 13.0.0) 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 the 2nd 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 2nd 7 year crediting period (the value valid for the 2nd commitment period of the Kyoto Protocol) is higher than the one previously applied (value of 25 instead of 21 values previously applied).

Step 1.4: 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 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)) are not any longer be valid/applicable for the 2nd 7-year crediting period (since other/more recent CDM baseline and monitoring methodology (ACM0001 (version 13.0.0)) is applied for the 2nd crediting period of the project activity).

As per the applied version of the valid CDM baseline and monitoring methodology (ACM0001 (version 13.0.0)) and related methodological tools, there are differentiated applicable methodological approaches that are considered (when compared to the previously applied ACM002 (version 2)) (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 2nd 7-year crediting period.
Thus, some of data and parameters as presented in the latest version of the PDD valid for the 1st crediting period 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 2nd 7-year crediting period and (iii) ex-ante determined parameters and default values are all determined/calculated as per applicable guidance of ACM0001 (version 13.0.0) + applicable methodological tools, the validity of most of the previously defined ex-ante determined parameters is thus limited for the project activity under its revised design configuration. The methodological approaches for the demonstration of validity of the previously derived baseline scenario, baseline emissions during the 2nd 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: Update the current baseline and the data and parameters

Step 2.1: Update the current baseline

The whole determination of the baseline scenario for the project activity under its revised design configuration (as per applicable guidance of ACM0001 (version 13.0.0) + applicable methodological tools) is included below under "*Determination of the baseline scenario*".

It is important to note that while the baseline scenario (in terms of emissions of methane) for the project activity (under both its previous and its revised design configurations) are not changed for the 2nd 7-year renewable crediting period (when compared to the baseline scenario assumed for its 1st 7-year crediting period), the applied methodological approaches for the determination of baseline scenario and baseline emissions (as per ACM0001 (version 13.0.0) + applicable methodological tools) are indeed different than the ones required by the previously applied methodology ACM0002 (version 2).

Thus, for completeness reasons, this revised version of the PDD (addressing the revised design configuration of the project activity as per applicable CDM rules) includes the whole determination of the baseline scenario and baseline emissions for the project activity (under its revised design configuration) as per the applicable guidance and requirements and stepwise approaches of ACM0001 (version 13.0.0) (regardless the fact baseline scenario in terms of methane emissions remains being the same as the one valid for its currently expired 1st 7-year crediting period).

The determination of baseline emissions (by following all applicable guidance and requirements of ACM0001 (version 13.0.0) and applicable related methodological tools) is presented in Section B.6.1 (under "*Determination of $F_{CH4,BL,y}$*"). Related ex-ante estimations of baseline emissions for the 2nd 7-year crediting period are summarized in Section B.6.3.

Determination of the baseline scenario for the project activity (under its revised design configuration) *(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" as required by ACM0001 (version 13.0.0)):*

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"[78] (version 06.0) as required by ACM0001 (version 13.0.0).

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":

STEP 0: 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. Furthermore, there is no need to apply this step for addressing the post-registration change in the project design either.

STEP 1: Identification of alternative scenarios

SUB-STEP 1a: 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 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. This is a plausible alternative scenario, however involves significant investment and additional costs of landfill operations with no associated revenues[79].

[78] 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.

[79] As explained in Section A.3, the project activity encompasses methane destruction through combustion of collected LFG in the set of internal combustion gas engines (since July 2016) as its unique GHG abatement measure. Despite of combustion of LFG in internal combustion gas engines (which are part of a grid-connected electricity generation infrastructure), the only type of GHG mitigation action encompassed by the CDM project activity "Caieiras landfill gas emission reduction" remains being destruction of methane emissions. 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 eligible for the project activity. In this context, revenues due to commercialization of electricity generated by such grid-connected electricity generation infrastructure are not considered/taken into account in the particular context of determination of the baseline scenario for the project activity under its revised design configuration.

LFG2: Atmospheric release of the landfill gas or partial capture of landfill gas and destruction to comply with regulations or contractual requirements, or to address safety and odour concerns. This scenario corresponds to the continuation of the current situation (the proposed project activity under its revised design configuration or any other alternatives are not implemented).

LFG3: LFG is partially not generated because part of the organic fraction of the solid waste is recycled and not disposed in the SWDS;

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

LFG5: 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 implemented at a landfill site of which purpose is the final disposal of solid waste through adoption of appropriate landfilling practices and techniques. As further explained in Section B.2, the project activity has not previously promoted and it is not expect to promote any change in waste recycling activities in the region where the UVS - Caieiras landfill is located (region of influence of this landfill) under both its previous and revised design configurations.

In this context, it is crucial to note that with or without the project activity being implemented (under its previous and/or under its revised design configuration), no activities involving recycling of the organic fraction of waste disposed at the UVS - Caieiras landfill, neither activities involving aerobic treatment, neither activities involving incineration of disposed waste streams have occurred, have been triggered or have been prevented (or would have occurred or would have been prevented) at the UVS - Caieiras landfill and/or in any other landfill, and/or, if applicable, any existent recycling station located in the region where the UVS - Caieiras landfill is located (region of influence of the landfill)[80].

Thus, alternative scenarios *LFG3*, *LFG4* and *LFG5* are hereby automatically excluded from the determination of baseline alternatives for the project activity (under its revised design). Such exclusion is under complete conformance with applicable guidance of ACM0001 (version 13.0.0). In fact, recycling of organic matter, aerobic treatment and incineration of Municipal Solid Waste (MSW) has not been common practice in Brazil.

The implementation and operation of the project activity has never promoted and/or is not expected to promote any quantitative change (including reduction) in the amount of organic solid waste that could or would be eventually recycled within the region of influence of the UVS - Caieiras landfill. In fact, this is an applicability condition/criteria of ACM0001 (version 13.0.0) of which compliance is further explained in Section B.2.

Identification of alternatives for utilization of LFG:

ACM0001 (version 13.0.0) establishes that in addition to the alternative baseline scenarios identified for the destruction of LFG, alternative scenarios for the use of LFG shall also be identified in case this is an aspect of the project activity.

As part of the operation of the project activity, since electricity generation using LFG as fuel is not included as an additional GHG abatement measure for the project activity, no baseline scenario for electricity generation using LFG as fuel is thus identified. Regardless of collected LFG being combusted (used as gaseous fuel) in the internal combustion gas engines (that are part of the electricity generation infrastructure fuelled by LFG and located within the geographical limits of the UVS – Caieiras landfill), the only type of GHG mitigation action encompassed by the CDM

[80] Section B.2 includes further details and explanations that the implementation and operation of the project activity does not potentially promote any reduction in the amount of organic waste that would be recycled in the absence of the project activity (baseline scenario) in the region of influence of the UVS - Caieiras landfill.

project activity “Caieiras landfill gas emission reduction” remains being destruction of methane emissions under its revised design configuration. While 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/considered for the project activity, in the particular context of the application of the stepwise approach of ACM0001 (version 13.0.0) for the identification of alternatives for utilization of LFG, scenarios *E1* through *E3* are thus directly excluded in the context of baseline identification analysis[81].

Heat generation scenarios using LFG collected at the UVS - Caieiras 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, etc.)). Therefore, under conformance with ACM00001 (version 13.0.0), scenarios *H1* through *H7* are directly excluded in the context of the baseline identification analysis.

Supply of LFG to a natural gas distribution network or even displacement of natural gas through supply of LFG directly to an end-user are not considered as part of the project activity either. Currently, there is no natural gas distribution network serving the limits of the UVS - Caieiras landfill. Moreover, this type of utilization for collected LFG is not part of the project activity either. Therefore, baseline emissions associated to the consumption or displacement of natural gas are not considered in the context of the baseline identification analysis either. This is also under conformance with ACM0001 (version 13.0.0).

Outcome of Step 1a:

The only alternatives to be taken into consideration after step 1a) are only *LFG1* and *LFG2*.

[81] 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 regarded as being eligible/considered for the project activity. Thus, alternative scenarios for electricity generation using LFG as fuel as per ACM0001 (version 13.0.0) (alternatives scenarios E1 to E3) are thus directly not considered for determination of baseline scenario and assessment of impacts over previous demonstrated addtionality of the project activity by its permanent design changes. It is relevant to note that, as further explained in Section A.3, non-accounting of CO_2 emission reductions due to generation of electricity in the grid-connected electricity generation infrastructure (of which the set of internal combustion gas engines powered by collected LFG represent the major components) is in line and under conformance with item (d) of the Ruling note “Rationale for rejection of PRC-0171-004” (CDM-PA0171-RULE01). With collected LFG being destroyed under efficient and controlled manner in both high temperature enclosed flares and in internal combustion gas engines, the project activity remains representing a CDM project activity promoting destruction of LFG (rich in methane). Methane destruction remains being the unique GHG abatement measure encompassed by the project activity. Since all electricity demand of the UVS - Caieiras landfill has been historically met by a reliable supply of grid-sourced electricity (since the start of operations of the landfill in year 2002), the utilization of a captive electricity generator to supply electricity for the landfill site (using renewable or fossil energy sources) never occurred and it would not be expected to occur in the absence of the project activity either.
It is relevant to note that, as further explained in Section A.3, a backup captive off-grid electricity generator fuelled by diesel is made available for backup and safety/emergency situations as part of the operation of the project activity. Thus, it is relevant to consider that, like the current situation of other landfill sites without a CDM project activities promoting collection and destruction/utilization of LFG being implemented and like the pre-project situation at the UVS - Caieiras landfill, no backup captive off-grid electricity generator fuelled by diesel or by any other fuel would be expected to be implemented at the landfill site in the absence of the project activity under its revised design configuration (baseline scenario).

Step 1b: Consistency with mandatory applicable laws and regulations:
So far, there are still no legal restrictions or requirements/obligations for the promotion of LFG collection and destruction in Brazil. 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 step 1b) are identified as *LFG1* and *LFG2*.

Application of STEP 2: Barrier analysis + STEP 3: Investment analysis + STEP 4: Common practice analysis:
The application of the following subsequent steps of the methodological tool "Combined tool to identify the baseline scenario and demonstrate additionality" in the context of the identification of the baseline scenario and assessment/demonstration of additionality of the project activity (under its revised design configuration) are all presented in Section B.5[82]:
- STEP 2: Barrier analysis
- STEP 3: Investment analysis
- STEP 4: Common practice analysis

[82] In terms of demonstration of additionality of the project activity (under its revised design configuration), the subsequent application of the stepwise approach of the methodological tool aims to demonstrate that the previously assessed of additionality of the project activity is not undermined by the permanent post-registration changes in the project design.
Such demonstration is performed by assessment of additionality of the project activity (under its revised design documentation) as per the currently valid approaches for demonstration of additionality.
As per the applicable methodological guidance of both ACM0001 (version 13.0.0) and the "Combined tool to identify the baseline scenario and demonstrate additionality" (version 06.0), determining baseline scenario for a LFG collection and destruction under the CDM is somehow combined with the assessment and demonstration of additionality for such project activity. While in the particular case of the previously occurred renewal of the 7-year crediting period of the project activity, it was not required/necessary to re-assess and re-demonstrate the additionality neither demonstrating the validity of the previously assessed/demonstrated additionality (of which in the particular case of the project activity (under its previous and not any longer valid design configuration) was previously assessed and demonstrated as presented in previous version of the PDD (valid for the currently expired 1st 7-year crediting period), 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 06.0) are thus regarded as not applicable 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 2nd 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" (version 03.0.1) and other applicable CDM guidelines and rules.
However, while the permanent post-registration changes in the project design do not represent changes that promote potential adverse impact over both the previously demonstrated additionality for the project activity as well as in terms of identification of baseline scenario, the application of the remaining steps of the "Combined tool to identify the baseline scenario and demonstrate additionality" are anyway presented in Section B.5. The application of such steps thus aims to meet applicable requirements for addressing the permanent post-registration changes in the project design as follows:
- demonstration that the previously assessed project's additionality is not undermined by the permanent post-registration change in the project design and;
- conclusion of the determination of the baseline scenario for the project activity under its revised design configuration.

In this particular context, B.4 and B.5 are thus complementary Sections since both Sections deal with the identification of the baseline scenario and demonstration of additionality of the project activity (under its revised project design). Thus, the application of the steps of the "Combined tool to identify the baseline scenario and demonstrate additionality" as undertaken in Section B.4 are also directly applicable in the context of the demonstration of additionality of the project activity (under its revised design configuration). On the other hand, as established by such methodological tool, steps of this tool as undertaken in Section B.5 are thus also applicable in the context of the identification of the baseline scenario for the project activity (under its revised design configuration).

Conclusion of the determination of the baseline scenario for the project activity (under its revised design configuration):

In summary, by taking into account the whole content of Sections B.4. and B.5, 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 (under its revised design configuration) 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*").

Furthermore, as further demonstrated in Section B.5, it is demonstrated that the previously assessed and demonstrated additionality for the project activity is not undermined by the permanent post-registration change in its design.

Note:

The demonstration that the previously assessed additionality for the project activity is not undermined by the permanent post-registration change in its design is further explained in Section B.5 (continuation of application of the stepwise approach of the "Combined tool to identify the baseline scenario and demonstrate additionality" (version 06.0)).

The baseline scenario for methane emissions are not affected by the post-registration change in the project design.

B.5. Demonstration of additionality

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Identification of the baseline scenario for the project activity (under its revised design configuration) (continuation of Section B.4) + assessment of adverse impact of the permanent post-registration changes in the project design over the previously assessed and demonstration additionality for the project activity:

By further applying the stepwise procedure of the latest version of the methodological tool "Combined tool to identify the baseline scenario and demonstrate additionality" (version 06.0) (application of the remaining subsequent steps of such methodological tool in the context of the identification of the baseline scenario and assessment/demonstration of additionality of the project activity (under its revised design configuration (as also applied in Section B.4))), the content of this Section aims the following:

- Concluding the identification of the baseline scenario for the project activity (under its revised design configuration) (of which details are also partially included in Section B.4). In this particular context, information made available in Section B.5 thus complements information made available in Section B.4.

- Demonstrating that the previously assessed additionality of the project activity is not undermined by the permanent post-registration change in its design[83].

[83] Such demonstration aims to demonstrate that the project activity is still additional when the post-registration changes in the project design are considered (i.e. methane destruction also occurring in the set of internal combustion gas engines (alternative methane destruction devices) + utilization of backup captive off-grid electricity generator (fuelled by diesel)), thus meeting applicable CDM requirement for addressing post-registration changes in the project design (demonstration of non-undermining of previously assessed additionality).

The assessment and demonstration of the project's additionality (under its revised design configuration) as per the currently valid CDM approaches/guidance is performed by following CDM rules and procedures applicable for the following:

- Addressing of potential adverse impacts of the permanent changes in the design of the registered CDM project activity over its previously assessed/demonstrated additionality and demonstrate the non-undermining of the previously demonstrated additionality for the project activity as per applicable rules and guidance of ACM0001 (version 13.0.0) + applicable methodological tools: direct application of the stepwise approach of the latest version of the "Combined tool to identify the baseline scenario and demonstrate additionality" (version 06.0)[84].

Continuation of the application of the stepwise approach of the methodological tool "Combined tool to identify the baseline scenario and demonstrate additionality":

STEP 2: Barrier analysis

Step 2a: Demonstration that previously assessed barriers are still valid under the revised design configuration of the project activity[85]

As outlined in all previous versions of the registered PDD valid for the currently expired 7-year crediting period of the project activity, at the time of the project initial design conceptualization and CDM consideration (within years 2004 and 2005) [86] and also at the time of its validation/registration under the CDM (within years 2005 and 2006) the baseline scenario for the project activity was directly identified as follows:

[84] It is noteworthy that the application of the stepwise approach of the methodological tool "Combined tool to identify the baseline scenario and demonstrate additionality" only became a requirement of the CDM baseline and monitoring methodology ACM0001 (for identification of baseline scenario and assessment/demonstration of additionality) from its version 12 onwards. While previous versions of ACM0001 (such as version 2 that is applied in the all versions of the PDD valid for the currently expired 1st 7-year crediting period of the project activity) do not refer to such methodological tool, the tool was thus not previously applied for demonstrating the additionality of the project activity.

[85] In the particular context of identification of the complete baseline scenario for the project activity (under its revised design configuration) + demonstration that the previously assessed additionality for the project activity is not undermined by the occurred and yet to occur (planned) post-registration changes in its design, Step 2 of the "Combined tool to identify the baseline scenario and demonstrate additionality" (version 06.0) includes demonstration that previously identified and assessed barriers are still valid under the revised design configuration of the project activity (instead of *"Identify barriers that would prevent the implementation of alternative scenarios"*).

Para. 304 of the latest version of the CDM validation and verification standard for project activities (CDM-VVS-PA) (version 01.0) explicitly includes the following related requirements:

> *"(…)*
> *If the proposed or actual changes affect the additionality of the registered CDM project activity, then the DOE shall confirm that:*
> *(a) If investment analysis has been used to demonstrate additionality, project participants have only modified the key parameters in the original spreadsheet calculations affected by the proposed or actual changes to the project activity;*
> *(b) If only barriers have been claimed to demonstrate additionality, project participants have demonstrated that the barriers are still valid under the new circumstances.*
> *(…)"*

[86] As previously indicated in the latest version of the registered PDD valid for the currently expired 1st 7-yer crediting period of the project activity, the time period encompassing years 2004 and 2005 is when the both initial conceptualization of the general design of the project activity and its CDM consideration occurred. Like previous versions of the PDD, all data, information and details applicable/valid 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 at the period encompassing years 2004 and 2005. The following previous versions of the PDD are valid for the currently expired 1st 7-year crediting period of the project activity: version 3 (dated 12/09/2005) and version 4 (dated 10/01/2013).

"The baseline is the atmospheric release of the gas and the baseline methodology considers that some of the methane generated by the landfill may be captured and destroyed to comply with regulations or contractual requirements, or to address safety and odor concerns".

The above-quoted direct identification of baseline scenario for methane emissions at the UVS – Caieiras landfill was previously confirmed by the Designated Operational Entity (DOE) responsible by the CDM validation of the project activity in year 2005/2006 as performed under full conformance with CDM procedural and methodological rules that were valid/applicable at that time (incl. full conformance with the currently discontinued CDM baseline and monitoring methodology ACM0001 (version 2)).

Furthermore, as also explicitly outlined in all versions of the registered PDD valid for the currently expired 1st 7-year crediting period of the project activity, the project's additionality is indicated as being demonstrated by following guidance of the *"Annex 1 – "Tool for the demonstration and assessment of additionality" from the Sixteenth Meeting of the Executive Board."* and by assuming the existence of "*Barriers*" for its implementation in the absence of CDM revenues as follows:

"(…) The main barrier is economic. There are no revenues associated with the surplus of around 30% of LFG collection and flaring. Technically, the landfill operator would have to increase the wells density, flaring capacity, energy consumption, among others. This will require significant investments (around 100 US$ / Nm^3/h of capacity installed for such size of landfill) and will draw up the landfill costs, mainly linked to energy consumption and LFG capture network operation and maintenance (around 10 US$ /1,000Nm^3 collected for such size of landfill). At the time of the project design initial conceptualization, potential competitors of the Caieiras landfill were: Bandeirantes, Lara (Maua), Pajoan (Itaquaquecetuba), CTR Pedreira (SP), CTR Paulinia (Paulinia), Anaconda (Sta Izabel), Coveg (Santana do Parnaíba). At the time of the project design initial conceptualization, none of these landfills had LFG collection and flaring system. The ones that had a collection system in place at that time were promoted by financial subsidies, like CDM project (…). Hence, the costs increasing would difficult Caierias competitiveness. (…)"

"(…) The main barrier is market options. At the time of the project design initial conceptualization, electricity generation using LFG as fuel were not competitive with the usual sources. Electricity normal price for the producer (59.65 R$/MWh), was lower than the power generation costs (per MWh) using LFG as fuel. To turn such project feasible, the Brazilian Government has created the "Alternative Sources for Electricity Generation" (PROINFA) Incentive Program. But for the first phase of the program, Caieiras landfill does not fulfil the requirements to participate. And at the time of the project design initial conceptualization, there was no perspective for a second program for the next years. (…)"

"At the time of the project design initial conceptualization, it was considered that the success of the CDM project would be an important element to help mitigating the technical barrier (…)"

"No revenues are associated with landfill gas capture and burning. As a consequence, selling CERs will provide the necessary revenue to turn the activity feasible." [SIC][87]

Based on the findings of the report Global Waste Management Outlook – 2015, issued by the International Solid Waste Association (ISWA) and United National Environment Programme (UNEP)[88] in year 2015, no significant advancements in the landfill gas

[87] The CDM validation report for the project activity (issued on 12/12/2005 by the DOE Det Norske Veritas A/S (DNV) (Report No: 2005-0458, rev. 04)) states the following regarding the assessment of the additionality for the project activity as per the PDD (version 3, dated 12/09/2005):

"Step 3 - Barrier analysis: It was demonstrated that the project is not a likely baseline scenario due to the additional costs necessary for increasing the LFG capture capacity without having any revenues. (…)" [SIC]

[88] The Report Global Waste Management Outlook – 2015, issued by UNEP and ISWA is available online:

https://www.uncclearn.org/sites/default/files/inventory/unep23092015.pdf

technology and collection efficiency have occurred in most emerging developing countries within the latest years. This is also the particular case of the host-country Brazil. As assessed below under Step 4 (Common practice analysis), in the particular case of the host-country Brazil, there are no activities similar to the proposed project activity under operation or implementation without consideration of CDM benefits. All initiatives encompassing LFG collection and destruction are implemented (or are being implemented) as project-based initiatives under the CDM. The same applies for initiatives promoting utilization of LFG for electricity generation. By taking into account the nature of the changes in the project design[89] and by also taking into account that, as justified in Box 2c in Section A.3, the only type of GHG mitigation measure encompassed by the project activity remains being destruction of methane emissions, the above summarized barriers are regarded as still being valid under the new circumstances (change in the project design) in the absence of CDM incentives.

Outcome of Step 2a: As an outcome/result of performed barrier analysis, it is demonstrated that implementing the project activity (under its revised design configuration and in the absence of CDM incentives/revenues) (baseline alternative *LFG1*) is prevented by barriers.
Thus, the previously identified and assessed barriers are demonstrated as still being valid/applicable for the project activity (under its revised design configuration) (i.e. the barriers are still valid under the new circumstances). It is relevant to note that while alternative *LFG2* represents the continuation of current practice (with no investment being performed by the project participants), no barriers are identified for such alternative.

Step 2b: Eliminate alternative scenarios which are prevented by the previously identified and assessed barriers

The previously identified and assessed barriers are demonstrated as still being valid/applicable for the project activity (under its revised design configuration). Previously identified barriers are still valid under the new circumstances (in the absence of CDM incentives).
Thus, baseline alternative *LFG1* is eliminated (in the particular context of identification of baseline scenario and demonstration of non-undermining of previously assessed additionality for the project activity).

[89]As summarized in Appendix 7, the post-registration changes in the project design encompasses: 1) destruction of methane also occurring through combustion of LFG in a set of internal combustion gas engines (which are represents additional/alternative methane destruction devices for the project activity) and 2) meeting of project's electricity demand through electricity generated by a backup captive off-grid electricity generator (fuelled by diesel)).
As justified in Section A.3 / Box 2c, the project activity does not encompass electricity generation using LFG as renewable energy source as an additional GHG abatement measure. Thus, 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 eligible and/or claimable for the project activity.

Outcome of Step 2b:

As an outcome of performed demonstration that previously identified and assessed barriers are still valid under the revised design configuration of the project activity, the following is identified:

Identification of the baseline scenario for the project activity (under its revised design configuration) (continuation of Section B.4):

- The baseline scenario represents the scenario not affected by identified barriers and such scenario thus does not represent the project activity (under its revised design configuration) being undertaken without being registered as a CDM project.
  The baseline scenario for the project activity under its revised design configuration is determined as follows:

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*") (Continuation of the pre-project practice / BAU scenario)

Assessment of adverse impact of the permanent post-registration changes in the project design over the previously assessed and demonstration additionality for the project activity:

- The implementation and operation of the project activity (under its revised design configuration) without CDM revenues/incentives is demonstrated as being affected by previously identified barriers (e.g. the barriers are still valid under the new circumstances). Thus, the previously assessed and demonstrated additionality for the project activity is not undermined by the permanent post-registration changes in its design.

By taking into account the above summarized conclusions, in the particular context of assessment of potential adverse impact of the occurred and yet to occur (planned) post-registration changes of the design of the project activity over its previously demonstrated additionality, it is thus sufficiently demonstrated that the previously assessed and demonstrated additionality for the project activity is not undermined by permanent post-registration changes in its design.

<u>Outcome of step 2:</u>
Identification of the baseline scenario for the project activity (under its revised design configuration) (continuation of Section B.4):

- The baseline scenario is the most attractive scenario and such scenario thus does not represent the project activity (under its revised design configuration) being undertaken without being registered as a CDM project.
  The baseline scenario for the project activity under its revised design configuration is determined as follows:

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*" (Continuation of the pre-project practice / BAU scenario)

Assessment of adverse impact of the occurred and yet to occur (planned) permanent post-registration change in the project design over the previously assessed and demonstration additionality for the project activity:

- The implementation and operation of the project activity (under its revised design configuration) without CDM revenues/incentives is demonstrated as being affected by previously identified barriers (e.g. the barriers are still valid under the new circumstances). Thus, the previously assessed and demonstrated additionality for the project activity is not undermined by the permanent post-registration changes in its design.

It is important to note that Step 4 of the methodological tool "Combined tool to identify the baseline scenario and demonstrate additionality" (version 06.0) is performed as a complementary credibility check in order to demonstrate that the previously assessed and demonstrated additionality of the project activity is indeed not undermined by the changes in its design configuration.

STEP 3: Investment analysis

This step is not applied.

STEP 4. Common practice analysis

In order to demonstrate the extent to which the project activity (under its revised design configuration) would be diffused in the relevant sector, a common practice analysis is performed as a credibility check in order to demonstrate that the previously assessed and demonstrated additionality of the project activity is indeed not undermined by the changes in its design configuration[90].

In this particular context, the application of Step 4, in order to demonstrate that the project activity (under its revised design configuration) remains not being common practice in the whole host country Brazil thus somehow complements the performed barrier analysis (Step 2).
As follows, applicable guidance of the latest version of the methodological tool "Common practice" (version 03.1) is thus considered in the context of application of Sep 4a of the "Combined tool to

[90] By taking into account that (i) as per currently valid CDM rules, the performance of a "Common practice analysis" for demonstrating the additionality of a proposed CDM project activity is regarded as a mere credibility check in the context of such demonstration (thus complementing the performance of a barrier analysis and/or, where applicable, an Investment analysis); and (ii) by also taking into account that no references to "Common practice analysis" is included in currently applicable CDM rules for addressing potential adverse impacts of post-registration changes (PRCs) in the project design over the previously demonstrated additionality of a registered CDM project activity; it is reasonable to assume that performance of a "Common practice analysis" for the project activity under its revised design configuration is not required in the particular context of the demonstration included in the whole Section 5 (demonstration that the previously assessed additionality of the project activity is not undermined by the occurred and yet to occur (planned) permanent changes in its design).
The CDM validation report for the project activity issued by the DOE Det Norske Veritas A/S (DNV) (Report No: 2005-0458, rev. 04, dated 12/12/2005) states the following regarding the assessment of the additionality for the project activity:

> *"Step 4 - Common practice analysis: DNV was able to confirm that possible future legislation that requires landfills to quantify and flare a certain amount of the gas produced is not likely to be implemented in near future when considering the waste disposition situation in Brazil. Today 56% of waste produced in Southeast of Brazil is disposed as dump and only about 37 % is destined to sanitary landfill. A major environmental problem related to domestic waste in Brazil is the lack of waste disposal to sanitary landfills."* [SIC]

The latest version of the CDM project standard for project activities (CDM-PS-PA) (version 01.0) includes references only to "*Barrier analysis*" and "*Investment analysis*" in its applicable guidance for addressing the impact of permanent post-registration changes in the project design over previously demonstrated additionality of CDM project activities.

No reference to "Common practice analysis" and/or other remaining step of the "Combined tool to identify the baseline scenario and demonstrate additionality" and/or other tool is referred in the CDM-PS-PA regarding addressing of PRCs. Anyhow, demonstration to which extent the project activity (under its revised design configuration) has been diffused in the relevant sector in Brazil is performed through application of "Step 4 - Common practice analysis".

identify the baseline scenario and demonstrate additionality" (version 06.0.0) as established by such last referred methodological tool.

Step 4a. The proposed CDM project activity(s)[91] applies measure(s) that are listed in the definitions section above

The project activity (under its revised project design) comprises methane destruction in both a set of high temperature enclosed flares and/or in a set of internal combustion gas engines (that represents, at the same time, (i) additional/alternative methane destruction devices for the project acticity 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).

While *"Methane Destruction"* is listed in the definition section of the latest version of the methodological tool "Common practice" (version 03.1) as a "*measure*", Step 4a of the "Combined tool to identify the baseline scenario and demonstrate additionality" is thus applied. This is under conformance with the stepwise approach of the methodological tool "Common practice".

Application of the stepwise approach of the methodological tool "Common practice":

Step 1: Calculate applicable capacity or output range as ±50% of the total design capacity or output of the proposed project activity:

The second "Brazilian Greenhouse Gases Emissions Inventory Report"[92] (published in July/2010) clearly states that from the period from year 1990 to 2002 the total amount of recovered methane in Brazilian landfills is considered as zero. Furthermore, from 2003 onwards, all methane destruction initiatives promoting combustion/utilization of LFG considered in such inventory represented project-based initiatives being implemented as CDM project activities promoting collection and flaring/utilization of LFG. The publication Second Brazilian Greenhouse Gases Emissions Inventory Report[93] states the following

> *"(…) all of Brazilian landfills with collection and destruction system (active system) are implemented projects under the CDM".*

Thus, in Brazil, there are no activities similar to the proposed project activity under operation or implementation without consideration of CDM benefits. All initiatives encompassing LFG collection and destruction are implemented (or are being implemented) as project-based initiatives under the CDM.

In the context of the application of this step, the determination of the total design capacity and/or output in terms of methane destruction of project activity (as required by applicable guidance of the methodological tool "Methodological tool "Common practice" (version 03.1)) is not plausible/applicable[94].

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[91] In the context of the application of the stepwise procedure of the methodological tool "Common practice" for assessing potential impact of the permanent post-registration changes in the project design over the previously demonstrated additionality for the project activity, the term "*proposed CDM project activity*" actually refers to the registered project activity.

[92] Source: Ministry of Science and Technology. The second Brazilian Greenhouse Gases Emissions Inventory Report. Page 62. Available online: http://www.mct.gov.br/upd_blob/0213/213909.pdf

[93] Document available online: http://www.mct.gov.br/upd_blob/0213/213909.pdf

[94] It is relevant to note that by having the project activity only encompassing methane destruction as GHG abatement measure, there are no equipment or conversion process used for the production of goods or provision of services to be considered. In this context, the following CDM definition of output is relevant.

> *Output: goods or services with comparable quality, properties, and application areas (e.g. clinker, lighting, residential cooking, waste disposal, steam produced, electricity produced).*

By, as an alternative, taking into account the nameplate installed capacity of the grid-connected electricity generation infrastructure located within the geographical limits of the UVS – Caieiras landfill (for which the set of internal combustion gas engines (project's methane destruction devices) represents the major components), as if the project activity were encompassing electricity generation as an additional GHG abatement measure, the applicable capacity or output range for the project activity (under its revised design configuration) could thus be calculated as follows:

- Total combined design nameplate power generation capacity (output) of the grid-connected electricity generation infrastructure located within the geographical limits of the UVS – Caieiras landfill (for which the set of internal combustion gas engines (project's methane destruction devices) represents the major components): 37.8 MW
- Calculated applicable output range (as per applicable guidance of the methodological tool "Common practice"): from 18.9 MW to 56.7 MW

Step 2: Identify similar projects (both CDM and non-CDM) which fulfil all of the following conditions:
(a) The projects are located in the applicable geographical area;
(b) The projects apply the same measure as the proposed project activity;
(c) The projects use the same energy source/fuel and feedstock as the proposed project activity, if a technology switch measure is implemented by the proposed project activity;
(d) The plants in which the projects are implemented produce goods or services with comparable quality, properties and applications areas (e.g. clinker) as the proposed project plant;
(e) The capacity or output of the projects is within the applicable capacity or output range calculated in Step 1;
(f) The projects started commercial operation before the project design document (CDM-PDD) is published for global stakeholder consultation or before the start date of proposed project activity, whichever is earlier for the proposed project activity.

In the context of the application of Step 2, similar initiatives that fulfil characteristics/aspects below are identified as follows (by taking into consideration the alternative approach applied under Step 1):

- Initiatives located in the host-country Brazil;
- Initiatives that promote methane destruction through LFG flaring and/or utilization of collected LFG as gaseous fuel for electricity generation (initiatives that generate electricity through the utilization of LFG);
- Initiatives within the calculated range in terms of nameplate power generation installed capacity (output) from 18.9 MW to 56.7 MW;
- Initiatives that started commercial operation prior to the performed global stakeholder consultation for the project activity on 04/12/2004[95];

At the time of occurred project initial design conceptualization + CDM consideration (thus prior to the period when the CDM global stakeholder consultation for the project activity was performed (period from 04/12/2004 to 03/01/2005)), there only one initiative (under operation) and/or under construction/commissioning promoting LFG collection and destruction and utilization in the whole host country Brazil:

While methane destruction *per se* cannot be assumed as representing a good or a service as per CDM rules, determination of the total design capacity and/or output in terms of methane destruction of a project activity (as required by applicable guidance of the methodological tool "Methodological tool "Common practice" (version 03.1)) is thus not plausible/applicable.

[95] As outlined in the Validation Report for the project activity, the initial version of its PDD was webhosted at the website of the DOE in charge of the validation assessment and stakeholders were invited to provide comments within a 30 days period from 04/12/2004 to 03/01/2005.

The CDM project "Bandeirantes Landfill Gas to Energy Project (BLFGE)" (UNFCCC reg. no. 0164)[96].

In the particular case of the host country Brazil, the CDM indeed has played a singular role for the implementation of LFG collection and destruction/utilization initiatives in landfills across the whole country (with the CDM triggering the implementation of ALL of such initiatives in the whole country).

This situation is still valid nowadays: in May/2018, ALL initiatives promoting methane destruction through collection and flaring and/or utilization of LFG currently under operation, construction and/or with expected/forecasted future implementation and operation in Brazil were registered (or under validation) as CDM project activities[97].

[96] The CDM project "Bandeirantes Landfill Gas to Energy Project (BLFGE)" started to utilize collected LFG as gaseous fuel for electricity generation in February/2004. The following is stated in the Monitoring Report for the 1st monitoring period of this particular CDM project activity (monitoring period from 23/03/2003 to 28/02/2006):

"(…) Some observations for the monitoring period:
- no electricity was dispatched during the whole January/2004;
- the electricity dispatched between 01/02/2004 and 31/03/2004 was excluded in this Monitoring Report because Eleropaulo hasn't monitored these data;
- in the period May/2004, June/2004 and July/2004, the measurements of electricity dispatched were made manually by Sotreq." [SIC]

[97] As per available UNFCCC CDM records, in May/2018 there were 56 initiatives registered/under validation as CDM project activities and 1 initiative registered as a Programme of Activities (PoA) promoting or planned/forecasted to promote LFG collection and destruction and/or utilization (as fuel for electricity or thermal energy (steam) generation or though supply of compressed/liquefied LFG to user(s) using trucks) in the host-country Brazil (including the CDM project activity "Caieiras landfill gas emission reduction"). Among such initiatives, there are initiatives yet under CDM validation stage. It is however noteworthy that not all of them are yet implemented/built and/or under operation:

Registered (or under validation) CDM Project activities promoting LFG collection and destruction/utilization in the host country Brazil			
UNFCCC no.	**Project tittle**	**Registration date**	**Nameplate installed/ to be installed electricity generation installed capacity (as per the registered PDD)** *(N/A: Not applicable.* *The project activity in question does not encompass utilization of collected LFG as fuel for electricity generation)*
0008	Brazil NovaGerar Landfill Gas to Energy Project	18/11/2004	N/A
0027	Onyx Landfill Gas Recovery Project – Trémembé, Brazil	24/11/2005	N/A
0052	Salvador da Bahia Landfill Gas Management Project	15/08/2005	20.1 MW. New electricity generation infrastructure located within the geographical limits of the landfill site was implemented in Jan. 2011 as a permanent post-registration change of the project design of which validation and its approval by UNFCCC was yet to occur in May/2018.
0091	Landfill Gas to Energy Project at Lara Landfill, Mauá, Brazil	15/05/2006	1 MW (that would be implemented within years 2005 and 2006) + 9 MW (that would be implemented within years 2007 and 2008). (The project's new electricity generation infrastructure is so far not yet implemented.)
0137	Brazil MARCA Landfill Gas to Energy Project	23/01/2006	Up to 11 MW. (The project's new electricity generation infrastructure is so far not yet implemented.)

0164	Bandeirantes Landfill Gas to Energy Project (BLFGE)	20/02/2006	22.2 MW.
0165	ESTRE's Paulínia Landfill Gas Project (EPLGP)	03/03/2006	N/A
0171	Caieiras landfill gas emission reduction		Up to 37.8 MW
0226	Anaconda Landfill Gas Project	15/12/2006	N/A
0373	São João Landfill Gas to Energy Project (SJ)	02/07/2006	24.64 MW
0648	Central de Resíduos do Recreio Landfill Gas Project (CRRLGP)	31/12/2006	8.556 MW. (The project's new electricity generation infrastructure was implemented in June/2015 as a permanent post-registration change of the project design (that was validated by DOE and approved by UNFCCC on 15/04/2015).)
0888	Aurá Landfill Gas Project	30/04/2007	N/A
0893	Canabrava Landfill Gas Project	08/04/2007	N/A
0911	ESTRE Itapevi Landfill Gas Project (EILGP)	17/08/2007	N/A
0912	Quitaúna Landfill Gas Project (QLGP)	27/05/2007	N/A
1133	Terrestre Ambiental Landfill Gás Project	06/05/2008	N/A
1134	ESTRE Pedreira Landfill Gas Project (EPLGP)	15/02/2008	N/A
1165	PROBIOGAS-JP – João Pessoa Landfill Gas Project	30/01/2008	N/A
1179	Embralixo/Araúna - Bragança Landfill Gas Project	15/10/2007	N/A
1249	URBAM/ARAUNA - Landfill Gas Project (UALGP)	14/10/2007	N/A
1491	CTRVV Landfill emission reduction project	28/05/2008	N/A
1506	Proactiva Tijuquinhas Landfill Gas Capture and Flaring project	13/08/2008	N/A
1626	Feira de Santana Landfill Gas Project		0.5 MW (that would be implemented in year 2009 + 0.5 MW (that would be implemented in 2011). (The project's new electricity generation infrastructure is so far not yet implemented.)
1636	Alto-Tietê landfill gas capture project	29/05/2008	N/A

1908	SANTECH – Saneamento & Tecnologia Ambiental Ltda. – SANTEC Resíduos landfill gas emission reduction Project Activity	19/02/2009	N/A
3464	Exploitation of the biogas from Controlled Landfill in Solid Waste Management Central – CTRS / BR.040	04/06/2011	5.704 MW (The project's new electricity generation infrastructure is so far not yet implemented.)
3958	CTR Candeias Landfill Gas Project	29/11/2011	4.245 MW (that would be implemented in year 2012 + 4.245 MW (that would be implemented in 2017). (The project's new electricity generation infrastructure is so far not yet implemented.)
4211	Manaus Landfill Gas Project	08/11/2011	19.2 MW. (The project's new electricity generation infrastructure is so far not yet implemented.)
4657	Itaoca Landfill Gas Project	11/08/2011	N/A
5947	CTL Landfill Gas Project	08/05/2012	19.2 MW (The project's new electricity generation infrastructure is so far not yet implemented.)
6553	CGR Guatapara Landfill Project	18/07/2012	5.5 MW
7110	Uberlândia landfills I and II	04/09/2012	2.852 MW
7637	Natal Landfill Gas to Energy Project	17/10/2012	4.2 MW (The project's new electricity generation infrastructure is so far not yet implemented.)
7799	Projeto de Gás de Aterro TECIPAR – PROGAT	23/10/2012	1.824 MW (The project's new electricity generation infrastructure is so far not yet implemented.)
8011	ENGEP & BEGREEN CDM Project at UTGR – Jambeiro Landfill	09/11/2012	N/A
8205	CGR Catanduva Landfill Gas Project	08/03/2013	4.5 MW (The project's new electricity generation infrastructure is so far not yet implemented.)
8213	ESTRE Piratininga Landfill Gas Project	26/12/2012	6.0 MW (The project's new electricity generation infrastructure is so far not yet implemented.)
8242	CTR Rosario Landfill Gas Project	26/02/2013	Up to 5.7 MW. (The project's new electricity generation infrastructure is so far not yet implemented.)
8603	Constroeste Landfill Gas to Energy Project	11/12/2012	7.2 MW. (The project's new electricity generation infrastructure is so far not yet implemented.)
8751	Proactiva CGA Iperó Landfill Gas to Energy Project	20/12/2012	8.556 MW. (The project's new electricity generation infrastructure is so far not yet implemented.)
9063	Macaúbas Landfill Gas Project	31/07/2013	Up to 12.8 MW. (The project's new electricity generation infrastructure is so far not yet implemented.)
9087	Gramacho Landfill Gas Project	26/12/2012	N/A. The project activity promotes LFG utilization other than as fuel for electricity generation. As part of the project activity, collected LFG is supplied to consumer through natural gas distribution network.
9228	CTR Maceio Landfill Gas Project	24/08/2013	Up to 10.5 MW. (The project's new electricity generation infrastructure is so far not yet implemented.)
9290	ITVR Sao Leopoldo landfill gas project	27/12/2012	N/A

9295	CTDR Bob Ambiental landfill gas project	24/06/2013	N/A
9298	CPTR Marituba landfill gas project	21/06/2013	N/A
9300	Rio Grande landfill gas project	24/06/2013	N/A
9302	CTR da Caturrita landfill gas project	28/06/2013	N/A
9943	Canhanduba Landfill Project	22/05/2014	Up to 3.180 MW (So far only 1.0 MW of installed electricity generation capacity.)
10257	Dois Arcos Landfill Gas Project Activity	13/04/2016	The project activity promotes LFG utilization other than as fuel for electricity generation. As part of the project activity, compressed/liquefied LFG is supplied to consumer using trucks
10261	Oeste de Caucaia Landfill Project Activity	22/04/2016	The project activity promotes LFG utilization other than as fuel for electricity generation. As part of the project activity, compressed/liquefied LFG is supplied to consumer using trucks.
-	CTR Feira de Santana Landfill Gas Project (CDM validation is completed. Under "pending publication" status at the UNFCCC CDM website)	-	Up to 3.0 MW. (The project's new electricity generation infrastructure is so far not yet implemented.)
-	CTR Teresina Landfill Gas Project (CDM validation is completed. Under "pending publication" status at the UNFCCC CDM website)	-	Up to 3.0 MW (The project's new electricity generation infrastructure is so far not yet implemented.)
-	Franca Araúna Landfill Bioenergy Gas Project (CDM validation is completed. Under "pending publication" status at the UNFCCC CDM website)	-	1.2 MW. (The project's new electricity generation infrastructure is so far not yet implemented.)
-	ESTRE Iguaçu Landfill Gas Project (under "validation activities are ongoing" status at the UNFCCC CDM website)	-	Up to 12.0 MW. The project's new electricity generation infrastructure is so far not yet implemented.
-	ESTRE Itaborai Landfill Gas Project (under "validation activities are ongoing" status at the UNFCCC CDM website)	-	Up to 22.5 MW. The project's new electricity generation infrastructure is so far not yet implemented.
PoA	Caixa Econômica Federal Solid Waste Management and Carbon Finance Project	PoA 6573	Electricity generation considered on a CPA basis. The so far existent unique CPA (CPA-1: Landfill gas recovery, energy generation and biogas distribution from CTR Santa Rosa) considers/encompasses utilization of collected LFG as gaseous fuel for electricity generation, however no electricity generation component was so far implemented.

It is noteworthy that while most of the LFG collection and destruction and/or utilization initiatives registered as CDM project activities were in fact implemented (built and started operations), some of such initiatives registered under the CDM or under CDM validation status were not yet implemented and/or never started to operate (especially the more recently registered ones under adverse market conditions for the CDM).

Moreover, there are previously registered CDM project activities promoting LFG collection and destruction/utilization that are not currently any longer under operation (due to technical reasons or due to adverse carbon market conditions (low prices and low liquidity for CERs)).

Among all currently so far implemented (built and under operation) initiatives promoting methane destruction through collection and flaring of LFG and LFG utilization of collected LFG as gaseous fuel for electricity generation hosted in Brazil, regardless of their implementation date, only 3 of the so far implemented initiatives have nameplate power generation installed capacity within the calculated range from 18.9 MW to 56.7 MW. Like all other LFG collection and destruction initiatives (by flaring) and/or utilization initiatives implemented in Brazil, such 3 initiatives were also implemented as CDM project activities:

Initiatives in Brazil encompassing methane destruction through collection and flaring of LFG and utilization of LFG as gaseous fuel for electricity generation in electricity generation facilities with total/combined installed capacity within the range from 18.9 MW to 56.7 MW			
CDM project activity details		**Nameplate power generation installed capacity**	**Implementation date for the project's new electricity generation infrastructure (power plant)**
0052	Salvador da Bahia Landfill Gas Management Project[98]	20.1 MW	January/2011
0164	Bandeirantes Landfill Gas to Energy Project (BLFGE)[99]	22.2 MW	February/2004
0373	São João Landfill Gas to Energy Project (SJ)[100]	24.64 MW	January/2008

Step 3: within the projects identified in Step 2, identify those that are neither registered CDM project activities, project activities submitted for registration, nor project activities undergoing validation. Note their number N_{all}.

While the initiatives identified in Step 2 are all registered, implemented and have operated as CDM project activities, therefore there is no single initiative in Brazil promoting LFG collection and utilization that was implemented not as a CDM project activity.

Thus, N_{all} is directly defined as 0 (zero).

Step 4: Within plants identified in Step 3, identify those that apply technologies that are different to the technology applied in the proposed project activity. Note their number N_{diff}.

Finally, there are LFG collection and destruction/utilization initiatives that are still under CDM validation stage and that are not yet built.

Anyhow, for sake of application of the stepwise approach of the methodological tool "Common practice", it is crucial to note that in the whole host-country Brazil there is no single initiative promoting LFG collection and destruction and/or utilization that was implemented (built and operated) without being registered as a CDM project activity. It is also relevant to note that for the particular case of almost all of the few registered project activities that encompass utilization of collected LFG as gaseous fuel for electricity generation, or the whole project activity was not yet implemented or the electricity generation component/infrastructure was not implemented (project activity operating promoting collection and destruction of LFG (through flaring)).

[98] Details about the CDM Project activity "Salvador da Bahia Landfill Gas Management Project" are available online: http://cdm.unfccc.int/Projects/DB/DNV-CUK1117823353.4/view

[99] Details about the CDM Project activity "Bandeirantes Landfill Gas to Energy Project (BLFGE)" are available online: http://cdm.unfccc.int/Projects/DB/DNV-CUK1134130255.56/view

[100] Details about the CDM Project activity "São João Landfill Gas to Energy Project (SJ)" are available online: http://cdm.unfccc.int/Projects/DB/DNV-CUK1145141778.29/view

While all initiatives identified in Step 2 are registered CDM project activities, there is no single initiative in Brazil promoting LFG collection and utilization that was implemented not as a CDM project activity.
Thus, like N_{all}, N_{diff} is also directly defined as 0 (zero).

Step 5: calculate factor $F = 1 – N_{diff} / N_{all}$ representing the share of similar projects (penetration rate of the measure/technology) using a measure/technology similar to the measure/technology used in the proposed project activity that deliver the same output or capacity as the proposed project activity.

The factor F ($F = 1 – N_{diff} / N_{all}$) is calculated as follows:

While N_{all} and N_{diff} are both defined as 0 (zero), the calculated value for factor F (calculated as "$F = 1 - N_{diff} / N_{all}$") is thus directly assumed as "*not determinable*" (1 minus an undeterminable ratio (0 / 0)).

By taking into account the "*non-determined*" value for factor F, the following conditions of the methodological tool "Common practice" for having the project activity (under its revised design configuration) being regarded as a common practice within a sector in the applicable geographical area are therefore not simultaneously met:

- Factor F > 0.2
- N_{all}-N_{diff} > 3.0

While as per applicable guidance of the methodological tool "Common practice", both conditions should be simultaneously fulfilled (in order to have the proposed project activity being regarded as a common practice within the sector in the applicable geographical area), since no value for Factor F and no value for the difference "$N_{all} - N_{diff}$" are determinable the particular case of the project activity, the implementation of the project activity (under its revised design) is thus demonstrated not being common practice during the whole period from the time of occurred project initial design conceptualization and CDM consideration (within years 2004 and 2005) until nowadays (May/2018).
This is relevant in the context of the assessment of adverse impact of the permanent post-registration change in the project design over the previously assessed and demonstration additionality for the project activity, thus sufficiently complementing and serving as a credibility check for the performed barrier analysis (Step 2).

Conclusion of the demonstration of impact of occurred and yet to occur (planned) post-registration changes in the project design over the previously assessed additionality for the project activity:
By taking into account the outcome of the application of the stepwise procedure of the "Combined tool to identify the baseline scenario and demonstrate additionality" (version 06.0.0) and the nature of the post-registration changes in the project design, it is demonstrated that project activity (under its revised design configuration) remains being additional when its revised design configuration is considered. In summary, the previously demonstrated additionality for the project activity is not undermined by the occurred and yet to occur (planned) permanent post-registration change in its design (i.e. gradual/phased implementation of internal combustion gas engines (as additional and additional/alternative methane destruction devices) + installation of backup captive off-grid electricity generator fuelled by diesel)[101].

[101] By considering their nature (as summarized in Appendix 7), the other post-registration changes encompassed by this revised version of the PDD (occurred revision of the monitoring plan and corrections (in information which do not affect project design)) represent changes that do not potentially undermine the previously demonstrated additionality for the project activity either.

Note:
Non-undermining of the previously assessed and demonstrated project's additionality by the occurred and yet to occur (planned) changes in the project design:
The occurred and yet to occur (planned) permanent changes in the project design do not compromise or negatively affect the previously assessed and demonstrated additionality for the project activity. Thus, the additionality of the project activity is not undermined.

B.6. Estimation of emission reductions

B.6.1. Explanation of methodological choices

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In accordance with ACM0001 (version 13.0.0) and applicable methodological tools, yearly emission reductions to be achieved by the project activity (under its revised project design configuration) (ER_y) during the 2nd 7-year crediting period are determined (in tCO_2e) as the difference between baseline emissions (BE_Y) and project emissions (PE_Y) as follows:

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

Where:

BE_y	Baseline emissions in year *y* (in tCO_2e/yr)
PE_y	Project emissions in year *y* (in tCO_2e/yr)

Determination of Baseline Emissions (BE_Y):

ACM0001 (version 13.0.0) establishes that baseline emissions (BE_y) are determined according to the following equation and comprise the following sources:

(A) Baseline emissions for methane emissions from anaerobic waste decomposition in the considered solid waste disposal site (SWDS) in the absence of the project activity;

(B) Baseline emissions for electricity generation using fossil fuels in the absence of the project activity;

(C) Baseline emissions for heat generation using fossil fuels in the absence of the project activity; and;

(D) Baseline emissions for natural gas use (from the natural gas distribution network) in the absence of the project activity.

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

Where:

$BE_{CH4,y}$	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, electricity generation using LFG as fuel is not considered/regarded as an additional GHG abatement measure for the project activity. Furthermore, no collected LFG is currently expected to be utilized 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, $BE_{EC,y,}$ $BE_{HG,y}$ and $BE_{NG,y}$ are not applicable in the context of the determination of baseline emissions for the project activity during its 2nd 7-year renewable crediting period and are all thus regarded as null.

Thus, the determination of baseline emissions is summarized as follows:

$BE_y = BE_{CH4,y}$ **(2)**

Baseline methane emissions ($BE_{CH4,y}$) are calculated in conformance with Step (A) of ACM0001 (version 13.0.0) by following the approaches presented below.

Step (A) (of ACM0001 (version 13.0.0)): Baseline emissions of methane from the SWDS ($BE_{CH4,y}$):

Baseline methane emissions from the anaerobic waste decomposition in the considered SWDS[102] ($BE_{CH4,y}$) 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 destroyed by the project activity infrastructure through combustion of collected LFG in the project's methane destruction devices and also by taking in account the amount of methane that would have been captured and destroyed in at the UVS - Caieiras 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 13.0.0)[103]:

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

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)

[102] SWDS represents abbreviation for Solid Waste Disposal Site.

[103] As established by ACM0001 (version 13.0.0), 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 in the absence of the project activity (baseline scenario). As per ACM0001 (version 13.0.0), it is assumed that for a typical landfill hosting a LFG collection and destruction 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 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 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.

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

Step A.1 (of ACM0001 (version 13.0.0)): Ex post determination of $F_{CH4,PJ,y}$

As per ACM0001 (version 13.0.0), 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 the 2nd 7-year renewable crediting period is to be ex-post determined (in tCH_4/yr) 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).

$F_{CH4,HG,y}$ 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 13.0.0), $F_{CH4,EL,y}$, $F_{CH4,HG,y}$ 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 02.0.0), 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 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)

Determination of $F_{CH4,sent\_flare,y}$:

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 02.0.0). As per the ACM0001 (version 13.0.0), 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 02.0.0) and by taking into account the following requirements defined by ACM0001 (version 13.0.0):

- 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 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 02.0.0) will be applied to determine $F_{CH4,sent\_flare,y}$ and $F_{CH4,EL,y}$ [104] 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 2nd 7-year crediting period.

[104] In the methodological tool "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" 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 $F_{i,t.}$

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 and/or applied monitoring equipment/instruments, one of the following measurement options will be chosen and the following formulas applied for the determination of as $F_{i,t}$ [105]:

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

Option A:

Flow measurement on a dry basis is not doable for a wet gaseous stream. Therefore, it is necessary to demonstrate that the gaseous stream is dry to use this option. 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 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)

[105] The selection of option A, B, C or D will be done on an ex-post basis.

MM_i Molecular mass of greenhouse gas *i* (in kg/kmol)

R_u Universal ideal gases constant (in Pa.m^3/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 m^3 dry 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)

$v_{H2O,t,db}$ 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.

Option C:

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 13.0.0), $PE_{flare,y}$ is determined by following applicable guidance of the methodological tool "Project emissions from flaring".

While share of collected LFG is expected to be combusted by flaring in a set of installed high temperature enclosed flares, then $PE_{flare,y}$ is the sum of the related emissions for each individual flare of which are calculated separately (as established by the methodological tool).

For each individual flare, the calculation procedure in the refereed 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 (of the methodological tool "Project emissions from flaring"): 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 02.0.0) 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 02.0.0) 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 minute *m* ($F_{CH4,RG,m}$). $F_{CH4,m}$ shall be determined on a dry basis.

Step 2 (of the methodological tool "Project emissions from flaring"): Determination of flare efficiency

As required by ACM0001 (version 13.0.0), the flare efficiency values will be determined for each flare. Also as per ACM0001 (version 13.0.0), flare efficiency represents the combustion efficiency of LFG in the flare in terms of CH_4 by considering *inter alia* the time that the flare in question is operating. For determining the combustion efficiency for the enclosed flare in question, there is the option to apply a default efficiency value or determining the flare efficiency based on monitored data (based on applicable measurements and calculations).

The time each one of the project's high temperature enclosed flares has operated is determined by monitoring the flame combustion status/condition by using a flame detector and, for the case of 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", where the flare efficiency will be determined on the basis of biannual basis related measurements. In case 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" will be used as an alternative.
Both options are summarized below:

Option A: Apply default value for flare efficiency[106].

Option B: Measure the flare efficiency.

Option A: 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 o 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.

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

(1) The temperature of the exhaust gas of the flare (monitoring parameter $T_{EG.m}$) and the flow rate LFG to the flare (monitoring parameter $F_{RG,m}$) 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 $Flame_m$).

[106] The methodological tool establishes that, for high temperature enclosed flares that are defined as low height flares, the flare efficiency in the minute *m* ($\eta_{flare,m}$) shall be adjusted, as a conservative approach, by subtracting 0.1 from the efficiency as determined in Options A or B. For example, the default value applied should be 80%, rather than 90%, and if for example the measured value was 99%, then the value to be used shall correspond to 89%. In May/2013, there was no low height flare installed as part of the project activity and it is not expected that any low height flare will ever installed as part of the project activity during the 2nd renewable crediting period. All high temperature enclosed flares which are installed as part of the project activity are high height flares.

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

In applying Option B, the project participants choose to determine $\eta_{flare,calc,m}$ using 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 with the following calculation formula being applied:

Option B.1: Biannual measurement of the flare efficiency

The calculated flare efficiency $\eta_{flare,calc,m}$ is determined as the average of two measurements of the flare efficiency made in year *y* ($\eta_{flare,calc,y}$), as follows:

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

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

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[107], and consists of the sum of methane flow in the minutes *m* that makes up the time period *t*.

Step 3 (of the methodological tool "Project emissions from flaring"): 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)

[107] 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*.

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

Step A.1.1 (of ACM0001 (version 13.0.0)): Ex ante estimation of $F_{CH4,PJ,y}$

An *ex-ante* estimate of $F_{CH4,PJ,y}$ is required to estimate methane baseline emission from the UVS - Caieiras landfill in order to estimate the emission reductions to be achieved by project activity during the 2nd 7-year crediting period.

As established by ACM0001 (version 13.0.0), $F_{CH4,PJ,y}$ is estimated as follows:

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

Where:

$F_{CH4,PJ,y}$ 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)

$BE_{CH4,SWDS,y}$ Amount of methane in the LFG that is generated from the SWDS[108] in the baseline scenario in year *y* (in tCO_2e)

η_{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 by applying guidance from 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 13.0.0);
- In the tool, *x* begins with the year that the SWDS started receiving solid waste (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 is assumed as being potentially obtained from previous studies.

For the ex-ante estimation of the amount of methane destroyed/combusted by the project activity ($F_{CH4,PJ,y}$) during each year *y* of the 2nd 7-year crediting period, $BE_{CH_4,SWDS,y}$, is determined as follows:

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

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)

[108] SWDS refers to the UVS - Caieiras landfill which is the solid waste disposal site where the project activity is implemented.

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)
φ_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 13.0.0). 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 13.0.0.) and assigned value for f_y, this parameter will thus not be monitored ex-post during the 2nd 7-year credtiting period.
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 (in 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. Essencis Soluções Ambientais S.A. highlights 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 13.0.0). While the project activity only involves collection and destruction of LFG at the UVS - Caieiras landfill (without promoting any change in the management and operation of the landfill), it does not prevent any waste from being deposited 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 the 2nd 7-year renewable 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.

Step A.2 (of ACM0001 (version 13.0.0)): Determination of $F_{CH4,BL,y}$

As required by ACM0001 (version 13.0.0), this step represents the application of the stepwise procedure for the quantitative 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, or to address eventually existent applicable safety and odors concerns (which are collectively referred to as "*requirement*"[109] under this step).

The four cases summarized in the table below are distinguished in ACM0001 (version 13.0.0). As also required by ACM0001 (version 13.0.0), the appropriate case for the particular baseline context of the project activity is identified and justified below:

Cases for determining methane captured and destroyed in the baseline as per ACM0001 (version 13.0.0)

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

[109] It is important to note that as per the related methodological approach applied by ACM0001 (version 13.0.0), a "*requirement*" to capture and destroy LFG in the baseline scenario does not necessarily should be regulatory or contractual requirements.

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 in Brazil:

Like the situation valid prior to the start of the 1st 7-year crediting period, currently there is still being no legal obligation to capture and destroy/utilize LFG at the UVS - Caieiras landfill[110]. Furthermore, this situation is currently not expected to be changed during the time period to be encompassed by the 2nd 7-year crediting period 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 due to following:

- Although there is 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), in the absence of the project activity, it is acknowledged that 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 conventional

[110] In September 2015, 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 a recently published article:

> *"(...) 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

passive LFG venting/combustion drains in order to appropriately address safety and odor concerns under the baseline scenario[111]. 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 13.0.0) 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 13.0.0), 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 regarded as not applicable cases for the determination of $F_{CH4,BL,y}$ in the context of the demonstration of the continuation of the previously derived baseline scenario and determination of baseline emissions for the 2nd 7-year renewable crediting period of the project activity.

Thus, the remaining possibly valid alternatives (cases) (after the analysis of existence of non-regulatory and non-contractual requirements to destroy methane due to safety and odor concerns) are thus Case 2 and Case 4.

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 – when the project activity initiated its operations), a very small fraction of methane generated at the UVS - Caieiras landfill was destroyed through combustion. In fact, a very reduced part of generated LFG was combusted through use of conventional LFG venting/combustion drains. Such conventional and rudimentary LFG management solution was at that time the only existent infrastructure for LFG management at the project site 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[112]. 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).

[111] 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. 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.

[112] 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 May/2018, there were yet about 90 conventional 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.

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[113].

By taking into account the definitions of "*LFG capture system*", "*Existing LFG capture and destruction system*" and "*existing LFG capture system*" as per ACM0001 (version 13.0.0)[114], 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 -

[113] 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 300 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 90 units in May/2018). In these conventional and 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 and 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. Unfortunately, the too low prices for CERs in May/2013 has acted as a barrier for promoting the further investment expenditures and face the additional operational and maintenance costs which would occur. 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 consideration (a) and (b), it is thus clear that the still existence of passive and conventional 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 the 2nd 7-year crediting period.

[114] As per ACM0001 (version 13.0,0), "*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 13.0.0), "*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." ACM0001 (version 13.0.0) also defines "*LFG capture system" as "*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."*

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 13.0.0):

- 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 2nd 7-year renewable 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 the 2nd 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 landfill and also as set by operational requirements for the UVS - Caieiras 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 to promote any management of LFG at the 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 drains, whenever the drains are not lid, LFG is just freely vented into the atmosphere through the drains. In practical terms, a very small fraction of total amount of LFG generated at the landfill have been actually combusted in the 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 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 (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[115]. Thus, in the absence of the proposed CDM project activity, no continuous 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 an operational requirement to address safety and odor concerns. It is also important to note that, as the operator of this landfill, Essencis Soluções Ambientais S.A. would not have any economic or operational incentive/motivation to convert the existing LFG venting/combustion drains into a more 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 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)[116].

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 13.0.0):

"*$F_{CH4,BL,y}$ 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)*

[115] No continuous combustion of LFG has also been the practice in most of the currently still existing remaining conventional and 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.

[116] It is important to observe that as per the situation valid in May/2018, 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.

$F_{CH4,BL,R,y}$ 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 13.0.0); 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[117]), the installation of a conventional system to destroy LFG (applying conventional passive LFG venting/combustion drains) with an assumed default and conservative CH_4 destruction efficiency of 20% (as established by ACM0001 (version 13.0.0)) is thus considered under a conservative and simplified approach [118].

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[117] 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.

[118] As per ACM0001 (version 13.0.0), 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 13.0.0):

> *"(…)*
> *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:*
> *$F_{CH4,BL,R} = 0.2 * F_{CH4,PJ,capt,y}$*

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).

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 13.0.0). By promoting combustion of LFG, such system also meets the definition of "*LFG capture and destruction system*" of ACM0001 (version 13.0.0). 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 13.0.0) (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 the 2nd 7-year crediting period in order to follow the guidance. By considering that in June/2013, more than 25,000 Nm^3/h of LFG has been continuously collected and destroyed by flaring 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 about 5,000 Nm^3/h of LFG would be destroyed by combustion (in the baseline conventional LFG venting/combustion drains) represents a very conservative and not realistic assumption.

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

By (i) taking into account the applicable definition of "*requirement*" as per ACM0001 (version 13.0.0); 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[119]:

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 13.0.0), $F_{CH4,PJ,capt,y}$ 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* (as determined in Step A.1), 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 $F_{CH4,BL,y}$).

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 13.0.0), $F_{CH4,PJ,capt,y}$ 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

[119] As per ACM0001 (version 13.0.0), 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:*

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

engines and set of the high temperature enclosed flares) in year *y* (as determined in Step A.1), (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 $F_{CH4,BL,y}$ [120]).

Step (B) (of ACM0001 (version 13.0.0)): Baseline emissions associated with electricity generation ($BE_{EC,y}$)

Not applicable. The only type of GHG 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 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.

Step (C) (of ACM0001 (version 13.0.0)): Baseline emissions associated with heat generation ($BE_{HG,y}$)

As the project activity (under its revised design configuration) 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.

Step (D) (of ACM0001 (version 13.0.0)): Baseline emissions associated with natural gas use ($BE_{NG,y}$)

As the project activity (under its revised design configuration) 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, baseline emissions associated with natural gas use in year *y* ($BE_{NG,y}$) are not considered. In summary, this step is not applicable.

Monitoring of the management of the landfill:
As required by ACM0001 (version 13.0.0), during the 2nd 7-year crediting period, 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 2nd 7-year crediting period, 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 during the 2nd crediting period, when compared to the landfill management and operation condition prior to implementation of the project activity and/or during the 1st crediting

[120] 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.

period. As required by ACM0001 (version 13.0.0), 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 13.0.0), project emissions (PE_y) are calculated (in tCO_2/yr) as follows:

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

Where:

PE_y	Project emissions in year *y* (in tCO_2/yr)
$PE_{EC,y}$	Project emissions from consumption of electricity due to the project activity in year *y* (tCO_2/yr)
$PE_{FC,y}$	Project emissions from consumption of fossil fuels due to the project activity (for purpose other than electricity generation) in year *y* (tCO_2/yr)

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 high temperature enclosed flares[121]. As required by ACM0001 (Version 13.0.0), 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 methodological tool "Tool to calculate project or leakage CO_2 emissions from fossil fuel". ACM0001 (version 13.0.0) 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 ($FC_{i,j,y}$) 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.

[121] 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.

Thus,

$PE_{FC,y} = PE_{LPG,y}$ **(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 methodological tool "Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion" (version 02) is applied as follows:

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

Where:

$FC_{LPG,y}$ Quantity of LPG consumed (in ton LPG);

$COEF_{LPG,y}$ 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 methodological tool "Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion" (version 02) as follows:

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

Where:

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

$EF_{CO2,LPG,y}$ CO_2 emission factor of fuel LPG (in tCO_2/GJ LPG)

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

As required by ACM0001 (version 13.0.0), 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 "Tool to calculate baseline, project and/or leakage emissions from electricity consumption".

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 (…)*"

ACM0001 (version 13.0.0) establishes the *following* when applying this methodological tool:

- *"$EC_{PJ,k,y}$[122] in the tool is equivalent to the amount of electricity consumed by the project*

[122] As per the methodological tool "Tool to calculate baseline, project and/or leakage emissions from electricity consumption" (version 1), $EC_{PJ,j,y}$ is the quantity of electricity consumed by the project electricity consumption source *j* in year *y*.

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, electricity sources *j* in the tool corresponds to the sources of electricity consumed due to the project activity: grid-sourced electricity and 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 other sources of electricity are currently expected to be used to meet the electricity demand of the project activity during the 2nd 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 used in the pre-project and baseline scenarios 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 not applicable/considered.

According to the methodological tool "Tool to calculate baseline, project and/or leakage emissions from electricity consumption", project emissions due to electricity consumption by the project activity ($PE_{EC,y}$) are calculated as follows:

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

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 sources of electricity consumed by the project activity, $PE_{EC,y}$ can thus be calculated as:

$$PE_{EC,y} = PE_{EC,grid,y} + PE_{EC,captive,y} \quad \textbf{(32)}$$

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 "Tool to calculate baseline, project and/or leakage emissions from electricity consumption" (version 1) 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 ($PE_{EC,grid,y}$)[123] are determined as follows:

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

Where:

$EC_{PJ,grid,y}$ Quantity of grid sourced electricity consumed by the project activity in year *y* (in MWh)

$TDL_{grid,y}$ Average technical transmission and/or distribution losses for providing electricity to the grid and/or for grid sourced electricity consumed by the project activity.

$EF_{EL,grid,y}$ 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."*

The following above-quoted options of the methodological tool will thus be analysed ex-post for the determination of $EF_{EL,grid,y}$ (with the most conservative (higher) value being chosen) as follows:

[123] 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). It is also relevant to note that, while the project activity is connected to a very stable and reliable electricity transmission/distribution lines, since its installation of in July/2016, the backup captive off-grid electricity generator (fuelled by diesel) has not been utilized (with exception of 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 selected as a generic approach. Within a specific monitoring period along the 2nd 7-year crediting period, in case it is confirmed that the installed backup captive off-grid electricity generator (fuelled by diesel) was not used during the period in question, project emissions due to the consumption of electricity from such backup captive generator will thus directly be determined as null/zero and, 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 "Tool to calculate baseline, project and/or leakage emissions from electricity consumption" (version 1) for the ex-post determination of $EF_{EL,grid,y}$ as established by guidance of tool for Case C.I).

- 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 04.0).

- 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:

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

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 tim 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").

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

As per Option A.1 of the methodological tool "Tool to calculate baseline, project and/or leakage emissions from electricity consumption" (version 1) 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 is calculated in accordance with the "Tool to calculate the emission factor for an electricity system" (version 04.0). This methodological tool determines the

CO_2 emission factor for the displacement of electricity generated by grid-connected power plants, 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 04.0), $EF_{CM,y}$ is determined as a weighted average of 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 04.0) 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. 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. 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[124].

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:

$$EF_{grid,OM\text{-}DDy} = \frac{\sum_{h} EG_{PJ,h} \cdot EF_{EL,DD,h}}{EG_{PJ,y}} \quad \textbf{(35)}$$

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 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

[124] The Ministry of Science, Technology, Innovation and Communications (MCTIC) has been calculating the CO_2 emission factor according to the methodology tool "Tool to calculate the emission factor for an electricity system" (version 04.0 and previous versions), approved by the CDM Executive Board. The CO_2 emission factor was obtained in the Brazilian DNA website. Source of data used: Tool to calculate the emission factor for an electricity system (version 04.0 and previous versions): The actual value 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 Brazilian DNA calculated the value based on the Tool. 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).

period should be used. This option does not require monitoring the emission factor during the crediting period.

<u>Option 2:</u> 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 is selected for the 2nd 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 DNA of Brazil has regularly published an official value for $EF_{grid,BM,y}$[125]. The latest published value (applicable for year 2014) is thus the value for the ex-ante selected parameter $EF_{grid,BM,y}$ and is calculated as follows:

$$EF_{grid,BM,y} = \frac{\sum_m EG_{m,y} \cdot EF_{EL,m,y}}{\sum_m EG_{m,y}} \quad \textbf{(36)}$$

Where:

$EF_{grid,BM,y}$	Build margin CO_2 emission factor in year *y* (tCO_2/MWh)
$EG_{m,y}$	Net quantity of electricity generated and delivered to the grid by power unit *m* in year *y* (MWh)
$EF_{EL,m,y}$	CO_2 emission factor of power unit *m* in year *y* (tCO_2/MWh)
m	Power units included in the build margin
y	Most recent historical year for which power generation data is available

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

The combined margin emissions factor is calculated as follows:

$$EF_{grid,CM,y} = EF_{grid,OM,y} * w_{OM} + EF_{grid,BM,y} * w_{BM} \quad \textbf{(37)}$$

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 (%)

[125] Details about the determination of values for the CO_2 emission factor for the national electricity grid of Brazil by the DNA of Brazil are made available online in the website of the DNA of Brazil: http://www.mctic.gov.br/mctic/opencms/textogeral/emissao_despacho.html

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 whole 2nd 7-year crediting period) are selected ex-ante, annual values for $EF_{grid,OM,y}$ within the credting period will be determined ex-post as required by the "Tool to calculate the emission factor for an electric system". Thus, during the 2nd 7-year crediting period, 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:
>
> $$PE_{EC,captive,y} = EC_{PJ,captive,y} * EF_{EL,captive,y} * (1 + TDL_{captive,y}) \quad \textbf{(38)}$$
>
> 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 $EF_{EL,grid,y}$, the Options A.1, A.2, B.1 and/or B.2 of the methodological tool will be analysed ex-post for the determination of $EF_{EL,captive,y}$.

Determination of leakage emissions (LE_y):

No leakage emissions are expected to occur. Moreover, no leakage effects are accounted for under ACM0001 (version 13.0.0).

Note: The post-registration changes addressed in this revised version of the PDD (permanent changes in the project design, the revision of the monitoring plan and performed corrections (in information which do not affect project design)) are under conformance with applicability requirements of ACM0001 (version 13.0.0) + applicable methodological tools. The scale and the level of accuracy and completeness in overall monitoring of the project activity are not adversely affected by such post-registration changes either. Applied monitoring (including the design of the monitoring plan) and GHG calculation approaches are however improved and complemented, thus meeting both additional monitoring requirements for the project activity (under its revised design configuration) and GHG calculation approaches required/established by ACM0001 (version 13.0.0) + applicable methodological tools.

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 13.0.0)
Purpose of data	Data is used for determination of baseline emissions
Additional comment	

Data/Parameter	GWP_{CH4}
Data unit	tCO_2e/tCH_4
Description	Global Warming Potential of CH_4
Source of data	"Global Warming Potential for Given Time Horizon" in table 2.14 of the errata to the contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, based on the effects of greenhouse gases over a 100-year time horizon. Available at: www.ipcc.ch/publications_and_data/ar4/wg1/en/ch2s2-10-2.html#table-2-14 The applied value is also in accordance with the "Standard for application of the global warming potential to clean development mechanism project activities and programmes of activities for the second commitment period of the Kyoto Protocol"
Value(s) applied	25
Choice of data or measurement methods and procedures	-
Purpose of data	Data is used for determination 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	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 02.0.0)
Value(s) applied	8,314
Choice of data or measurement methods and procedures	-
Purpose of data	Data is use for determination of baseline emissions
Additional comment	-

<table>
<tr><td>Data/Parameter</td><td>MM_k</td></tr>
<tr><td>Data unit</td><td>kg/kmol</td></tr>
<tr><td>Description</td><td>Molecular mass of gas k</td></tr>
<tr><td>Source of data</td><td>Default values as per the methodological tool “Tool to determine the mass flow of a greenhouse gas in a gaseous stream” (version 02.0.0)</td></tr>
<tr><td>Value(s) applied</td><td>For considered gases k that are greenhouse gases (GHGs), the values below are applied for MMi.
The methodological tool “Tool to determine the mass flow of a greenhouse gas in a gaseous stream” establishes the following:

“The determination of the molecular mass of the gaseous stream ($MM_{t,db}$) requires measuring the volumetric fraction of all gases (k) in the considered gaseous stream. However as a simplification, only the volumetric fraction of gases k that are greenhouse gases and are considered in the emission reduction calculation in the underlying methodology must be monitored and the difference to 100% may be considered as pure nitrogen. The simplification is not acceptable if it is differently specified in the underlying methodology.”

ACM0001 (version 13.0.0) does not include any restriction to such simplification. Thus, only the volumetric fraction of gases that are greenhouse gases and are considered in related calculations (CH_4 in the particular case of the project activity) and the difference to 100% is just considered as pure nitrogen.

<table>
<tr><th>Compound</th><th>Structure</th><th>Molecular mass (kg / kmol)</th></tr>
<tr><td>Nitrogen</td><td>N_2</td><td>28.01</td></tr>
</table>
</td></tr>
<tr><td>Choice of data or measurement methods and procedures</td><td>-</td></tr>
<tr><td>Purpose of data</td><td>Data is used for determination of baseline emissions.</td></tr>
<tr><td>Additional comment</td><td>-</td></tr>
</table>

Data/Parameter	**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 02.0.0)
Value(s) applied	The following values of molecular mass are applicable for CH_4 (the only GHG which is considered): Compound: Methane; Structure: CH_4; Molecular mass (kg/kmol): 16.04
Choice of data or measurement methods and procedures	-
Purpose of data	Data is used for determination 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 02.0.0)
Value(s) applied	101,325
Choice of data or measurement methods and procedures	-
Purpose of data	Data is used for determination 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 02.0.0)
Value(s) applied	18.0152
Choice of data or measurement methods and procedures	-
Purpose of data	Data is used for determination 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 02.0.0)
Value(s) applied	273.15
Choice of data or measurement methods and procedures	-
Purpose of data	Data is used for determination of baseline emissions
Additional comment	-

Data/Parameter	η_{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[126] and also by taking into consideration the design and operational characteristics/aspects of the UVS - Caieiras landfill + the general construction, design and forecasted implementation of the project's LFG collection network during the 2nd 7-year crediting period[127].
Purpose of data	Data is used for determination of baseline emissions.
Additional comment	Selected value can also be represented as percentage, since 0.9280 = 92.80%

[126] *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%."* [SIC]

This document also mentions the following:

> *"(…) 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

The UVS - Caieiras landfill is a well-engineered landfill as shown by the maximum classification obtained in IQR in 2009, 2010 and 2011 (Page 57 of the 2011 edition of the "Inventário dos resíduos sólidos domiciliares"), the index annually published by CETESB, the environmental state agency, to evaluate landfill characteristics.
The document "*Inventário dos resíduos sólidos domiciliares, 2011 edition*" was delivered to the DOE as part of the evidences of the validation process of the project activity.

[127] As part of the expected implementation and operation of the project activity during the 2nd 7-year renewable crediting period, there is a willingness of the project participant Essencis Soluções Ambientais S.A. to convert most of the still remaining conventional LFG venting/combustion drains into appropriate LFG collecting wells and connect such wells into the project's LFG collection pipeline network, thus increasing the project's LFG collection efficiency when compared to the situation in the last years of the 1st 7-year crediting period. During the last years of the 1st 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 possible to 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). Due to that the overall efficiency of the project's LFG collection and destruction system is assumed as being lower than 92.80% during such period. The forecasted improvements in the project's LFG collection system to occur during the 2nd 7-year renewable crediting period will allow increase in the project's LFG collection efficiency.

Data/Parameter	$TDL_{grid,y}$
Data unit	-
Description	Average technical transmission and distribution losses for providing electricity to the grid and/or for grid sourced electricity consumed by the project activity.
Source of data	Applicable default values as per the "Tool to calculate baseline, project and/or leakage emissions from electricity consumption" (version 01).
Value(s) applied	20% (for electricity imported by the project activity through the electricity grid the project activity is connected to ($TDL_{grid,import,y}$))
Choice of data or measurement methods and procedures	The "Tool to calculate baseline, project and/or leakage emissions from electricity consumption" (version 01) defines, as alternative, default value of 20% for project consumption sources (applicable for determination of project emissions due to consumption of grid-sourced electricity by the project activity). The selection of this default value is under conformance with applicable guidance of ACM0001 (version 13.0.0). The selection of 20% value for $TDL_{grid,import,y}$ also meet applicable guidance of the "Tool to calculate baseline, project and/or leakage emissions from electricity consumption" (version 01).
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	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 04.0)
Value(s) applied	0.75 (75%) during the 2nd 7-year crediting period
Choice of data or measurement methods and procedures	The applicable value valid for 2nd crediting period as per the methodological tool "Tool to calculate the emission factor for an electricity system" (version 04.0) is selected.
Purpose of data	Data is used for determination of project emissions due to the consumption of grid-sourced electricity by the project activity.
Additional comment	Value for w_{BM} will only be used in case alternative approach 1 (option A.1 of the methodological tool "Tool to calculate baseline, project and/or leakage emissions from electricity consumption") is selected for the determination of project emissions due to the consumption of grid-soured electricity by the project activity ($PE_{EC,grid,y}$).

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 04.0)
Value(s) applied	0.25 (25%) during the 2nd 7-year crediting period
Choice of data or measurement methods and procedures	The applicable value for the 2nd crediting period as per the methodological tool "Tool to calculate the emission factor for an electricity system" (version 04.0) is selected.
Purpose of data	Data is used for determination of project emissions due to the consumption of grid-sourced electricity by the project activity.
Additional comment	Value for w_{OM} will only be used in case alternative approach 1 (option A.1 of the methodological tool "Tool to calculate baseline, project and/or leakage emissions from electricity consumption") is selected for the determination of project emissions due to the consumption of grid-soured electricity by the project activity ($PE_{EC,grid,y}$).

Data/Parameter	$\varphi_{default}$
Data unit	Dimensionless
Description	Default value for 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). Source for weather condition data: http://www.tempoagora.com.br/previsaodotempo.html/brasil/Caieiras-SP/
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	Data is used for ex-ante estimation of annual accumulated values for the "Amount of methane which is destroyed by the project activity through combustion of collected LFG in project's methane destruction devices" ($F_{CH4,PJ,y}$) in the context of ex-ante estimation of emission reductions to be achieved by the project activity during the 2nd 7-year renewable crediting period.
Additional comment	-

Data/Parameter	OX
Data unit	Dimensionless
Description	Oxidation factor (reflecting the amount of methane from the considered 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	Data is used for ex-ante estimation of annual accumulated values for the "Amount of methane which is destroyed by the project activity through combustion of collected LFG in project's methane destruction devices" ($F_{CH4,PJ,y}$) in the context of ex-ante estimation of emission reductions to be achieved by the project activity during the 2nd 7-year renewable crediting period.
Additional comment	

Data/Parameter	F
Data unit	Dimensionless
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	Data is used for ex-ante estimation of annual accumulated values for the "Amount of methane which is destroyed by the project activity through combustion of collected LFG in project's methane destruction devices" ($F_{CH4,PJ,y}$) in the context of ex-ante estimation of emission reductions to be achieved by the project activity during the 2nd 7-year renewable crediting period.
Additional comment	-

Data/Parameter	$DOC_{f,default}$
Data unit	Dimensionless
Description	Fraction of degradable organic carbon (DOC) in MSW that decomposes in the considered 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	Data is used for ex-ante estimation of annual accumulated values for the "Amount of methane which is destroyed by the project activity through combustion of collected LFG in project's methane destruction devices" ($F_{CH4,PJ,y}$) in the context of ex-ante estimation of emission reductions to be achieved by the project activity during the 2nd 7-year renewable crediting period.
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	**$MCF_{default}$**
Data unit	Dimensionless
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: "*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;"* 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	Data is used for ex-ante estimation of annual accumulated values for the "Amount of methane which is destroyed by the project activity through combustion of collected LFG in project's methane destruction devices" ($F_{CH4,PJ,y}$) in the context of ex-ante estimation of emission reductions to be achieved by the project activity during the 2nd 7-year renewable crediting period.
Additional comment	-

<table>
<tr><td>Data/Parameter</td><td>DOC_j</td></tr>
<tr><td>Data unit</td><td>Dimensionless</td></tr>
<tr><td>Description</td><td>Fraction of degradable organic carbon in the waste type j (weight fraction)</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), that refers to IPCC 2006 Guidelines for National Greenhouse Gas Inventories, (adapted from Volume 5, Tables 2.4 and 2.5).</td></tr>
<tr><td>Value(s) applied</td><td>
<table>
<tr><th>Waste type j</th><th>DOC_j (% wet waste)</th></tr>
<tr><td>Wood and wood products</td><td>43</td></tr>
<tr><td>Pulp, paper and cardboard (other than sludge)</td><td>40</td></tr>
<tr><td>Food, food waste, beverages and tobacco (other than sludge)</td><td>15</td></tr>
<tr><td>Textiles</td><td>24</td></tr>
<tr><td>Garden, yard and park waste</td><td>20</td></tr>
<tr><td>Glass, plastic, metal, other inert waste</td><td>0</td></tr>
</table>
</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>Data is used for ex-ante estimation of annual accumulated values for the “Amount of methane which is destroyed by the project activity through combustion of collected LFG in project’s methane destruction devices” ($F_{CH4,PJ,y}$) in the context of ex-ante estimation of emission reductions to be achieved by the project activity during the 2nd 7-year renewable crediting period.</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).
Source of data for mean annual temperature (MAT) and mean annual precipitation (MAP): Tempo Agora (http://www.tempoagora.com.br/previsaodotempo.html/brasil/Caieiras-SP/)</td></tr>
<tr><td>Value(s) applied</td><td>
<table>
<tr><th>Degradation speed</th><th>Waste type</th><th>k_j</th></tr>
<tr><td rowspan="2">Slowly degrading</td><td>Wood, wood products</td><td>0.03</td></tr>
<tr><td>Pulp, paper and cardboard (other than sludge), textiles</td><td>0.06</td></tr>
<tr><td>Moderately Degrading</td><td>other (non-food) organic putrescible Garden, yard and park waste</td><td>0.10</td></tr>
<tr><td>Rapidly degrading</td><td>Food, food waste, sewage sludge, beverages and tobacco</td><td>0.185</td></tr>
</table>
</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:
Mean Annual Temperature (MAT) = 19 ^{o}C
Mean Annual Precipitation (MAP) = 1,374 mm – (wet climate).</td></tr>
<tr><td>Purpose of data</td><td>Data is used for ex-ante estimation of annual accumulated values for the “Amount of methane which is destroyed by the project activity through combustion of collected LFG in project’s methane destruction devices” ($F_{CH4,PJ,y}$) in the context of ex-ante estimation of emission reductions to be achieved by the project activity during the 2nd 7-year renewable crediting period.</td></tr>
<tr><td>Additional comment</td><td>Domestic sludge was assumed to be rapidly degrading and rubber and leather slowly degrading waste.</td></tr>
</table>

Data/Parameter	W_j
Data unit	Dimensionless
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	
Choice of data or measurement methods and procedures	-
Purpose of data	Data is used for ex-ante estimation of annual accumulated values for the "Amount of methane which is destroyed by the project activity through combustion of collected LFG in project's methane destruction devices" ($F_{CH4,PJ,y}$) in the context of ex-ante estimation of emission reductions to be achieved by the project activity during the 2nd 7-year renewable crediting period.
Additional comment	No composition analysis for MSW disposed at the UVS - Caieiras landfill is currently available.

Waste type *j*	W_j (% wet waste)
Wood and wood products	4.7
Pulp, paper and cardboard (other than sludge)	17.1
Food, food waste, beverages and tobacco (other than sludge)	44.9
Textiles	2.6
Garden, yard and park waste	0.0
Glass, plastic, metal, other inert waste	30.7

Data/Parameter	$SPEC_{flare}$
Data unit	°C (for temperature values) Nm^3/h (for LFG flow values) Number of days (for maintenance schedule interval values)
Description	Manufacturer's flare specifications for temperature, flow rate and maintenance schedule interval.
Source of data	Flare manufacturer[128]

[128] 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[129]:

$SPEC_{flare, Flare 1}$ **$SPEC_{flare, Flare 2}$** **$SPEC_{flare, Flare 3}$**	**Min.**	**Max.**
Operational LFG flow (for continuous operation):	650 Nm^3/h	6,500 Nm^3/h (until the occurred performance of service intervention on 08/06/2015) 7,500 Nm^3/h (after the occurred performance of service intervention on 08/06/2015)[130]
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	

$SPEC_{flare, Flare 4}$	**Min.**	**Max.**
LFG flow (for continuous operation):	650 Nm^3/h	6,500 Nm^3/h (until the occurred performance of service intervention on 08/06/2015) 7,500 Nm^3/h (after the occurred performance of service intervention on 08/06/2015)

	Required temperature of the exhaust gas of the flare (to ensure LFG destruction (combustion) under high CH_4 destruction efficiency):	500 ºC	1,200 ºC

[129] 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 2nd 7-year crediting period in order to accommodate projected 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.

[130] 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.

By taking into account the performed service intervention in the flares on 08/06/2015 and its impact over the ex-ante determined parameter "Manufacturer's specification for the flare" ($SPEC_{flare}$), the following criteria/conditions are to be taken into account for the ex-post determination of values of flare efficiency for the flares in the context of determination of project emissions from flaring along the 2nd 7-year crediting period:

- Until 08/06/0215 - 08:59 AM, for each minute m, the flow rate LFG sent to the flares referred as "Flare 2" and "Flare 3" (sub-monitoring parameters $F_{CH4,RG,m,flare-2} = F_{CH4,sent\_flare,y,flare-2}$ and $F_{CH4,RG,m,flare-3} = F_{CH4,sent\_flare,y,flare-3}$) should not be higher than 6,500 Nm^3/h; otherwise flare efficiency is assumed as 0% and no emission reductions are therefore accounted for LFG combusted in these flares in the minute m in question.
- Until 08/06/0215 - 01:59 PM, for each minute m, the flow rate LFG sent to the flares referred as "Flare 1" and "Flare 4" (sub-monitoring parameters $F_{CH4,RG,m,flare-1} = F_{CH4,sent\_flare,y,flare-1}$ and $F_{CH4,RG,m,flare-4} = F_{CH4,sent\_flare,y,flare-4}$) should not be higher than 6,500 Nm^3/h; otherwise flare efficiency is assumed as 0% and no emission reductions are therefore accounted for LFG combusted in these flares in the minute m in question.

- From 09:00 AM - 08/06/0215 onwards, for each minute m, the flow rate LFG sent to the flares referred as "Flare 2" and "Flare 3" (sub-monitoring parameters $F_{CH4,RG,m,flare-2} = F_{CH4,sent\_flare,y,flare-2}$ and $F_{CH4,RG,m,flare-3} = F_{CH4,sent\_flare,y,flare-3}$) should not be higher than 7,500 Nm^3/h; otherwise flare efficiency is assumed as 0% and no emission reductions are therefore accounted for LFG combusted in these flares in the minute m in question.

- From 02:00 PM - 08/06/0215 onwards, for each minute m, the flow rate LFG sent to the flares referred as "Flare 1" and "Flare 4" (sub-monitoring parameters $F_{CH4,RG,m,flare-1} = F_{CH4,sent\_flare,y,flare-1}$ and $F_{CH4,RG,m,flare-4} = F_{CH4,sent\_flare,y,flare-4}$) should not be higher than 7,500 Nm^3/h; otherwise flare efficiency is assumed as 0% and no emission reductions therefore are accounted for LFG combusted in these flares in the minute m in question.

	<table><tr><td>Required minimum frequency for inspection service (incl. inspection in the conditions of the flare isolation ceramics revetment material):</td><td>every 6 months</td></tr><tr><td>Required/recommended minimum frequency for replacement of the flare isolation ceramics revetment material:</td><td>after 10 years of regular and appropriate operation</td></tr></table>
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 2nd 7-year crediting period, ex-ante selected data will be compared against monitored data related to the operation of the flares, including: a) Minimum and maximum monitoring records for data regarding inlet LFG flow rate, (b) Minimum and maximum monitoring records for data of temperature in the exhaust gas of each individual high temperature enclosed flare; and (c) Duration in days of time periods between maintenance events for each individual high temperature enclosed flare.
Purpose of data	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[131].
Additional comment	All flare specification and operation details/requirements are based on information provided by the equipment manufacturer.

[131] 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 13.0.0) refers to the term "project emissions from flaring".

Data/Parameter	**$EF_{grid,BM,y}$**
Data unit	tCO_2/MWh
Description	Build margin CO_2 emission factor in year *y*
Source of data	Data is ex-ante determined as per applicable guidance of the methodological tool "Tool to calculate the emission factor for an electricity system" (version 04.0) valid for 2nd crediting period. The selected value valid for all years encompassed by the 2nd 7-year crediting period is the value calculated by the DNA of Brazil and valid for year 2012 ($EF_{grid,BM,2012}$). Data is made available online: 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 04.0) valid for 2nd crediting period.
Purpose of data	Data will be used for the determination of project emissions (due to the consumption of grid-sourced electricity by the project activity).
Additional comment	-

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 in year *y*
Source of data	Applicable conservative default value as per the methodological tool "Tool to calculate baseline, project and/or leakage emissions from electricity consumption" (version 01) valid for 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 "Tool to calculate baseline, project and/or leakage emissions from electricity consumption" (version 01).
Purpose of data	Calculation of project emissions (due to the consumption of electricity sourced by captive off-grid electricity generator by the project activity).
Additional comment	-

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 "Tool to calculate baseline, project and/or leakage emissions from electricity consumption" (version 01) applicable for option A.2.
Value(s) applied	1.3
Choice of data or measurement methods and procedures	Data is determined as per applicable guidance of the methodological tool "Tool to calculate baseline, project and/or leakage emissions from electricity consumption" (version 01).
Purpose of data	Calculation of project emissions (due to the consumption of grid-sourced electricity by the project activity).
Additional comment	

Note: The post-registration changes addressed in this revised version of the PDD (permanent changes in the project design, the revision of the monitoring plan and performed corrections (in information which do not affect project design)) are under conformance with applicability requirements of ACM0001 (version 13.0.0) + applicable methodological tools.
The scale and the level of accuracy and completeness in overall monitoring of the project activity are not adversely affected by such post-registration changes either. Applied monitoring (including the design of the monitoring plan) and GHG calculation approaches are however improved and complemented, thus meeting both additional monitoring requirements for the project activity (under its revised design configuration) and GHG calculation approaches required/established by ACM0001 (version 13.0.0) + applicable methodological tools.

B.6.3. Ex ante calculation of emission reductions

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As presented in Section B.6.1, while emission reductions to be achieved by the project activity are determined as the difference between baseline emissions (BE_y) and project emissions (PE_y), as established by ACM0001 (version 13.0.0), 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 2nd 7-year renewable crediting period:

Determination of ex-ante estimations for baseline emissions (BE_y):

While the project activity encompasses destruction of methane through collection and combustion of LFG in a set of high temperature enclosed flares and in a set of internal combustion gas engines (of which each one is part of a grid-connected electricity generation facility fuelled uniquely by LFG and located within the geographical limits of the UVS – Caieiras landfill), by following the applicable methodological approaches and assumptions + ex-ante determined values presented in Section B.6.1 and B.6.2 respectively, baseline emissions (BE_y) are thus determined as follows:

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

Determination of $BE_{CH4,y}$:

For the 2nd 7-year crediting period $BE_{CH4,y}$ 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 $F_{CH4,PJ,y}$ ($F_{CH4,BL,y} = 0.2 * F_{CH4,PJ,y}$). See Section B.6.1 for further details.

GWP_{CH4} Global warming potential of CH_4 (t CO_2e/t CH_4). GWP_{CH4} is ex-ante determined as 25. See Section B.6.2 for further details.

$F_{CH4,PJ,y}$ Amount of methane which is destroyed by the project activity through combustion of collected LFG in project's methane destruction devices in year y (tCH_4/yr). In the context of ex-ante estimation of emission reductions, as established by ACM0001 (version 13.0.0), $F_{CH4,PJ,y}$ is determined (in tCH_4/year) as follows in the particular case of the project activity:

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

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

Where:

$F_{CH4,PJ,y}$ Amount of methane which is destroyed by the project activity through combustion of collected LFG in project's methane destruction devices in year y (tCH_4/yr)

η_{PJ} Efficiency of the LFG capture system that will be installed in the project activity. η_{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 are applied. See Section B.6.2 for details about such ex-ante determined values.

A calculation spreadsheet including ex-ante estimates of emission reduction to be achieved by the project activity (under its revised design configuration) is enclosed to this PDD. This calculation spreadsheet includes all required related calculations for the ex-ante estimation of $BE_{CH4,y}$ during the 2nd 7-year crediting period.

The ex-ante estimation of $BE_y = BE_{CH4,y}$ is thus summarized as follows[132]:

	Estimation of $BE_{CH4,SWDS,y}$ (tCO2e)	Estimation of $F_{CH4,PJ,Y}$ (tCH4)	Estimation of $F_{CH4,BL,y}$ (tCH4)	Estimation of baseline emissions (BE_y) = Estimation of baseline emissions for methane (BE_{CH4}) (tCO2e)
Year	$BE_{CH4,SWDS,y} = \varphi * (1-f) * GWP_{CH4} * (1-OX) * 16/12 * F * DOC_f * MCF * \Sigma\Sigma w_{j,x} * DOC_j * e^{-kj(y-x)} * (1-e^{-kj})$	$F_{CH4,PJ,y} = n_{PJ} * BE_{CH4,SWDS,y} / GWP_{CH4}$	$F_{CH4,BL,r,y} = 0.2 * F_{CH4,PJ,y}$	$BE_y = BE_{CH4,y} = (1-OX_{top\_layer}) * (F_{CH4,PJ,y} - F_{CH4,BL,y}) * GWP_{CH4}$
2013	1,416,615	2,737	547	49,271
2014	1,535,367	56,993	11,399	1,025,871
2015	1,646,897	61,133	12,227	1,100,391
2016	1,752,380	65,048	13,010	1,170,870
2017	1,852,808	68,776	13,755	1,237,972
2018	1,949,021	72,348	14,470	1,302,258
2019	2,041,733	75,789	15,158	1,364,204
2020	2,131,549	19,510	3,902	351,177
Total	**14,326,370**	**422,334**	**84,466**	**7,602,014**

Note: Above reported values of $BE_{CH4,SWDS,y}$ for years 2013 and 2020 are valid for the entire years regardless of the starting and ending dates of the crediting period (from 01/01/2013 to 31/12/2013 and from 01/01/2020 to 31/12/2020 respectively). All other values applicable for years 2013 and 2020 ($F_{CH4,PJ,y}$, $F_{CH4,BL,y}$, $BE_y = BE_{CH4,y}$) are valid for the fractions of these years which are encompassed by the 2nd 7-year renewable crediting period: from 13/12/2013 to 31/12/2013 and from 01/01/2020 to 30/03/2020 respectively.

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 grid electricity 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 presented in Section B.6.1, $PE_{EC,grid,y}$ is determined as follows:

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

[132] Since as per the applied approach for ex-ante estimating baseline emissions of CH_4, the efficiency of the flares in terms of CH_4 destruction are not accounted; estimated baseline emissions of methane are thus not changed as a result of combustion of collected LFG also in the set of internal engine combustion gas engines (additional/alternative methane destruction devices for the project activity) when compared to combustion of collected LFG only in the set of high temperature enclosed flares.

$PE_{EC,grid,y}$ 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 4,967 MWh per year[133]. 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) plus an additional 5% for less-electricity consumption intensive ancillary equipment. It is also assumed that equipment will work continuously (24 hours a day) under full power during the whole 2nd 7-year crediting period [134].

$TDL_{grid,y}$ Average technical transmission and/or distribution losses for grid sourced electricity consumed by the project activity in year *y.* For the particular case of determination of $PE_{EC,grid,y}$, $TDL_{,grid,y}$ is ex-ante determined as being 20% ($TDL_{grid,import,y}$). Further details are included in Section B.6.2.

$EF_{EL,grid,y}$ CO_2 emission factor for grid-sourced electricity in year y (in tCO_2/MWh). $EF_{EL,grid,y}$ 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 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 "Tool to calculate baseline, project and/or leakage emissions from electricity consumption"), 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 04.0) and 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).

[133] The 4,967 MWh per year value represents the annual consumption of grid-sourced electricity for the project's LFG collection and destruction infrastructure in the particular context of ex-ante estimates of emission reductions to be achieved by the project activity. As further explained in Sections B.6.1, B.7.1 and B.7.3, any 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 always be accounted as consumption of grid-sourced electricity.

[134] It is important to note that additional power consuming equipment (e.g. additional centrifugal blowers) may be eventually 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 2nd 7-year crediting period (equipment continuously operating under full power) is appropriate (and under a certain level incorporates an increase in consumption of grid-sourced electricity by the project activity that may eventually occur).

w_{BM} Weighting of build margin emissions factor. w_{BM} is ex-ante determined as 75% (0.75).

$EF_{grid,BM,y}$ 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[135].

$EF_{grid,OM,y}$ Operating margin CO_2 emission factor in year *y* (in tCO_2/MWh). In the particular case of the project activity, $EF_{grid,OM,y} = EF_{grid,OM-DD,y}$.

Operational Margin CO2 emission factor (dispatch analysis calculation method ($EF_{grid,OM-DD,y}$):
In the 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 2017:

Operating Margin Emission Factor of Brazilian Integrated Electric System for year 2017 (dispatch analysis calculation method)

Operating Margin Emission Factor, year2017 Average CO_2 Emission Factor (tCO_2/MWh)											
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0.5419	0.5148	0.5867	0.5905	0.6086	0.5846	0.6052	0.6102	0.6060	0.5997	0.6019	0.6078

The average value of $EF_{grid,OM-DD,2017}$ is thus calculated as 0.5882 tCO_2/MWh. Values of $EF_{grid,OM-DD,2017}$ are determined and reported by the DNA of Brazil. Further details are available online at the website of the DNA of Brazil.

The values of $EF_{grid,BM,2012}$ are determined and reported by the DNA of Brazil. Further details are available online.

$EF_{grid,CM,y}$ is thus calculated as follows:

$EF_{grid,CM,y} = w_{OM} * EF_{grid,OM,y} + w_{BM} * EF_{grid,BM,y} = 0.25 * 0.5882 + 0.75 * 0.2010 = 0.2978$ tCO_2/MWh
(related calculations are summarized in the emission reduction calculation spreadsheet enclosed to the PDD).

[135] 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 04.0 and previous versions) are made available online:

http://www.mctic.gov.br/mctic/opencms/textogeral/emissao_despacho.html

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 $EF_{grid,OM\text{-}DD,2017}$ (valid for year 2017) 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 2nd 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 affecting the value to be calculated for $EF_{grid,CM,y}$ for each individual year encompassed by the crediting period).

This simplification is in accordance with applicable CDM rules[136].

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[137].

Estimates as per Option B.1.:

The following formulae is applied for the estimates of $EL_{grid,y}$ as per Option B.1:

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

[136] 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 no major changes in the average and marginal CO_2 intensity for electricity generated at the national electricity grid of Brazil are expected to occur during the 2nd 7-year crediting period 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 the 2nd 7-year crediting period.
- 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 2nd 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.

[137] 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

Where:

$FC_{Diesel,t}$	Amount of fossil fuel diesel consumed by the installed backup captive off-grid electricity generator during the time period t. $FC_{Diesel,t}$ is estimated as 1,018,219 kg by taking into account the specific fuel consumption 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 generared 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.

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 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 generators nor estimated amount of fossil fuel diesel to be consumed by the generator. 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[138].

[138] Since July/2016, the project's electricity demand can be technically 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).

Determination of ex-ante estimations of project emissions due to consumption of LPG by the project activity ($PE_{LPG,y}$):

By following the applicable methodological approaches and assumptions presented in Section B.6.1, $PE_{LPG,y}$ is determined as follows:

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

Where:

$FC_{LPG,y}$ Quantity of LPG consumed by the project activity in year *y*. $FC_{LPG,y}$ is estimated to be 750 kg (0.750 ton) of LPG per year.

$COEF_{LPG,y}$ CO_2 emission coefficient for LPG (in tCO_2/ton LPG). By applying option B of the methodological tool, $COEF_{LPG,y}$ is determined as follows:

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

Where:

$COEF_{LPG,y}$ is estimated by taking into account the assumed following values and assumptions for $NCV_{LPG,y}$ and $EF_{CO2,LPG,y}$:

$NCV_{LPG,y}$ Net calorific value of the fuel LPG. The estimated value for $NCV_{LPG,y}$ within the whole 2nd 7-year crediting period is 0.0492 TJ/ton LPG (49.2 GJ/ton LPG) (value sourced by the Brazilian Energetic Balance Report, year 2015 (Table VIII.9 – Specific Mass and Heating Values – 2014)[139]).

$EF_{CO2,LPG,y}$ CO_2 emission factor of fuel LPG. The estimated value for $EF_{CO2,LPG,y}$ within the whole 2nd 7-year crediting period is 65.6 tCO_2/TJ LPG (0.0656 tCO_2/GJ LPG) (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))).

Estimation of annual values for $FC_{LPG,y}$:

The quantity of LPG consumed by the project activity in year *y* (in MWh) is estimated as 750 kg (0.75 ton) per year during the whole 2nd 7-year crediting period. This value is assumed based on reported and verified LPG consumption figures as part of the latest periodic verifications for the project activity within the currently expired 1st crediting period (as

[139] The Brazilian Energetic Balance Report – 2015 (Relatório Energético Nacional – 2015) is the latest report and it is based on data for year 2014. This official governmental report was published by the entity Empresa de Pesquisas Energéticas (EPE) and is available online: https://ben.epe.gov.br/BENRelatorioFinal.aspx?anoColeta=2015&anoFimColeta=2014

indicated in Monitoring Reports for the 6th and 7th periodic verifications for the project activity)[140]

Estimation of annual values for $COEF_{LPG,y}$:

The CO_2 emission coefficient for LPG is estimated to be 3.2275 tCO_2/ton LPG during the 2nd 7-year crediting period. This value is determined by considering reported values for $NCV_{LPG,y}$ and $EF_{CO2,LPG,y}$ as part of the latest periodic verifications for the project activity within the currently expired 1st crediting period (as indicated in Monitoring Reports for the 6th and 7th periodic verifications for the project activity). The value for $NCV_{LPG,y}$ and $EF_{CO2,LPG,y}$ may change slightly during the 2nd 7-year crediting period. However, such potential change is not expected to be material.

Ex-ante estimations of total project emissions during the 2nd 7-year crediting period are thus summarized as follows:

PE_y	Consmption of grid-sourced electricity (MWh)	Consumption of electricity sourced by captive off-grid electricity generator (fuelled by diesel) (MWh)	Project emissions due to electricity consumption (tCO_2e)	LPG consumption by the project activity (ton)	Project emissions due to LPG consumption (tCO_2e)[141]	Total Project emissions (tCO_2)
Year	$EC_{PJ,grid,y}$	$EC_{PJ,captive,y}$	$PE_{EC,y} = (EC_{PJ,captive,y} * EF_{captive,y} * (1+TDL_{captive,y})) + (EC_{PJ,grid,y} * EF_{grid,y} * (1+TDL_{grid,import,y}))$	$FC_{LPG,y}$	$PE_{FC,y} = FC_{LPG,y} * EF_{LPG}$	PE_y
2013	259	0	403	0.039	0.13	403
2014	4,967	0	7,748	0.750	2.42	7,751
2015	4,967	0	7,748	0.750	2.42	7,751
2016	4,967	0	7,748	0.750	2.42	7,751
2017	4,967	0	7,748	0.750	2.42	7,751
2018	4,967	0	7,748	0.750	2.42	7,751
2019	4,967	0	7,748	0.750	2.42	7,751
2020	1,225	0	1,911	0.185	0.60	1,911
Total	**31,285**	**0**	**48,805**	**5.0**	**16**	**48,820**

[140] During the monitoring periods from 01/09/2011 to 31/03/2012 (6th periodic verification with monitoring period encompassing 7 months) and from 01/04/2012 to 30/09/2012 (7th periodic verification with monitoring period encompassing 6 months) (within the 1st 7-year crediting period) the project activity consumed 225 kg and 775 kg of LPG respectively. In the particular case of ex-ante estimates of emission reduction to be achieved by the project activity during the 2nd 7-year crediting period, it is thus estimated that the project activity will consume 750 kg (0.750 ton) of LPG per year. 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 been evaluating 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 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.

[141] 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.

Note: Values of $EC_{PJ,grid,y}$ and $PE_{EC,y}$ applicable for years 2013 and 2020 are valid for the fractions of these years which are encompassed by the 2nd 7-year renewable crediting period: from 13/12/2013 to 31/12/2013 and from 01/01/2020 to 30/03/2020 respectively.

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 the 2nd 7-year renewable crediting period are summarized as follows:

ER_y	Emission reductions (tCO_2e)
Year	$ER_y = BE_y - PE_y$
2013	48,868
2014	1,018,120
2015	1,092,640
2016	1,163,119
2017	1,230,221
2018	1,294,507
2019	1,356,453
2020	349,265
Total	**7,553,194**
Annual average[142]	1,199,180

Note: Values applicable for years 2013 and 2020 are valid for the fractions of these years which are encompassed by the 2nd 7-year renewable crediting period: from 13/12/2013 to 31/12/2013 and from 01/01/2020 to 30/03/2020 respectively.

Details about all the 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 the 2nd crediting period is enclosed to this PDD.

[142] The annual average of the estimated reductions over the crediting period is calculated (as a function of the total emission reductions estimated for the whole 2nd crediting period) by taking into account that, as a result of the previously performed activities for its renewal, the length of project's 2nd crediting period encompassing 2,299 days is slightly shorter than 7 full years (2,555 days).

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)
2013	49,271	403	0	48,868
2014	1,025,871	7,751	0	1,018,120
2015	1,100,391	7,751	0	1,092,640
2016	1,170,870	7,751	0	1,163,119
2017	1,237,972	7,751	0	1,230,221
2018	1,302,258	7,751	0	1,294,507
2019	1,364,204	7,751	0	1,356,453
2020	351,177	1,911	0	349,265
Total	**7,602,014**	**48,820**	0	**7,553,194**
Total number of crediting years	7			
Annual average over the crediting period[143]	1,206,931	7,751	0	1,199,180

Note: Values of $ER_{,y}$ applicable for years 2013 and 2020 are valid for the fractions of these years which are forecasted to be encompassed by the 2nd 7-year renewable crediting period: from 01/09/2013 to 31/12/2013 and from 01/01/2020 to 31/08/2020 respectively. The annual average of the estimated reductions over the crediting period is calculated (as a function of the total emission reductions estimated for the whole 2nd crediting period) by taking into account that, as a result of the previously performed activities for its renewal, the length of project's 2nd crediting period encompassing 2,299 days is slightly shorter than 7 full years (2,555 days).

[143] In May/2018, the following figures in terms of already achieved GHG emission reduction by the project activity under its previous and not any longer valid design configuration along part of the 2nd 7-year crediting period were available for the project activity:

- Monitoring period from 13/12/2013 to 12/06/2014: 252,412 tCO_2e (CERs issued)
- Monitoring period from 13/06/2014 to 31/12/2014: 360,815 tCO_2e (CERs issued)
- Monitoring period from 01/01/2015 to 15/05/2015: 158,131 tCO2e (CERs issued)
- Monitoring period from 16/05/2015 to 31/12/2015: 374,022 tCO2e (CERs issued)
- Monitoring period from 01/01/2016 to 30/06/2016: 328,135 tCO2e (CERs issued)

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	Measurements/monitoring performed by the project participants. 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*: - Original construction and operational design of the UVS - Caieiras landfill; - Technical specifications and requirements for the management of the UVS - Caieiras landfill; - Applicable local or national regulations dealing with management and operation of existing landfills. Any occurred or planned relevant change in terms of management of the 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 the 2nd 7-year crediting period. Baseline emissions 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 will be installed in the project activity (η_{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 using 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 2nd 7-year crediting period. 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 13.0.0), 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.
Monitoring frequency	Annually.
QA/QC procedures	Not applicable.
Purpose of data	Determination 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. Measured as part of the operation of the project activity by applying appropriate LFG flow meter(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 the 2nd 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 (η_{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 using 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 meter(s) will be performed by using a reference primary device provided by a third party independent accredited calibration laboratory. Calibration events will be performed in a frequency as per instrument specifications and/or instrument manufacturer's recommendations. Instrument(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 baseline emissions.
Additional comment	This parameter will be monitored in case Options B or C of the methodological tool "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" (version 02.0.0) is 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. Measured as part of the operation of the project activity by applying appropriate LFG flow meter(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 the 2nd 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 (η_{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 using 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. 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. 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 baseline emissions.
Additional comment	This parameter will be monitored in case Option A of the methodological tool "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" (version 02.0.0) is applied for the determination of $F_{CH4,flared,y}$ and $F_{CH4,EL,y}$.

Data/Parameter	$v_{CH4,t,db}$
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)
Source of data	Measurements/monitoring performed by the project participants. 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 the 2nd 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 (η_{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 using 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 operating in dry-basis. Volumetric flow measurement should always refer to the actual pressure and 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 in the continuous CH_4 content gas analyzer will be performed by utilization of calibration span gas with certified CH_4 content (for span checking/adjustment). Utilization of an inert calibration gas (e.g. N_2) will also occur (for span checking/adjustment). All calibration gases (span gases) must have a certificate provided by the gas supplier and must be under their validity period. Periodic calibration events will be performed in a frequency as per instrument specifications and/or instrument manufacturer's recommendations. Instrument(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 baseline emissions.
Additional comment	This parameter will be monitored in case Option B of the methodological tool "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" (version 02.0.0) 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 "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" (version 02.0.0) are applied instead.

Data/Parameter	$v_{CH4,t,wb}$
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)
Source of data	Measurements/monitoring performed by the project participants. Measured as part of the operation of the project activity by applying 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 the 2nd 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 (η_{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 using 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 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 analyzers). 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 will be performed by utilization of calibration span gas with certified CH_4 content (for span checking/adjustment). Utilization of an inert calibration gas (e.g. N_2) will also occur (for span checking/adjustment). All calibration gases (span gases) must have a certificate provided by the gas supplier and must be under their validity period. Periodic calibration events will be performed in a frequency as per instrument specifications and/or instrument manufacturer's recommendations. Instrument(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 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 02.0.0) 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 is applied instead.

Data/Parameter	$M_{t,db}$
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. 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 the 2nd 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 (η_{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 using 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). 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. 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 baseline emissions.
Additional comment	This parameter will be monitored only in case Option D of the methodological tool "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" (version 02.0.0) is applied for the determination of $F_{CH4,flared,y}$ and $F_{CH4,EL,y}$.

Data/Parameter	T_t
Data unit	K[144]
Description	Temperature of the LFG stream in time interval *t*
Source of data	Measurements/monitoring performed by the project participants. 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 the 2nd 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 (η_{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 using 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 ρ_{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). 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. Instrument(s) will be subject to a regular maintenance and testing regime in accordance to appropriate national/international standards/requirements and/or best practice. Spare instrument(s) may be kept.
Purpose of data	Calculation of baseline emissions.
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).

[144] 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.

Data/Parameter	**P_t**
Data unit	Pa[145]
Description	Pressure of the LFG stream in time interval *t*
Source of data	Measurements/monitoring performed by the project participants. 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 the 2nd 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 (η_{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 using 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 ρ_{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). 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. Instrument(s) will be subject to a regular maintenance and testing regime in accordance to appropriate national/international standards/requirements and/or best practice. Spare instrument(s) may be kept.
Purpose of data	Calculation of baseline emissions.
Additional comment	-

[145] 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.

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 the 2nd 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 (η_{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 using 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	Measurements/monitoring performed by the project participants. 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 the 2nd 7-year crediting period. In the context of the ex-ante estimation of emission reductions to be achieved by the project activity during the 2nd 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	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 13.0.0).
Monitoring frequency	Continuous measurements will be aggregated manually or automatically. Accumulated measurement records will be reported at least with an 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. 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 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 (as per the project configuration in May/2013). 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). Also as an assumption, it is considered that the project activity will operate 24 hours a day during the 2nd 7-year renewable crediting period. Measurement records will be cross-checked against available receipts/invoices/reports for imports and/or purchase of grid-sourced electricity. 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	**$EF_{grid,OM,y} = EF_{grid,OM-DD,y}$**
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 04.0). The selected value considered for all years encompassed by the 2nd 7-year crediting period in the context of the ex-ante estimation of emission reductions is the value calculated by the DNA of Brazil and valid for year 2017 (the most recent value available). Data is made available online: http://www.mctic.gov.br/mctic/opencms/textogeral/emissao_despacho.html
Value(s) applied	0.5882

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 04.0).
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. 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 the 2nd 7-year crediting period.
Measurement methods and procedures	For each equipment unit *j* using *the LFG* monitor that the plant is operating in hour *h* by the monitoring any one or more of the following three parameters: (a) Temperature. Determine the location for temperature measurements and minimum operational temperature based on manufacturer's specifications of the burning equipment. Document and justify the location and minimum threshold in the PDD; (b) Flame. Flame detection system is used to ensure that the equipment is in operation; (c) Products generated. Monitor the generation of steam for the case of boilers and air-heaters and glass for the case of glass melting furnaces. This option is not applicable to brick kilns. $Op_{j,h}$ = 0 when: (a) One of more temperature measurements are missing or below the minimum threshold in hour h (instantaneous measurements are made at least every minute); (b) Flame is not detected continuously in hour h (instantaneous measurements are made at least every minute); (c) No products are generated in the hour h. Otherwise, $Op_{j,h}$ = 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 13.0.0), the monitoring parameter $Op_{j,h}$ is not applicable to the project's high temperature enclosed flares.

Additional comment	Monitoring of the operational status/conditions of each one of the internal combustion gas engines 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 on each hour *h*. Moreover, the operational status of each individual internal combustion gas engines will be monitored for each hour *h*.

Data/Parameter	**$F_{CH4,EG,t}$**
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
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 2nd 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 (η_{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 using 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 according to an appropriate national or international standard (such as the UK's Technical Guidance LFTGN05 or a similar standard). The time period *t* over which the mass flow is measured must be at least one hour. 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. 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). 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 baseline emissions.
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	$T_{EG,m}$
Data unit	ºC
Description	Temperature in the exhaust gas of the enclosed flare in minute *m*
Source of data	Measurements 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 the 2nd 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 (η_{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 using 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 installed 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 the flare is not functioning correctly and may require maintenance. 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. 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[146].
Monitoring frequency	Continuous measurements will be recorded and reported with a least every minute frequency.
QA/QC procedures	Temperature measurement instrument/equipment should be replaced or calibrated in accordance with their maintenance schedule.
Purpose of data	Data will be used for the determination of baseline emissions[147].

[146] 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 2nd 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.

[147] It is relevant to note that, as shown in Section B.6.1., as per the applied methodological approach, monitoring records of $T_{EG,m}$ 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).

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. Measurements are required to determine if manufacturer's flare specifications for operating temperature are met. Periodic calibration events will be performed in measurement instruments by a third party independent accredited calibration laboratory in a frequency as per instrument specifications and/or instrument manufacturer's recommendations. Instruments will be subject to a regular maintenance and testing regime in accordance to appropriate national / international standards/requirements and/or best practice. Spare instrument(s) may be kept.

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 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 the 2nd 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 (η_{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 using 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 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	Data will be used for the determination of baseline emissions.

Additional comment	Applicable to all flares. The condition will be regularly monitored for each individual high temperature enclosed flare. 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. Instruments will be subject to a regular maintenance and testing regime in accordance to appropriate national / international standards/requirements and/or best practice. Spare instrument(s) may be kept.

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 the 2nd 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 (η_{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 using 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 dates when that maintenance events were completed in year *y*. Records of content and dates for performed maintenance events must include all relevant aspects of the performed maintenance work (including details of the person(s) undertaking the work, parts/component replaced and/or repaired, 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	Data will be used for the determination of baseline emissions.
Additional comment	Monitoring of this parameter is required for the particular case of enclosed flares when Option B is the selected approach for determining flare efficiency. Dates for performed maintenance events in the flares will be compared to valid maintenance schedules for the flares (in order to check whether performed maintenance events meets the minimum frequency (time between maintenance events) as specified by the flare manufacturer(s) – ex-ante determined paramenter "Manufacturer's flare specifications for temperature, flow rate and maintenance schedule interval" ($SPEC_{flare}$)).

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[148].
Measurement methods and procedures	Recording of measurements of LPG consumed by project activity in year *y*.
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	Data will be used for the determination of project emissions (due to the consumption of the fossil fuel LPG by the project activity).
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. Instruments will be subject to a regular maintenance and testing regime in accordance to appropriate national / international standards/requirements and/or best practice. Spare instrument(s) may be kept. 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 been evaluating 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 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.

[148] The estimated value is determined by taking into account the previously reported values of LPG consumed by the project activity during the past monitoring periods encompassed by the 1st 7-year crediting period for the project activity at the time of occurred renewal of its crediting period.

Data/Parameter	$NCV_{LPG,y}$
Data unit	GJ/ton LPG
Description	Net calorific value of the fuel LPG
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[149]). Source of value applied in the context of ex-ante estimation of emission reductions during the 2nd 7-year crediting period: Brazilian Energetic Balance Report, year 2015 (Table VIII.9 – Specific Mass and Heating Values – 2014[150])
Value(s) applied	49.2
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. 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	Data will be used for the determination of project emissions (due to the consumption of the fossil fuel LPG by the project activity).
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.

[149] Any future revision of the IPCC Guidelines will be taken into account

[150] The Brazilian Energetic Balance Report – 2015 (Balanço Energético Nacional (BEN) – 2015) is the latest report and it is based on data for year 2014. This official governmental report was published by the entity Empresa de Pesquisas Energéticas (EPE) and is available online:

https://ben.epe.gov.br/BENRelatorioFinal.aspx?anoColeta=2015&anoFimColeta=2014

Data/Parameter	$EF_{CO2,LPG,y}$
Data unit	tCO_2/GJ LPG
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)[151]. Appropriate net calorific value (NCV) for LPG may be used for converting energy basis data into mass basis data. For the ex-ante estimation of emission reductions to be achieved by the project activity during the 2nd 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. 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	Data will be used for the determination of project emissions (due to the consumption of the fossil fuel LPG by the project activity).
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.

Data/Parameter	$EC_{PJ,captive,y}$
Data unit	MWh

[151] Any future revision of the IPCC Guidelines will be taken into account.

Description	Quantity of electricity generated in 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 the 2nd 7-year crediting period. In the context of the ex-ante estimation of emission reductions to be achieved by the project activity during the 2nd 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	Appropriate electricity meter(s) will be used.
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. 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	Measurement records will be crosschecked against available diesel consumption receipts/invoices issued by the diesel supplying company. 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. 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	**$FC_{Diesel,y}$**
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 2nd 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	Measurements using flow meters or volume meters. As an alternative measurements will be based on records of an integrated electronic system of the generator, which shows the percentage of stored fuel 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. 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. 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[152]).
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 2nd 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. 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	-

[152] 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)[153].
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 2nd 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. 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	$EG_{Diesel-Generator,y}$
Data unit	MWh
Description	Quantity of electricity generated in captive diesel backup generator during the year *y*
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 2nd 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	Use appropriate electricity meter(s).

[153] Any future revision of the IPCC Guidelines will be taken into account.

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. 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. 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. It is important to note that, if all electricity generated by the backup captive off-grid electricity generator (fuelled by diesel) are consumed by the project activity, $EG_{Diesel\text{-}Generator,y} = EC_{PJ,captive,y}$. $EG_{Diesel\text{-}generator,y}$ will be monitored in case Alternative approach 1 is used for the determination of Project emissions due to the consumption of electricity sourced by backup captive off-grid electricity generators (fuelled by diesel) ($PE_{EC,captive,y}$).

Data/Parameter	**$TDL_{grid,y}$**
Data unit	MWh
Description	Average technical transmission and distribution losses for providing electricity to the grid and/or 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 "Tool to calculate baseline, project and/or leakage emissions from electricity consumption" (version 01) or use of recent, accurate and reliable data available within the host country.
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). 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	MWh
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 "Tool to calculate baseline, project and/or leakage emissions from electricity consumption" (version 01). For the ex-ante estimates of emission reductions, the default value is applied.
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. 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	-

Note: The post-registration changes addressed in this revised version of the PDD (permanent changes in the project design, the revision of the monitoring plan and performed corrections (in information which do not affect project design)) are under conformance with applicability requirements of ACM0001 (version 13.0.0) + applicable methodological tools. The scale and the level of accuracy and completeness in overall monitoring of the project activity are not adversely affected by such post-registration changes either. Applied monitoring (including the design of the monitoring plan) and GHG calculation approaches are however improved and complemented, thus meeting both additional monitoring requirements for the project activity (under its revised design configuration) and GHG calculation approaches required/established by ACM0001 (version 13.0.0) + applicable methodological tools.

B.7.2. Sampling plan

>>
Not applicable.

B.7.3. Other elements of monitoring plan

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General monitoring:
The following instruments/equipment will be used to monitor required data along the 2nd 7-year renewable crediting period (depending on the applied measurement options and calculation approaches - to be chosen ex-post)[154]:

Instrument or Source of data	Measurement option		Data monitored	
Appropriate volumetric or mass flow meters (one individual LFG flow meter for each high temperature enclosed flare and for each internal combustion gas engine, with separated measurement data being recorded and reported for each flare and each internal combustion gas engine)	A	Volume flow – dry basis; Volumetric fraction dry or wet basis	$V_{t,db,j}$	Volumetric flow of LFG stream *j* in time interval *t* on a dry basis (in m^3 dry gas/h). *j* = LFG delivery pipeline to each operative high temperature enclosed flare and/or each operative internal combustion gas engine.
	B	Volume flow – wet basis; Volumetric fraction dry basis	$V_{t,wb,j}$	Volumetric flow of LFG stream *j* in time interval *t* on a wet basis (in m^3 dry gas/h). *j* = LFG delivery pipeline to each operative high temperature enclosed flare and/or each operative internal combustion gas engine.
	C	Volume flow – wet basis; Volumetric fraction wet basis	$V_{t,wb,j}$	Volumetric flow of LFG stream *j* in time interval *t* on a wet basis (in m^3 wet gas/h). *j* = LFG delivery pipeline to each operative high temperature enclosed flare and/or each operative internal combustion gas engine.
	D	Mass flow – dry basis; Volumetric fraction dry or wet basis	$M_{t,db,j}$	Mass flow of LFG stream *j* in time interval *t* on a dry basis (in kg/h). *j* = LFG delivery pipeline to each operative high temperature enclosed flare and/or each operative internal combustion gas engine.
Continuous CH_4 content gas analyser unit	-		$v_{CH4,t,db/wb,j}$	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)

[154] Measurement options defined in the methodological tool "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" (version 02.0.0) when referring to "*Adequate volumetric or mass flow meter(s)*" and defined in the methodological tool Project emissions from flaring" (version 02.0.0) in other cases. Different measurement options are indeed defined in the methodological tool "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" (version 02.0.0) when referring to "Adequate volumetric or mass flow meter(s)". The applicable guidance of the methodological tool "Project emissions from flaring" (version 02.0.0) also refers to different measurement and calculation options.

Instrument or Source of data	Measurement option	Data monitored	
LFG pressure sensor(s)	-	$\mathbf{P_t}$	Pressure of the LFG stream directed to the flares and/or to internal combustion gas engines in time interval *t* (in Pa or mbar) Note: $\mathbf{P_t}$ may not be monitored when using LFG flow meter(s) that automatically consider and measures LFG temperature and LFG pressure, thus expressing LFG volumetric or mass flows in normalised units.
LFG temperature sensor(s)	-	$\mathbf{T_t}$	Temperature of the LFG stream directed to the flares and/or to internal combustion gas engines in time interval *t* (in K or ºC) Note: $\mathbf{T_t}$ may not be monitored when using LFG flow meter(s) 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)	-	$\mathbf{p_{H20,t,Sat}}$	Saturation pressure of H_2O at temperature T_t in time interval *t* This parameter is solely a function of the LFG stream temperature T_t and can be found at referenced literature.
Electricity meter(s)	-	$\mathbf{EC_{PJ,y}}$ = $\mathbf{EC_{grid,y}}$	Amount of grid electricity consumed by the project activity in year y (in MWh)
		$\mathbf{EC_{PJ,captive,y}}$	Quantity of electricity generated in 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)	-	$\mathbf{EF_{grid,OM,y}}$ = $\mathbf{EF_{grid,OM-DD,y}}$	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). 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 04.0).

Instrument or Source of data	Measurement option	Data monitored	
Mass/weight scale(s)		**$FC_{LPG,y}$**	Amount of LPG consumed by the project activity in year *y* (in ton)[155]
	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 context of operation/monitoring for the project activity	**-**	**Management of SWDS**	Management of SWDS The design and operational conditions of the 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 landfill; - Applicable local or national regulations
Meter(s) or equipment electronics.	**-**	**$Op_{j,h}$**	Operation of the equipment that consumes LFG (internal combustion gas engines). 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: - Amount of electricity generated in hour *h* - 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 02).
Not based on measurements Monitoring performed in the context of operation/monitoring for the project activity	**Calculation approach (option) 1 or 3**	**$NCV_{Diesel,y}$**	Net calorific value of the fuel diesel in year y (in GJ/ton diesel). 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 02).

[155] 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 been evaluating 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 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.

Instrument or Source of data	Measurement option	Data monitored	
(based on calculations)			
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 "Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion" (version 02).
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 02).
Measurements undertaken by a third party accredited entity	**B.1**	$F_{CH4,EG,t}$	Mass flow of methane in the exhaust gas of each flare on a dry basis at reference conditions in the time period *t* (kg) For each one of the installed high temperature enclosed flares, 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). The time period *t* over which the mass flow is measured must be at least one hour. 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 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.

Instrument or Source of data	Measurement option	Data monitored	
Thermocouples	**A or B.1**	$T_{EG,m}$	Temperature in the exhaust gas of the enclosed flare in minute *m* (ºC) For each one of the installed high temperature enclosed flares, it will be continuously measured the temperature of the exhaust gas of the flare through use of appropriate temperature measurement instrument (e.g. thermocouple(s)). 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. For each flare, the temperature of the exhaust gas has 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. In case more than one temperature port is fit 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 manufacturer's specifications for temperature of exhaust gas. Each one of the 4 high temperature enclosed flares currently installed as part of the project activity only has one monitoring port for temperature of the exhaust gas. Measurements are required to determine if manufacturer's flare specifications for operating temperature are met.
Optical flame detector (using ultra violet (UV) 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*"). 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 (UV) or infra red technology or both).
Not based on measurements. Records from Project participants will be considered.	**B.1**	$Maintenance_y$	Maintenance events completed in year *y* (calendar dates) for each one of the high temperature enclosed flares combusting LFG. For each installed high temperature enclosed flare, dates when maintenance events are performed in year *y* are to be recorded. Records of maintenance logs will

Instrument or Source of data	Measurement option	Data monitored	
			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 "Tool to calculate baseline, project and/or leakage emissions from electricity consumption" (version 01).

During the 2nd 7-year crediting period, 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 and generated 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 related grid-sourced electricity purchase invoices and/or historical reports (issued by local electricity distribution company) will 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 2nd 7-year crediting period, records of quantity of LPG eventually consumed by the project activity will remain being 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 if applicable.

By the use of appropriate software application, recorded monitoring data will be regularly retrieved, aggregated and reported in order to be considered in the context of calculations of emission reduction achieved by the 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 2nd 7-year crediting period, all monitoring data will remain being 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 during the 2nd crediting period.

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 2nd 7-year crediting period, 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 the 2nd 7-year crediting period.

The project's operational and management structure will rely on trained staff (incl. contractors) with responsibilities clearly defined. All collaborators and employees involved with operation of the 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 during the 2nd 7-year crediting period 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 13.0.0), the design and operational conditions of the UVS - Caieiras landfill during the 2nd 7-year renewable crediting period 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 2nd 7-year crediting period, 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 13.0.0), 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").

Note: The post-registration changes addressed in this revised version of the PDD (permanent changes in the project design, the revision of the monitoring plan and performed corrections (in information which do not affect project design)) are under conformance with applicability requirements of ACM0001 (version 13.0.0) + applicable methodological tools. The scale and the level of accuracy and completeness in overall monitoring of the project activity are not adversely affected by such post-registration changes either. Applied monitoring (including the design of the monitoring plan) and GHG calculation approaches are however improved and complemented, thus meeting both additional monitoring requirements for the project activity (under its revised design configuration) and GHG calculation approaches required/established by ACM0001 (version 13.0.0) + applicable methodological tools.

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

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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[156], thus the remaining operational lifetime for the project's LFG collection and destruction infrastructure potentially exceeds 9 years in May/2018 (after being operated for more than 11 years).

C.3. Crediting period of project activity

C.3.1. Type of crediting period

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While the project activity applies 7-year renewable crediting period option, this PDD is thus valid for the 2nd 7-year renewable crediting period.

C.3.2. Start date of crediting period

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The 2nd 7-year renewable crediting period started on 13/12/2013[157].

C.3.3. Duration of crediting period

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7-year (renewable)[158]

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[156] 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

[157] While as per the previous version of the PDD, the starting date of the 2nd 7-year crediting period was indicated as 01/04/2013, the effective date of renewal of crediting period later approved by UNFCCC is 13/12/2013.

[158] While the 2nd 7-year crediting period for the project activity starts on 13/12/2013 and ends on 30/03/2020, it encompasses slightly less than 7 full years (due to occurred relative delay within the process for informing intention of renewal of the crediting period). While the 1st 7-year crediting period for the project activity ended on 30/03/2013, the starting date of its 2nd crediting period reflects the effective date of renewal of crediting period by UNFCCC.

SECTION D. Environmental impacts

D.1. Analysis of environmental impacts

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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 (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 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[159].

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 1st 7-year crediting period (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, 2019 and 2020 (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

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[158] The operational environmental permit for the electricity generation infrastructure of which the set of internal combustion gas engines are part of (Permit no. 29000393 for the enterprise "*TERMOVERDE CAIEIRAS LTDA.*") is included in the list available at the website of the environmental agency CESTESB of enterprises which were granted with an operational permit in March/2016 for which 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

The issued operational environmental permit 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)

[159] 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)

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 1st 7-year crediting period (PDD version 4, dated 10/01/2013) + Validation Report for the project activity (dated 12/12/2005).

As per applicable CDM rules, no local CDM stakeholder consultation was required for the implementation of the electricity generation infrastructure (for which the set of internal combustion gas engines represents major components). No stakeholder meeting was required by the competent local environmental authority CETESB in the context of the environmental licencing for such electricity generation infrastructure (under its 1st implementation phase).

E.2. Summary of comments received

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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 1st 7-year crediting period (PDD version 4, dated 10/01/2013) + Validation Report for the project activity (dated 12/12/2005).

E.3. Consideration of comments received

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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 1st 7-year crediting period (PDD version 4, dated 10/01/2013) + Validation Report for the project activity (dated 12/12/2005).

SECTION F. Approval and authorization

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The registered CDM project activity has been 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[160]. 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, Norway also became a Party for the project activity. LoA from Annex I Party Norway was more recently issued by the DNA of Norway on 25/09/2014. This LoA authorizes and approves Nordic Environment Finance Corporation as project participant.

As per applicable CDM rules, no additional approval and/or authorisation from DNAs of the above-mentioned parties was required for the permanent post-registration changes in the project design.

[160] 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.
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Contact person	Mr. Eduardo Azzari

Organization name	Nordic Environment Finance Corporation
Country	Norway
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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.

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Further details/clarifications about previous consideration of utilization of LFG as fuel for fuel for industrial boilers and/or fuel for a TDU (under both baseline and project scenarios) and rationale/justifications for not any longer considering these earlier considered potential alternatives as part of the project design in the context of the renewal of the project's 7-year crediting period (incl. its compliance with applicable CDM rules)[161]:

Regarding the previously existent expectation of utilization of collected LFG as gaseous fuel in industrial boilers, the following is outlined in the latest version of the registered PDD for the 1st 7-year renewable crediting period (PDD version 4, dated 10/01/2013):

> *"(…) At the time of the project design initial conceptualization, the CTR landfill[162] had a LFG selling contract under discussion with local industries. At that time it was assumed that whenever the contract was concluded, the associated revenues from the sale of LFG would make collection of LFG in the CTR landfill more economically attractive (collection estimated from 25 to 40% of all methane generated in the landfill), thus without the need of CERs additional revenue for making it economically feasible.*
>
> *These industries would utilize collected LFG, (after its treatment and purification), for drying up paper after the homogenization of cellulose fibers. This drying process would be made by using steam generated using LFG as fuel in boilers. At the time of the project design initial conceptualization, it was also assumed the company would also had a potential to use LFG for generation of electricity for internal use.*
>
> *LFG to be sold would need to contain at least 45% of methane, as to be established in the contract. The rest of generated and not collected LFG would be emitted into the atmosphere without any kind of treatment in the absence of the project activity.*
>
> *(…)*
>
> *At the time of the project design initial conceptualization, the specific pre-project condition of the CTR landfill was to recover LFG up to a quantity to possibly be sold to a local industry. This quantity would guarantee the local safety conditions and would be beyond any regulation or legal demand applicable for the CTR Caieiras landfill. Moreover, this quantity would be above the usual practices on landfills in Brazil, easier to determine, and more straightforward. Also, collection of this quantity to be sold to local industry (estimated from 23% to 40% of the LFG generated) would be paid with the revenues from its sale. (…) At the time of the project design initial conceptualization, it was assumed that these quantities of LFG to be sold to the client would be measurable, agreed in contract and registered."* [SIC]

The registered PDD for the 1st 7-year crediting period also highlights the following:

[161] Details about the also previously considered (and not any longer valid) utilization of LFG as fuel for electricity generation (under previously and not any longer considered approach and design configuration are included in the latest version of the PDD valid for the currently expired 1st 7-year crediting period for the project activity).

[162] As outlined in previous versions of the PDDs valid for both the 1st and 2nd 7-year crediting periods of the project activity, the UVS - Caieiras landfill was previously named 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).

"*(…) In January 2013, no use of any share of collected LFG as fuel by a local industry has yet occurred. At the time of the initial project design conceptualization, a total of 15,698 tCH_4 was earlier forecasted to be annually sold to a local industry as gaseous fuel (to be combusted in industrial boilers) without having associated GHG emission reductions (due to destruction of methane or displacement of fossil fuel in the boilers) being claimed as CERs by the project activity. Essencis Soluções Ambientais S.A. indeed initiated dialogues with industrial facilities for the commercial supply of LFG (or purified LFG) as gaseous fuel. However, no related commercial agreement was yet established. Regardless of the occurred relative increase in the estimated amount of LFG to be generated and collected by the project activity (due to occurred quantitative increment in MSW disposal from year 2007 onwards), the same amount of LFG is still being considered as being eventually exported to an industrial facility.*" [SIC]

Regarding the earlier existent expectation of utilization of collected LFG as gaseous fuel for a TDU, the following is also outlined in the registered PDD for the 1st 7-year renewable crediting period:

"*At the time of the project design initial conceptualization, there was another considered internal application for collected LFG under study: collected LFG would be used as fuel to run a TDU (thermal desorption unit) installed in the UVS - Caieiras landfill to treat polluted and contaminated soils. At the time of the project design initial conceptualization, the TDU was already in operation but with another fuel source. (…) At that time, the TDU unit was fuelled by LPG. In January 2013, the installed TDU unit was fuelled by diesel. So far LFG was never used as fuel in the TDU unit."* [SIC]

It is important to note that at the time of the completion of the PDD valid for the 1st 7-year renewable crediting period (in year 2005), the following was explicitly established by the valid version of ACM0001 baseline and monitoring methodology (ACM0001 version 2):

"This methodology is applicable to landfill gas capture project activities, where the baseline scenario is
the partial or total atmospheric release of the gas and the project activities include situations such as:
a) The captured gas is flared; or
b) The captured gas is used to produce energy (e.g. electricity/thermal energy), but no emission reductions are claimed for displacing or avoiding energy from other sources; or
c) The captured gas is used to produce energy (e.g. electricity/thermal energy), and emission reductions are claimed for displacing or avoiding energy generation from other sources. In this case a baseline methodology for electricity and/or thermal energy displaced shall be provided or and approved one used, including the ACM0002 "Consolidated Methodology for Grid-Connected Power Generation from Renewable". If capacity of electricity generated is less than 15 MW, and/or thermal energy displaced is less than 54 TJ (15 GWh), small-scale methodologies can be used."

Regarding the previously considered continuous utilization of collected LFG as gaseous fuel for electricity generation, the following is outlined in the registered PDD for the 1st 7-year renewable crediting period:

- *"(…) At the time of the project design initial conceptualization, it was also assumed the company would also had a potential to use LFG for generation of electricity for internal use."*
- *"(…) At the time of the project initial design conceptualization, it was assumed that it could be interesting to have a small electricity production to supply internal demand in the future. In that case, electricity for gas pumping would be produced from biomass source."*

Thus, in order to fully adequate the registered CDM project activity to currently valid CDM rules and requirements, the earlier considered (but never implemented) potential utilization of LFG as fuel for

industrial boilers and as fuel for power generation is thus not any longer considered as part of the project design for the Caieiras landfill gas emission reduction.

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 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

Revised version of the PDD (version 9.0, dated 20/07/2018) includes the following post-registration changes:

- Permanent changes in the design of the project activity:
  - Inclusion of destruction of methane through combustion of LFG in a set of internal combustion gas engines (with gradual/phased implementation schedule) that represents additional/alternative methane destruction devices for the project activity with operations since July/2016. Despite these gas engines represents major components for an electricity generation infrastructure located within the geographical limits of the UVS – Caieiras landfill, the project activity under its revised design configuration does not include electricity generation as an additional GHG abatement measure for which emission reductions would be claimed. Thus, CO_2 emission associated to generation of electricity (using LFG as renewable energy source) are not to be accounted/claimed as part of the project activity.

  - Meeting of project's electricity demand through electricity generated by a backup captive off-grid electricity generator (fuelled by diesel) (with nameplate installed capacity of 700 kVA (560 kW for a power factor of 0.8)) is added as an option since July/2016.

- Permanent changes from the registered monitoring plan:
  - Revision of the applied monitoring and GHG calculation approaches by including additional monitoring requirements and calculation approaches for determining the following emissions as a result of the changes in the project design:

    (i) Baseline emissions for methane (due to destruction of LFG (rich in methane) also occurring in the set of internal combustion gas engines (regarded as additional/alternative methane destruction devices).
    (ii) Project emissions (due to the consumption of electricity sourced by the installed backup captive off-grid electricity generator (fuelled by diesel)).
    Project emissions due to consumption of electricity (sourced by the grid or backup generator (fuelled by diesel)) by the project activity will determined by applying guidance of Scenario C of the methodological tool "Tool to calculate baseline, project and/or leakage emissions from electricity consumption" (version 01) to these sources of electricity consumption.

  As a result of the related revision of the applied GHG calculation and monitoring approaches, additional ex-ante determined parameters and parameters monitored ex-post are added (i.e. $Op_{j,h}$, $EF_{EL,captive,y}$, $EF_{EL,grid,y}$, $EC_{PJ,captive,y}$, $FC_{Diesel,y}$, $NCV_{Diesel,y}$, $EF_{CO2,Diesel,y}$, $EG_{Diesel\text{-}Generator,y}$ and $TDL_{captive,y}$) and the parameter $TDL_{grid,y}$ will be monitored ex-post (as established by the methodological tool "Tool to calculate baseline, project and/or leakage emissions from electricity consumption").

- Corrections (that do not affect the project design):
  - General text and terminology revision of project description in order to fully comply with the currently applicable requirements for completing the CDM-PDD form (version 10.1) (as established by its attachment "Instructions for completing this form") and to enhance/improve the project design description.

- Minor text improvements (incl. review of statements and correction of previously existent typographic mistakes) in order to improve the overall project description.

- Revision of ex-ante estimates of emission reductions to be achieved by the project activity during its 2nd 7-year crediting period (by inter alia taking into account the determination of project emissions due to consumption of electricity by the project activity through application of Scenario C of the methodological tool "Tool to calculate baseline, project and/or leakage emissions from electricity consumption" (version 01)).

- The name of the landfill hosting the project activity is changed from "CTR Caieiras landfill" to "UVS - Caieiras landfill" reflecting the occurred change in early 2017 of the designation of the landfill hosting the project activity that was made 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.

- Updated contact information details for the project participant Essencis Soluções Ambientais S.A. is added (in line with the latest version of the completed Modalities of Communication (MoC) form for the project activity).

- Details about performed task-force involving capital and labour intensive maintenance, repair and parts replacement work in existing project's LFG collection infrastructure and operational improvements for such infrastructure held during the period from July/2016 to July/2017 are added in Section A.3.

Revised version of the PDD (version 6.0, dated 17/05/2016) includes the following post-registration changes:

- Permanent changes in the design of the project activity:
  - *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-2015 to 12/04/2016:*
    As result of a previously taken decision of Essencis Soluções Ambientais S.A. to convert the area/region within the UVS - Caieiras landfill where the project's LFG flaring infrastructure was previously implemented and has operated (since year 2007) as a new MSW disposal area, such project's infrastructure was thus required to be moved to other area/region within the landfill. The project activity's LFG flaring infrastructure moving process was initiated in June/2015 and was concluded on 14/02/2016. In the context of the occurred moving process of the LFG flaring infrastructure, 3 new 4-stage and more efficient centrifugal blowers were purchased and were installed in the new location of the infrastructure together transferred equipment/instruments (thus replacing the 4 previously installed and currently worn 3-stage centrifugal blowers that have operated since the start of operations of the project activity in year 2007). Furthermore, a new programmable logic controller (PLC) unit and new database for storing/archiving of monitoring records were also installed (with operation starting on 18/12/2015 (with the old database being kept available for sake of historical monitoring data archiving)).

  - *Performed service intervention in each one of the installed 4 high temperature enclosed flares for addressing previously 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 project's 4 high temperature enclosed flares on 08/06/2015 and aimed addressing previously detected undesirable and abnormal intermittent/sporadic vibration + noise problems in the installed flares. This service intervention was performed by technical service representatives authorized by the flares' designer and manufacturer BTS - Termodinâmica de Sistemas Ltda. and included re-design of the LFG burner unit in each flare (through the

replacement of the previously installed 5 LFG injectors in each flare burner unit by 5 new injectors (with slightly larger dimensions and slightly higher LFG firing capacity)) + related inspection/testing/commissioning services. By making use of slightly larger LFG injectors in the burner unit of the flares, the performed service intervention resulted in slight increase of the maximum nameplate LFG flaring capacity for each one of the installed flares (7,500 Nm^3/h (and not any longer 6,500 Nm^3/h) as defined by the designer and manufacturer of the flares. Such flare specification change requires update in the previously defined value of 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" ($SPEC_{flare}$)).

- Correction in information (that do not affect the project design):
  - Duplicated table with details for the monitoring parameter "Temperature in the exhaust gas of the enclosed flare in minute m" ($T_{EG,m}$) was deleted from Section B.7.1.
  - Typo and grammar errors and mistakes were corrected in different sections of the PDD.

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Document information

Version	*Date*	*Description*
10.1	28 June 2017	Revision to make editorial improvement.

Version	*Date*	*Description*
10.0	7 June 2017	Revision to: • Improve consistency with the “CDM project standard for project activities” and with the PoA-DD and CPA-DD forms; • Make editorial improvement.
09.0	24 May/2017	Revision to: • Ensure consistency with the “CDM project standard for project activities” (CDM-EB93-A04-STAN) (version 01.0); • Incorporate the “Project design document form for small-scale CDM project activities” (CDM-SSC-PDD-FORM); • Make editorial improvement.
08.0	22 July 2016	EB 90, Annex 1 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: • Include provisions related to statement on erroneous inclusion of a CPA; • Include provisions related to delayed submission of a monitoring plan; • Provisions related to local stakeholder consultation; • Provisions related to the Host Party; • Make editorial improvement.
05.0	25 June 2014	Revision to: • 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)); • Include provisions related to standardized baselines; • 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; • Change the reference number from F-CDM-PDD to CDM-PDD-FORM; • 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 Initial adoption.

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