



**Validation report form for post-registration changes for
CDM project activities
(Version 03.0)**

BASIC INFORMATION

Title and UNFCCC reference number of the project activity	Oeste de Caucaia Landfill Project Activity UNFCCC Ref. Number 10261
Process track	<input type="checkbox"/> Prior approval <input checked="" type="checkbox"/> Issuance <input type="checkbox"/> Renewal of crediting period
Version number of the validation report	1.1
Completion date of the validation report	20/05/2021
Type(s) of PRCs	<input checked="" type="checkbox"/> Temporary deviations from the registered monitoring plan, applied methodologies, standardized baselines or other methodological regulatory documents ¹ <input type="checkbox"/> Corrections <input type="checkbox"/> Changes to the start date of the crediting period <input type="checkbox"/> Inclusion of a monitoring plan <input checked="" type="checkbox"/> Permanent changes to the registered monitoring plan, or permanent deviation of monitoring from the applied methodologies, standardized baselines or other methodological regulatory documents <input checked="" type="checkbox"/> Changes to the project design <input type="checkbox"/> Changes specific to afforestation and reforestation project activities
Version number of PDD to which this report applies	5
Project participants	GNR Fortaleza Valorização de Biogás Ltda.
Host Party	Brazil
Applied methodologies and standardized baselines	ACM0001: Flaring or use of landfill gas, version 15.0
Mandatory sectoral scopes	Sectoral Scope: 13 - Waste handling and disposal
Conditional sectoral scopes, if applicable	Sectoral Scope: 1 - Energy industries (renewable - / non-renewable sources)
Name and UNFCCC reference number of the DOE	Name: KBS Certification Services Pvt. Ltd. UNFCCC reference number: E-0051

¹ Other standards, methodologies, methodological tools and guidelines (to be) applied in accordance with the applied(selected) methodologies are collectively referred to as the other (applied) methodological regulatory documents).

**Name, position and signature of the
approver of the validation report**



Kaushal Goyal
Managing Director
KBS Certification Services Pvt. Ltd.

SECTION A. Executive summary

Description of project:

The "Oeste de Caucaia Landfill Project Activity" was implemented with the objective to capture, purification and injection of the landfill gas (LFG) generated at the landfill of Oeste de Caucaia into a natural gas distribution network, at Caucaia Municipality (in the state of Ceará), in order to avoid emissions of methane to the atmosphere produced by the anaerobic decomposition of the dumped waste from Caucaia Municipality and displacing the use of natural gas. Any LFG excess will be flared.

The project consists of three phases:

- Phase I: LFG capture, upgraded facility and distribution to the natural gas network, reducing uncontrolled release to atmosphere;
- Phase II and III: Increase of the LFG processing capacity depending on the project performance.

The capture system was operational in 12/2015 and the upgrading facility started operation in 12/2017.

The GHG emission reductions were calculated on the basis of the approved methodology ACM0001 – Flaring or use of landfill gas, version 15.0 of 08/11/2013 and the monitoring plan included in the revised registered Project Design Document, version 5 of 15/02/2021 submitted.

The project was validated by RINA (validation report version 1.5Aa issued on 13/04/2016) and it was registered on 22/04/2016 under the CDM registration reference No. 10261. A validation opinion on the changes to the project design presented in the revised PDD version 5 of 15/02/2021 and a temporary deviation is submitted.

Validation process

This report summarizes the findings from the validation of the revised PDD of the project, performed on the basis of UNFCCC criteria for CDM, as well as criteria given by the CDM Validation and Verification Standard for project activities, CDM Project Cycle Procedure for project activities and CDM Project Standard for project activities. The Validation Opinion is not meant to provide any consultancy towards the project participants. However, stated requests for clarifications and/or corrective actions may have provided input for improvement of the project design.

Conclusion

GNR Fortaliza Valorização de Biogás Ltda has commissioned KBS to perform the validation of the revised PDD (version 5 dated 15/02/2021) and revised MR (version 3 dated 15/02/2021) of the project "Oeste de Caucaia Landfill Project Activity". In conclusion, it is KBS's opinion that the revised documents meet all the relevant requirements established in the CDM Project Standard.

Hence, KBS requests that the validation opinion on changes from the project activity as described in the revised PDD and revised MR for the project activity "Oeste de Caucaia Landfill Project Activity" in Brazil may be considered by the Board.

The following points were raised in the request for issuance Incomplete received on 26/04/2021. The responses are provided bellow. The MR (version 3 of 14/05/2021) and related documents were updated accordingly.

1: Paragraph 283 of VVS-PA:

The DOE is requested to explain how it validated the temporary deviation from the registered monitoring plan, in particular:

(a) Deviation 1:

(i) It is not evident that the formulas described on page 8 of the monitoring report are applied in the ER sheets;

(ii) The ER sheets (for example in file "Annex 30 to CER Sheet") include parameter "Maximum LFG Methane fraction in DEVIATION" in sheet "Assumptions" which is used to determine "LFG Methane fraction (%)". However, there is no explanation what this parameter is and why it is used in the calculation;

(iii) On page 8, the monitoring report concluded that the estimate presented is conservative since it does not add the methane losses in the biogas purification process (DC) to the result of methane concentration in biogas. The DOE is requested to substantiate how this is conservative, considering that lower D (for not adding methane losses in the biogas purification process) would result in higher volumetric fraction of CH₄ in the LFG and eventually higher BE_{CH₄,y} which not conservative;

(iv) The DOE is requested to substantiate how it is conservative not to consider fraction of the biomethane which was flared. The monitoring report on page 11 states that biomethane which does not reach the required parameters to be delivered to the NG distribution system is flared. As this may include biomethane with volumetric fraction lower than the requirement, excluding lower volumetric fraction would result in volumetric fraction of CH₄ in the LFG being overestimated, and eventually BE_{CH₄,y} being overestimated;

Response: Regarding to deviation 1, PP explained that the sensor responsible for measuring the methane fraction in the LFG was not operational between 21/09/2018 (10h:52m) and 22/10/2020 (08h:20m). The deviation proposed initially aimed to determine the methane content in the LFG from the volume of gas and methane fraction in biomethane at the end of the process.

However, as detailed in item 5 below, a new approach has been adopted consisting of a statistical analysis of the methane content measurements recorded immediately before and after the period in which the sensor was not operational.

Consequently, the requests related to Deviation 1 (items *i* to *iv* above) are no longer applicable to the revision of the Monitoring Report and related documents. Request 5 below details the deviation 1 revision. The spreadsheet "Historical statistical analysis CH4 MR.xlsx" presents the results of the statistical analysis.

(b) Deviation 3:

(i) The PP considered the highest temperature of LFG as 78 degree C whereas the value observed is 78.333 degree C, instead of rounded down value 78 degree C;

Response: The PP has reassessed data from temperature of LFG throughout the entire monitored period and found that the highest temperature value is of 78.473 °C which has not been rounded with the purpose of determining emission reductions.

(ii) The ER sheet for August 2020 shows that the highest measured temperature is 1370.

Response: The value recorded 1370 for temperature of LFG is not a real operative value. This is in fact a value registered by the supervisory system when the temperature meter presents transmission signal errors. Throughout the entire monitoring period, the error values have been detected and replaced by Deviation 3 result (item b i, above).

2: Paragraph 309(b) of VVS-PA:

The DOE is requested to explain how it validated the changes to the project design, in particular:

(a) There is no opinion on assessment on the reasons for the expansion of landfill area;

Response: The ASMOC landfill has received waste, since its opening, from the metropolitan region of Fortaleza. The origin of the waste that will be deposited in the expansion area is the same, as stated in the Environmental Impact Assessment (EIA) and environmental permits. The Environmental Impact Assessment related to the expansion of the landfill is dated 2011. At that time the report mentioned that the lifetime of the existent landfill area was of four more years, i.e. the landfill would be closed by 2015. Therefore, for the waste collected in the metropolitan region of Fortaleza to have an adequate final destination, the expansion would be necessary. As stated in the EIA, based on the literature, in Brazil there are no other practices rather than landfilling MSW such as incineration, composting or recycling that would postpone or avoid the landfill expansion.

(b) There is no explanation how the expected annual amount of waste is lower than the amount described in the registered PDD with the increased area of landfill.

Response: The reference for the amount of waste considered in the PDD was the gas capture study conducted by a specialized company (LANDTEC), while for the PDD PRC the amount of waste monitored by the company until 2019 and the estimates made in the environmental impact study regarding the expansion of the landfill area were considered (from 2020 until the end of the crediting period).

Evidence of the amount of waste deposited between 2005 and 2019 as monitored by the landfill manager (ECOFOR) was provided for the DOE and updated accordingly in the PRC PDD.

The expansion area started receiving waste in 2020. The estimated waste disposal capacity for the landfill expansion area as per the EIA is 22,139,996 t until the expected lifetime is reached.

If we sum the amount of waste considered in the PDD between 2020 and 2031 (last year of the third crediting period) the result is 29,869,279 t of MSW (according to LANDTEC study), while the total waste considered in the PRC PDD is 24,881,314 t. Therefore, the projection of waste to be disposed as stated in the PDD PRC in the coming years is more conservative and was considered as being more appropriate to determine the ex-ante emission reductions of the project.

It should be noted that the design of the landfill as stated in the EIA took into account modern construction techniques to ensure the stability of the slopes and that, despite having been executed in 2011, the projections of the amount of waste disposed in the last three years (2017, 2018 and 2019) proved to be quite consistent with the data monitored by ECOFOR.

Year	MSW (t) EIA projection	MSW (t) Monitored
2017	1,620,316	1,641,774
2018	1,672,291	1,654,471
2019	1,726,010	1,728,751

3: Paragraph 272 (e) of VVS-PA:

In the validation report for PRC the DOE referred to paragraph 338(b) and 339 of the VVS-PA for the requirement for mandatory site visit. However, it has not considered the relevant requirement for mandatory site visit applicable to PRC, i.e. paragraph 301 of VVS-PA.

Response: The paragraph was correctly updated in section C.3 of this report.

4: Paragraph 258 of PS-PA:

- (i) Monitoring report on page 13 lists the equipment for measurement. However, each equipment is not shown in the monitoring diagram described on page 8 of monitoring report;
- (ii) Total number of gas meters listed on page 13 of monitoring report (i.e. 3 meters) does not match total number of gas meters shown in the monitoring diagram on page 8 of monitoring report (i.e. 7 meters).

Response: The illustrative diagram on page 8 of the Monitoring Report was included with the purpose of emphasizing the location of the meters from which data used in the Deviation 1 was taken. Deviation 1 was revised (see request 5 below). In this sense the diagram is no longer presented in the revised version of the Monitoring Report. In addition, a revised illustrative diagram reflecting equipment listed in page 13 was included.

5: Paragraph 373(c) of VVS-PA:

The monitoring report on page 28 states that during the monitored period Options A and B were used to determine the mass flow of gases containing methane. Option B is applicable when the volume flow in wet basis and volumetric fraction in dry basis. The DOE is requested to explain how it verified the correctness of application of option B, in particular the application of equation 6 of the revised PDD for the period October 2018 to August 2020, as it is observed in some instances that LFG temperature is above 60 degree C (which shows that the volume flow is wet basis), however equation 6 is not used to convert volumetric flow from wet basis to dry basis.

Response: The CERs calculation has been revised and is now considering the application of Options A and B to determine the mass flow of gases containing methane throughout the entire monitoring period, considering the temperature threshold and corrected application of equation 6 of the revised PDD.

6: Paragraph 373(e) of VVS-PA:

The DOE is requested to explain how it verified parameter "Methane density at standard T and P" which value is fixed for the entire monitoring period as 0.7168 kg/m³ as:

- (i) Version 15 of ACM0001 does not have this value;
- (ii) The revised PDD does not include this parameter as parameters fixed ex-ante;
- (iii) The revised PDD requires that the density be calculated as per equation 5;
- (iv) The monitoring report states that the flow meter measures the flow at normal conditions whereas this parameter refers to standard conditions.

Response: All flow meters used in the project activity during the monitored period measures stream flows at normal condition automatically according to meters specification. However, the parameter Volumetric flow of greenhouse gas ($V_{t,db}$) presented in the *"Tool to determine the mass flow of a greenhouse gas in a gaseous stream -Version 02.0.0"* is not under normal conditions, neither the Density of greenhouse gas. So, considering the normalized flow meters installed at the project plant, the calculation of the Density of greenhouse gas should be under normal conditions as well.

Thus, Density of greenhouse gas was calculated as follows:

$$\rho_{i,n} = \frac{P_n * MM_i}{R_u * T_n}$$

Where:

- $\rho_{i,n}$ = Density of greenhouse gas i in the gaseous stream at normal conditions (kg gas i/wet m³ gas i);
- P_n = Absolute pressure at normal conditions (Pa);
- MM_i = Molecular mass of greenhouse gas i (kg/kmol);

R_u = Universal ideal gases constant (8,314 Pa.m³/kmol.K);
 T_n = Temperature at normal conditions (K).

SECTION B. Validation team, technical reviewer and approver

B.1. Validation team member

No.	Role	Type of resource	Last name	First name	Affiliation (e.g. name of central or other office of DOE or outsourced entity)	Involvement in			
						Desk/document review	On-site inspection	Interviews	Validation findings
1.	Team Leader/Technical Expert (TA 13.1)	EI	Leiroz	Andrea	Central Office	✓	-	✓	✓

B.2. Technical reviewer and approver of the validation report on PRCs

No.	Role	Type of resource	Last name	First name	Affiliation (e.g. name of central or other office of DOE or outsourced entity)
1.	Technical reviewer	IR	Kandari	Sanjay	Central Office
2.	Manager Technical & Certification	IR	Chaudhari	Tushar Eknath	Central Office
3.	Authorizer	IR	Goyal	Kaushal	Central Office

SECTION C. Means of validation

C.1. Desk/document review

A desk review is undertaken, involving but not limited to,

- A review of the data and information presented to verify their completeness;
- A review of the revised PDD;
- A review of the monitoring plan and monitoring methodology, paying particular attention to the frequency of measurements, the quality of metering equipment including calibration requirements, and the quality assurance and quality control procedures;
- An evaluation of data management and the quality assurance and quality control system in the context of their influence on the generation and reporting of emission reductions.

The list of documents reviewed is included in the section 'Appendix 3' of this report.

C.2. On-site inspection

Duration of on-site inspection: DD/MM/YYYY to DD/MM/YYYY				
No.	Activity performed on-site	Site location	Date	Team member
1.				

As result of the COVID-19 pandemic, taking into account the rules of relevant national and local authorities (local to the DOE offices as well as to locality of the site visits), World Health Organization (WHO) recommendations, policies of the DOE and other relevant travel restrictions and guidance (for example, a requirement to self-isolate upon return from specific countries), a DOE may postpone site visits for onsite inspections required by the "Validation and Verification Standard for project activities" version 02.0 /9/.

If the site visits cannot be postponed, a proper justification should be provided by the DOE why the site visits cannot be postponed, including the demonstration of a significant impact of delaying the site visits on the DOE, or project participants or coordinating/ managing entity (e.g. commitment/ timeline as per the validation or verification contract, CER delivery commitment by project participants) reliance on applicable force majeure provisions in the validation or verification contracts, if needed.

For this project, PP has made commitment/timeline as per the verification contract /45/. Hence, the DOE has skipped the on-site visit /46/. However, as per the CDM EB, the DOE may use other standard auditing techniques for validation or verification as referred to in sections 9.1.3 of the VVS-PA /9/.

Validation team has used the following alternative means for its assessment and to justify that they are sufficient for the purpose of validation. Along with desk review, audit team has conducted remote audit interview as follows:

- A complete desk review of the revised PDD /6/, submitted MR (initial and final versions) /1/ /2/, as well as applicable country legal requirement and supportive evidences have been checked by the Validation Team.
- Validation team has performed a remote site inspection via videoconference (Skype) with PP in order to check implementation, project boundary, current situation, evaluation of data management, QA/QC system, monitoring and metering equipment, monitoring procedures, calibration etc. Interview questions were filled as per Validation team interview checklist and also videos were captured.
- Cross-checks between information provided by interviews, under the scope of all information and references provided in MR and supporting documents.
- Cross-checked evaluation, for information received from interviews, under the scope of all information and references provided in MR and supporting documents.

Details of interviewees, topics covered and additional information presented in the below section “C.3 – Interviews”.

Validation team has also checked the site visit requirements mentioned in paragraph 301 of the VVS for PA version 02.0 /9/. However, the presential site visit was not conducted due to the COVID-19 pandemic. The site visit cannot be postponed since PP has made commitment/timeline as per the verification contract /45/.

C.3. Interviews

No.	Interviewee			Date	Subject	Team member
	Last name	First name	Affiliation			
1.	Sampaio	Fernanda	GNR	22/12/2020	Project implementation, management, operation and monitoring.	Andrea Leiroz
2.	Veiga	Ana Paula	BENG		CERs calculation, project monitoring and data analysis.	
3.	Sprovieri	João	BENG			

C.4. Sampling approach

No sampling approach is used during verification.

C.5. Clarification requests (CLs), corrective action requests (CARs) and forward action requests (FARs) raised

Areas of validation findings	No. of CL	No. of CAR	No. of FAR
Compliance with PDD form	-	-	-
Temporary deviations from the registered monitoring plan, applied methodologies, standardized baselines or other methodological regulatory documents	-	02	-

Corrections	-	-	-
Changes to the start date of the crediting period	-	-	-
Inclusion of a monitoring plan	-	-	-
Permanent changes to the registered monitoring plan, or permanent deviation of monitoring from the applied methodologies, standardized baselines or other methodological regulatory documents	-	-	-
Changes to the project design	-	-	-
Changes specific to afforestation and reforestation project activities	-	-	-
Others (please specify)	-	-	-
Total	-	02	-

SECTION D. Validation findings

D.1. Compliance with PDD form

Means of validation	PDD applies the applicable CDM-PDD-FORM: Project design document form version 11.0 /12/. KBS verified that the renewal crediting period, information transferred to the later valid version of the PDD form is materially the same as that in the registered PDD /6/.
Findings	No findings have been raised.
Conclusion	KBS confirms that final PDD is completed using the valid version of the applicable CDM-PDD-FORM: Project design document form version 11.0 /12/ in compliance with para 412 (a) (i) of VVS for PA version 02 /9/. All the information has been correctly transferred from registered PDD /5/ to the current PDD /6/ which is filled in the latest CDM PDD form available in UNFCCC website. KBS confirms that the transfer of information from the old form to the new form is correct and materially the same as the information in the registered PDD in compliance with para 412 (a) (ii) of VVS for PA version 02 /9/. PDD is in compliance with the instruction provided in the template.

D.2. Temporary deviations from the registered monitoring plan, applied methodologies, standardized baselines or other methodological regulatory documents

Means of validation	<p><u>Deviation 1:</u></p> <p>In the registered monitoring plan described in the PDD, the parameter $v_{i,t,db}$ (volumetric fraction of greenhouse gas CH₄ in the LFG), which is applied on calculation of project and baseline emissions, is continuously measured by a gas analyser (on dry basis), and it is aggregated hourly (at least). This procedure is also in line with "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" version 02.0.0 /20/.</p> <p>As verified during the remote audit, the gas analyser has two sensors that measures both the methane fraction in the LFG in the inlet of the plant and in the biomethane in the outlet of the upgrading plant. For the period from 21/09/2018 (10h:52min) to 23/09/2020 (23h:59 min), the gas analyser sensor that should provide the measurement of the volumetric fraction in the LFG was not operational and thus, the parameter $v_{i,t,db}$ could not be monitored in accordance with the registered monitoring plan.</p> <p>According to CDM project standard for project activities, version 02.0, para 231 /10/, CDM validation and verification standard for project activities, version 02.0, para 283 /9/ and in order to apply conservative assumptions or discount factors to the calculations to the extent required to ensure that emission reductions will not be overestimated as a result of the temporary deviation for the requested monitoring period, the conservative procedure will be elaborated as follows:</p> <ul style="list-style-type: none"> A temporary deviation is proposed in order to provide this parameter using an alternative method. This parameter was calculated during this period, based on a statistical analysis using conservative assumptions defining a non-overestimated conservative choice of default data. The statistical analysis took into consideration two sample periods (range of data). One period before the interruption of $v_{i,t,db}$ readings (from 22/12/2017 at 15h:24m to 21/09/2018 10h:51m – inside the monitored period) and another period after the interruption of $v_{i,t,db}$ readings (from 22/10/2020 at 08h:21m to 01/05/2021 00h:00m – outside the monitoring period) /61/. Both sample periods had the equipment responsible for measuring the $v_{i,t,db}$ (gas analyser in dry
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basis) proper calibrated /32/. Data was cross checked against the raw data downloaded from the supervisory system /63/.

- Since a range of data was used, the conservative default data has been calculated assuming a range that represents the lower 95% confidence limits of a normally distributed dataset. The Microsoft Excel © formulae "PERCENTILE" has been used taking into account (i) the sample periods range of data and (ii) the interval percentile value (k) of 2.5% /61/.
- The result of this statistical analysis returned a conservative default value of 58.318962% of CH₄ in LFG and has been used to replace missing vi,t,db (volumetric fraction of greenhouse gas CH₄ in the LFG in dry basis) data throughout the Deviation 1 period.

KBS verified the conservativeness of the proposed measurement method observing that the result is also not overestimated, since it is lower than the sample average (59.197308% CH₄ in LFG) and sample median (59.21520% CH₄ in LFG). Thus, the volumetric fraction of the greenhouse gas CH₄ in the LFG was considered as the percentile of the sample values.

Deviation 2:

For the monitoring period from 22/12/2017 to 23/09/2020, the parameter "Flame detection of flare in the minute m" (Flame_m) was not implemented for the flare line and thus, not registered by the supervisory system.

According to CDM project standard for project activities, version 02.0, para 231, CDM validation and verification standard for project activities, version 02.0, para 283 and in order to apply conservative assumptions or discount factors to the calculations to the extent required to ensure that emission reductions will not be overestimated as a result of the temporary deviation for the requested monitoring period, the conservative procedure will be elaborated as follows:

- It has been demonstrated that the flare is equipped with valves on the input gas line that close automatically if the device becomes non- operational /52/. Thus, if LFG flow is registered for the flare line, then the LFG flow is combusted by this destruction device.
- As per flare operational description provided by manufacturer /52/, the gas flows to the pilot device and a spark is generated to ignite the pilot flame and the automatic mode attempts to light the pilot three times.
- At the end of these attempts, if pilot flame is not ignited, "Pilot Failure" lamp will be illuminated and the operator will have to press the reset push-button to restart the unit.
- Upon proving the pilot flame, the automatic block valve is opened and the gas blower is started allowing gas flow to the flare.

KBS verified the manufacturer's specifications /52/ and verified that although the parameter was not formally recorded, the gas flow is automatically blocked by the system when the flame is not lit. Thus, KBS considered that the deviation described above is conservative.

Deviation 3:

In the registered monitoring plan described in the PDD, the parameter T_t (Temperature of the gaseous stream in time interval t), which is applied on calculation of project and baseline emissions, is continuously measured by temperature sensor meter, and it is aggregated hourly (at least). This procedure is also in line with "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" (Version 02.0.0) /20/. For the entire months 12/2017, 01/2018, 02/2018 and 09/2020 and 08/2020 (from 28/08/2020 (11h:23m) to 31/08/2020 (23h:59m)), the temperature sensor meter that should provide the measurement was not operational and the parameter T_t could not be monitored in accordance with registered monitoring plan as verified against the monthly raw data downloaded from the supervisory system /30/.

According to CDM project standard for project activities, version 02.0, para 231 /10/, CDM validation and verification standard for project activities, version 02.0, para 283 /9/ and in order to apply conservative assumptions or discount factors to the calculations to the extent required to ensure that emission reductions will not be overestimated as a result of the temporary deviation for the requested monitoring period, the conservative procedure will be elaborated as follows:

	<ul style="list-style-type: none"> As stated in the “Tool to determine the mass flow of a greenhouse gas in a gaseous stream” /20/, it is necessary to demonstrate that the gaseous stream is dry or wet by demonstrating that the temperature of the gaseous stream (T_i) is less than 60°C (dry basis) or higher than 60°C (wet basis) at the flow measurement point. For the deviation period, since it was not possible to demonstrate if the gaseous stream is dry or wet, it was conservatively adopted a temperature of 78.473°C (wet basis, being the highest LFG temperature registered during the entire monitoring period) /62/ and thus, converting the measured volumetric flow from wet basis to dry basis, as defined in Option B of the “Tool to determine the mass flow of a greenhouse gas in a gaseous stream” /20/. <p>KBS verified the raw data downloaded from the supervisory /30/ during the remote audit and confirmed that 78.473°C was the highest temperature during the monitoring period and consider conservative to adopt this value for the months which the temperature was not monitored. Moreover, it was verified an error in the measurement of the temperature. The wrong value recorded 1370 for temperature of LFG is not a real operative value. This is in fact a value registered by the supervisory system when the temperature meter presents transmission signal errors. Throughout the entire monitoring period, the error values have been detected and replaced by 78.473°C.</p> <p>The conservativeness of the proposed assumption was confirmed checking the calculation considering a lower temperature than 78.473°C, for example 70°C. Considering this lower temperature, the quantity of total methane collected and sent to consumer will increase and as a consequence, the baseline emissions associated with natural gas use will also increase. Therefore, consider the highest temperature monitored during the monitoring period for the months where the temperature sensor was not operational is more conservative than adopt any other temperature below this value. The table below shows the comparison done for the month 09/2020.</p> <table border="1"> <thead> <tr> <th>Temperature</th><th>Total methane collected and sent to consumer</th><th>Baseline emissions associated with natural gas use</th></tr> </thead> <tbody> <tr> <td>70°C</td><td>1,295,250 Nm³</td><td>2,724 tCO₂e</td></tr> <tr> <td>78.473°C</td><td>1,057,753 Nm³</td><td>2,224 tCO₂e</td></tr> </tbody> </table>	Temperature	Total methane collected and sent to consumer	Baseline emissions associated with natural gas use	70°C	1,295,250 Nm ³	2,724 tCO ₂ e	78.473°C	1,057,753 Nm ³	2,224 tCO ₂ e
Temperature	Total methane collected and sent to consumer	Baseline emissions associated with natural gas use								
70°C	1,295,250 Nm ³	2,724 tCO ₂ e								
78.473°C	1,057,753 Nm ³	2,224 tCO ₂ e								
Findings	CAR 01 and CAR 02 were raised and successfully closed. The findings are discussed in Appendix 04 of the validation report.									
Conclusion	<p>The temporary deviations (as showed in the table below) applied by PP are in accordance with CDM project standard for project activities, version 02.0, para 231 and Appendix para (b).</p> <table border="1"> <thead> <tr> <th>Deviation number</th><th>Applied period</th></tr> </thead> <tbody> <tr> <td>1</td><td>01/10/2018 (08h:08min) to 23/09/2020 (11h:26 min)</td></tr> <tr> <td>2</td><td>22/12/2017 to 23/09/2020</td></tr> <tr> <td>3</td><td>12/2017, 01/2018, 02/2018, 09/2020 and 08/2020 (from 28/08/2020 (11h:23m) to 31/08/2020 (23h:59m))</td></tr> </tbody> </table>	Deviation number	Applied period	1	01/10/2018 (08h:08min) to 23/09/2020 (11h:26 min)	2	22/12/2017 to 23/09/2020	3	12/2017, 01/2018, 02/2018, 09/2020 and 08/2020 (from 28/08/2020 (11h:23m) to 31/08/2020 (23h:59m))	
Deviation number	Applied period									
1	01/10/2018 (08h:08min) to 23/09/2020 (11h:26 min)									
2	22/12/2017 to 23/09/2020									
3	12/2017, 01/2018, 02/2018, 09/2020 and 08/2020 (from 28/08/2020 (11h:23m) to 31/08/2020 (23h:59m))									

D.3. Corrections

Means of validation	N/A
Findings	N/A
Conclusion	N/A

D.4. Changes to the start date of the crediting period

Means of validation	N/A
Findings	N/A
Conclusion	N/A

D.5. Inclusion of a monitoring plan

Means of validation	N/A
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Findings	N/A
Conclusion	N/A

D.6. Permanent changes to the registered monitoring plan, or permanent deviation of monitoring from the applied methodologies, standardized baselines or other methodological regulatory documents

<p>Means of validation</p>	<p>The revised PDD presents permanent changes in the monitoring plan related to the revision of section B.6.1 in order to include additional options to determine the mass flow of gases containing methane depending on the properties (e.g., temperature, humidity, among others) of the monitored gas flow (i.e., LFG or biomethane).</p> <p>During the remote audit, it was verified through the raw data downloaded from the supervisory /30/ that there are temperatures below and above 60°C. Furthermore, it was verified that the volumetric fraction of methane is measured on a dry basis. Therefore, it was confirmed the necessity to revise the monitoring plan.</p> <p>As stated in the MR, the inclusion of other options provided by the methodology tool “Tool to determine the mass flow of a greenhouse gas in a gaseous stream” /20/ that were not considered in the registered version of the PDD /5/ sought to increase consistency between the PDD and the operational reality of the project. Thus, option B was included as an option to determine the mass flow of gases containing methane and the following parameters were included in section B.6.2 and B.7.1, respectively:</p> <ul style="list-style-type: none"> • MM_{H_2O}: The molecular mass of water is 18.0152 kg/kmol is according to the methodology tool “Tool to determine the mass flow of a greenhouse gas in a gaseous stream” /20/ application criteria as the methane is the greenhouse gas considered and the remaining gases are pure nitrogen for simplification. • $P_{H_2O,t,Sat}$: Saturation pressure of H_2O at temperature T_t in time interval t. This parameter is solely a function of the gaseous stream temperature T_t and can be found at reference [1] of the methodology tool “Tool to determine the mass flow of a greenhouse gas in a gaseous stream” /20/ for a total pressure equal to 101 325 Pa. <p>In addition, some adjusts were made in the following parameters:</p> <p><u>Parameters that are made available ex-ante</u></p> <ul style="list-style-type: none"> - R_u: The universal ideal gases constant used is 8 314 Pa.m³/kmol.K is according to the “Tool to determine the mass flow of a greenhouse gas in a gaseous stream” /20/. The purpose of data was updated since this parameter is used for the determination of the baseline emissions and the information regarding to “Additional comment” was removed; - MM_i: The molecular mass of greenhouse gas methane is 16.04 kg/kmol is according to the “Tool to determine the mass flow of a greenhouse gas in a gaseous stream” /20/ application criteria as the methane is the greenhouse gas considered and the remaining gases are pure nitrogen for simplification. The purpose of data was updated since this parameter is used for the determination of the baseline emissions and the information regarding to “Additional comment” was removed; - MM_k: The molecular mass of greenhouse gas nitrogen is 28.01 kg/kmol is according to the “Tool to determine the mass flow of a greenhouse gas in a gaseous stream” /20/ application criteria as the methane is the greenhouse gas considered and the remaining gases are pure nitrogen for simplification. The information regarding to “Additional comment” was removed; - P_n: The total pressure at normal conditions is 101,325 Pa is according to the “Tool to determine the mass flow of a greenhouse gas in a gaseous stream” /20/. The information included under “Additional comment” was removed; - T_n: The temperature at normal conditions is 273.15 K is according to the “Tool to determine the mass flow of a greenhouse gas in a gaseous stream” /20/. The information included under “Additional comment” was removed. <p><u>Parameters monitored ex-post</u></p> <ul style="list-style-type: none"> - $V_{t,db}$: Volumetric flow of the gaseous stream in time interval t on a dry basis
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	<p>(m³/h). The information under “Additional comment” was revised according to the “Tool to determine the mass flow of a greenhouse gas in a gaseous stream” /20/;</p> <ul style="list-style-type: none"> - $V_{t,wb}$: Volumetric flow of the gaseous stream in time interval t on a wet basis (m³/h). The information under “Additional comment” was revised according to the “Tool to determine the mass flow of a greenhouse gas in a gaseous stream” /20/; - $v_{i,t,db}$: Volumetric fraction of greenhouse gas i in a time interval t in a dry basis. The information under “Additional comment” was revised according to the “Tool to determine the mass flow of a greenhouse gas in a gaseous stream” /20/ to include option B; - $v_{i,t,wb}$: Volumetric fraction of greenhouse gas i in a time interval t in a wet basis. The information under “Additional comment” was revised according to the “Tool to determine the mass flow of a greenhouse gas in a gaseous stream” /20/ to include option A; - T_t: temperature of the gaseous stream in time interval t. The information under “Additional comment” was revised according to the “Tool to determine the mass flow of a greenhouse gas in a gaseous stream” /20/; - P_t: Pressure of the gaseous stream in time interval t. The information under “Additional comment” was revised according to the “Tool to determine the mass flow of a greenhouse gas in a gaseous stream” /20/. <p>It was confirmed that there is no increase in capacity of the LFG capture system or addition of new equipment that increases its capacity to upgrade the captured landfill gas. Hence, these revisions do not affect the applicability of the methodology nor the additionality and scale of the project.</p>
Findings	Refers to CAR 02 raised and successfully closed in section D.2.
Conclusion	The permanent changes to the registered monitoring plan applied by PP are in accordance with CDM project standard for project activities, version 02.0, para 238 and Appendix para (c).

D.7. Changes to the project design

Means of validation	<p>Along with this verification, it is being proposed a project design change in the registered PDD. A revised PDD version 5 dated 15/02/2021 /6/ is being submitted along with the verification report.</p> <p>The post-registration change consisted of an update of the existent landfill area from what was described in the registered PDD /6/.</p> <p>The amount of waste deposited at the project site was also updated according to the most recent data monitored by the project proponent /54/ /59/, which were not available during the validation of the Project Activity. No significant difference can be observed with respect to the information provided in the first registered version of the PDD, but emission reductions were revised accordingly. Nonetheless, this update resulted in a more conservative ex-ante estimative, since there will be no increase in the ex-ante estimated LFG generation capacity.</p> <p>The changes in the project activity are related to the following:</p> <ul style="list-style-type: none"> • The landfill area expansion; • The amount of waste deposited at the project site. <p>The PDD dated 03/09/2015 /5/ submitted for registration specifies a area of 84.1 ha for waste disposal, however in 2019 ECOFOR (landfill's operator) granted a license /48/ to expand the landfill area in approximately 73 ha. Thus, the actual area of the project activity is 157.1 ha. The Caucaia metropolitan landfill has received waste, since its opening, from the metropolitan region of Fortaleza. The origin of the waste that will be deposited in the expansion area is the same, as stated in the Environmental Impact Assessment (EIA) /54/ and environmental permits /48/ /55/. The Environmental Impact Assessment related to the expansion of the landfill is dated 2011. At that time the report mentioned that the lifetime of the existent landfill area was of four more years, i.e. the landfill would be closed by 2015. Therefore, for the waste collected in the metropolitan region of Fortaleza to have an adequate final destination, the expansion would be necessary. As stated in the EIA /54/, based on the literature, in Brazil there are no other practices rather than landfilling</p>
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MSW such as incineration, composting or recycling that would postpone or avoid the landfill expansion. Thus, it is KBS's opinion that the update of the existent landfill area from what was described in the registered PDD /5/ was a necessity to continue with the adequate final destination of the waste in the region.

In addition, there is a change in the amount of waste deposited in the project site based on the most recent data monitored by PP /54/ /59/. These information was not available during the validation of the project activity. The reference for the amount of waste considered in the PDD /5/ was the gas capture study conducted by a specialized company (LANDTEC), while for the revised PDD /6/ the amount of waste monitored by the company until 2019 and the estimates made in the environmental impact study regarding the expansion of the landfill area were considered (from 2020 until the end of the crediting period).

The expansion landfill area started receiving waste in 2020. The estimated waste disposal capacity for the landfill expansion area as per the EIA /54/ is 22,139,996 t until the expected lifetime is reached.

If we sum the amount of waste considered in the PDD /5/ between 2020 and 2031 (last year of the third crediting period) the result is 29,869,279 t of MSW (according to LANDTEC study), while the total waste considered in the revised PDD /6/ is 24,881,314 t. Therefore, the projection of waste to be disposed as stated in the revised PDD /6/ in the coming years is more conservative and was considered as being more appropriate to determine the ex-ante emission reductions of the project. Thus, no significant difference was observed with respect to the information provided in the registered PDD. The total amount of waste deposited at the project site changed from 49,855,644 tonnes (registered PDD /5/) to 49,066,187 tonnes (revised PDD /6/).

These changes represents a decrease in the estimated ex-ante baseline emissions from 3,960,757 tCO₂ (registered PDD /5/) to 3,809,128 tCO₂ (revised PDD /6/) and an increase in the project emissions from 295,771 tCO₂ (registered PDD /5/) to 322,449 tCO₂ (revised PDD /6/).

As a consequence, the change in the project design resulted in a conservative ex-ante estimative since the estimated emission reductions decrease from 3,664,985 tCO₂ (registered PDD /5/) to 3,486,678 tCO₂ (revised PDD /6/).

These changes have been included in the revised PDD /6/ and in the revised emission reduction calculation spreadsheet /8/ provided by project participant and assessed as acceptable by KBS.

The applied consolidated methodology was ACM0001 – Flaring or use of landfill gas (version 15.0) /13/. The changes in the project activity described above have no impact on the applicability and application of applied methodology. Sections B.1, B.2 and B.3 that refers to applicability and project boundary were not updated in the revised PDD. Section B.4 regarding baseline scenario was not impacted by the changes in the design.

Regarding additionality (section B.5), the project additionality was originally demonstrated by applying an investment analysis following the tool “Combined tool to identify the baseline scenario and demonstrate additionality” /14/. The changes described above do not impacted the additionality of the project activity.

Sections B.6.1 and B.6.3 that refers to explanation of methodological choices and ex-ante calculation of emission reductions were correctly updated in the revised PDD /6/.

Emission reductions are directly monitored and calculated *ex-post*, using the approach indicated in the ACM0001 – Flaring or use of landfill gas (version 15.0) /13/.

- All assumptions and data used by the project participants are listed in the PDD and/or supporting documents, including their references and sources;
- All documentation used by the project participants as the basis for assumptions and source of data is correctly quoted and interpreted in the PDD;
- All values used in the PDD are considered reasonable in the context of the proposed CDM project activity;
- The baseline methodology has been applied correctly to calculate project

	emissions, baseline emissions, leakage and emission reductions; All estimates of the baseline, project and leakage emissions can be replicated using the data and parameter values provided in the PDD /6/.
Findings	No findings have been raised.
Conclusion	<p>Project design</p> <p>KBS verified that the changes in the project design complies with the relevant requirements in the Project Standard, version 2 as per Appendix Paragraph (d) /10/.</p> <p>KBS verified that the proposed changes in the revised PDD /6/ are in accordance with the actual implementation of the project activity, considering the revision in the landfill area and amount of waste deposited at the project site.</p> <p>KBS checked and verified complementary data and related information used to assess and explain the change made in the project activity and the impact of such change in the project's implementation, emission reductions, additionality and applicability and application of baseline methodology.</p> <p>The revised PDD /6/ and the calculations provided in the revised spreadsheet /8/ clearly and transparently identify the change from the project activity as described in the registered project design document. The change made in the revised PDD /6/ is related to the expansion in the existent landfill area and amount of waste deposited at the project site.</p> <p>The justification and assumptions made in the calculations considering the actual values are considered reasonable and acceptable.</p> <p>The changes in the project activity do not affect negatively the project activity operation however it affects the amount of emission reductions expected by the project activity. The changes do neither impact adversely the additionality of the project nor the applicability/application of ACM0001 (version 15.0).</p> <p>By assessing the evidences presented and cross-checking the information with references used, it is KBS's opinion that all data, rationales, assumptions, justifications and documentation provided by the project participants to support demonstration of additionality are credible and reliable.</p> <p>Hence, it is KBS's opinion that the changes do <u>not</u> raise any concerns with regard to i) additionality, ii) the scale of the CDM project activity and/or iii) the applicability and application of baseline methodology and complies with the requirements of the Project Standard, version 2 Paragraph (d) of the Appendix /10/.</p>

D.8. Changes specific to afforestation and reforestation project activities

Means of validation	N/A
Findings	N/A
Conclusion	N/A

SECTION E. Internal quality control

The draft validation report prepared by team leader is reviewed by an independent technical reviewer (having competence of relevant technical area himself/herself or through an independent technical area expert) to confirm the internal procedures established by KBS are duly followed and the validation report/opinion is reached in an objective manner and complies with the applicable CDM requirements.

The independent technical reviewer may approve or reject the draft validation report. The findings may be identified even at this stage, which needs to be satisfactorily resolved, before the request for PRC is submitted to UNFCCC. The final decision is taken by the Manager Technical and Certification. The technical reviewer and Manager (Technical & Certification) can be same person.

The final decision is authorized by Managing Director, KBS once the report is approved by the Manager (Technical & Certification).

SECTION F. Validation opinion

KBS Certification Services Pvt. Ltd. has been contracted by GNR Fortaleza Valorização de Biogás Ltda to undertake independent validation of the post registration changes of the CDM project activity "Oeste de Caucaia Landfill Project Activity" and UNFCCC Reference Number 10261 to ensure that the post registration changes meet all relevant requirements to the UNFCCC for CDM project activities including CDM Validation and Verification Standard for project activities.

Validation methodology and process:

The validation has been performed as described in the VVS, version 02.0, and consists of the following steps:

- Review of the revised PDD, version 5 dated 15/02/2021;
- Desk review of the revised MR, and the relevant documents;
- Remote audit Interviews;
- Preparation of the Validation Report.

It is DOE's opinion that the revised documentation submitted is conforming to the requirements for Post Registration Changes as stipulated in the Clean Development Mechanism Validation and Verification Standard and thus DOE is recommending the approval of the post registration changes.

Appendix 1. Abbreviations

Abbreviations	Full texts
ANEEL	Brazilian Electricity Energy Agency
BE	Baseline Emissions
BM	Build Margin
CAR	Corrective Action Request
CDM	Clean Development Mechanism
CDM EB	CDM Executive Board
CER(s)	Certified Emission Reduction(s)
CH ₄	Methane
CL	Clarification Request
CO ₂	Carbon Dioxide
CO ₂ e	Carbon Dioxide Equivalent
DNA	Designated national Authority
DOE	Designated Operational Entity
EF	Emission Factor
ER	Emission Reductions
FAR	Forward Action Request
GHG(s)	Greenhouse Gas(es)
GWP	Global Warming Potential
IPCC	Intergovernmental Panel on Climate Change
LFG	Landfill Gas
MR	Monitoring Report
OM	Operating Margin
PDD	Project Design Document
PE	Project Emissions
PP	Project Participant
PRC	Pos Registration Changes
QA/QC	Quality Assurance/Quality Control
tCO ₂ e	Tonnes of Carbon Dioxide Equivalent
UNFCCC	United Nations Framework Convention on Climate Change
VVS	Validation and Verification Standard

Appendix 2. Competence of team members and technical reviewers

Personnel Name:		Andrea Leiroz	
Qualified to work as:			
Team Leader	<input checked="" type="checkbox"/>	Technical Expert	<input checked="" type="checkbox"/>
Validator/Verifier	<input checked="" type="checkbox"/>	Financial Expert	<input type="checkbox"/>
Technical Reviewer	<input type="checkbox"/>	Local Expert (India)	<input checked="" type="checkbox"/>
Area(s) of Technical Expertise			
Sectoral Scope	Technical Area		
Energy industries (renewable/non-renewable sources)	TA 1.1: Thermal energy generation from fossil fuels and biomass including thermal electricity from solar		
	TA 1.2: Energy generation from renewable energy sources		
Waste handling and disposal	TA 13.1. Solid waste and wastewater		
	TA 13.2. Manure		

Approved by (Manager C & T)	Sanjay Kandari
Approval date:	17/12/2018

Personnel Name:		Sanjay Kandari	
Qualified to work as:			
Team Leader	<input checked="" type="checkbox"/>	Technical Expert	<input checked="" type="checkbox"/>
Validator/Verifier	<input checked="" type="checkbox"/>	Financial Expert	<input checked="" type="checkbox"/>
Technical Reviewer	<input checked="" type="checkbox"/>	Local Expert (India)	<input checked="" type="checkbox"/>
Area(s) of Technical Expertise			
Sectoral Scope		Technical Area	
Energy Industries (renewable/non-renewable sources)		TA 1.1: Thermal energy generation from fossil fuels and biomass including thermal electricity from solar	
Energy industries (renewable/non-renewable sources)		TA 1.2: Energy generation from renewable energy sources	
Energy demand		TA 3.1. Energy Demand	
Waste Handling and Disposal		TA 13.1 Waste Handling and Disposal TA 13.2 Manure	
Approved by (Manager C & T)		Akhilesh Joshi	
Approval date:		11/12/2015	

Appendix 3. Documents reviewed or referenced

No.	Author	Title	References to the document	Provider
/1/	GNR Fortaleza Valorização de Biogás Ltda.	Monitoring report.	Version 1 of 27/11/2020	Project participant
/2/	GNR Fortaleza Valorização de Biogás Ltda.	Final Monitoring Report	Version 3 of 19/05/2021	Project participant
/3/	GNR Fortaleza Valorização de Biogás Ltda.	ER calculation sheet corresponding to MR version 1.	Corresponding to MR version 1	Project participant
/4/	GNR Fortaleza Valorização de Biogás Ltda.	Final ER calculation sheet corresponding to Final MR.	Corresponding to MR version 3	Project participant
/5/	GNR Fortaleza Valorização de Biogás Ltda.	Registered PDD.	Version 4 of 03/09/2015	UNFCCC website
/6/	GNR Fortaleza Valorização de Biogás Ltda.	Revised PDD.	Version 5 of 15/02/2021	Project participant
/7/	RINA Services S.p.A.	Validation report.	Version 1.5Aa of 13/04/2016	UNFCCC website
/8/	GNR Fortaleza Valorização de Biogás Ltda.	Revised ER calculation spreadsheet. Ecofor_CERs PRC_v.1_2020.11.xlsx	Version 1 of 11/2020	Project participant
/9/	CDM Executive	Clean Development Mechanism	Version 02.0 of	UNFCCC

	Board	Validation and Verification Standard for project activities.	29/11/2018	website
/10/	CDM Executive Board	Clean Development Mechanism Project Standard for project activities.	Version 02.0 of 29/11/2018	UNFCCC website
/11/	CDM Executive Board	Clean Development Mechanism Project Cycle Procedure for project activities.	Version 02.0 of 29/11/2018	UNFCCC website
/12/	CDM Executive Board	CDM-PDD-FORM: Project design document form.	Version 11.0 of 31/05/2019	UNFCCC website
/13/	CDM Executive Board	Large-scale Consolidated Methodology ACM0001: Flaring or use of landfill gas.	Version 15.0 of 08/11/2013	UNFCCC website
/14/	CDM Executive Board	TOOL02: Methodological tool: Combined tool to identify the baseline scenario and demonstrate additionality.	Version 0.5.0.0 of 23/11/2012	UNFCCC website
/15/	CDM Executive Board	TOOL03: Methodological tool: Tool to calculate project or leakage CO ₂ emissions from fossil fuel combustion.	Version 02.0 of 02/08/2008	UNFCCC website
/16/	CDM Executive Board	TOOL04: Methodological tool: Emissions from solid waste disposal sites.	Version 07.0 of 16/04/2015	UNFCCC website
/17/	CDM Executive Board	TOOL05: Methodological tool: Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation.	Version 01.0 of 16/05/2008	UNFCCC website
/18/	CDM Executive Board	TOOL06: Methodological tool: Project emissions from flaring.	Version 02.0 of 20/07/2012	UNFCCC website
/19/	CDM Executive Board	TOOL07: Methodological tool: Tool to calculate the emission factor for an electricity system.	Version 04.0 of 04/10/2013	UNFCCC website
/20/	CDM Executive Board	TOOL08: Methodological tool: Tool to determine the mass flow of a greenhouse gas in a gaseous stream.	Version 02.0 of 03/06/2011	UNFCCC website
/21/	CDM Executive Board	TOOL09: Methodological tool: Determining the baseline efficiency of thermal or electric energy generation systems.	Version 01.0 of 28/07/2009	UNFCCC website
/22/	CDM Executive Board	TOOL10: Methodological tool: Tool to determine the remaining lifetime of equipment.	Version 01 of 16/10/2009	UNFCCC website
/23/	CDM Executive Board	TOOL11: Methodological tool: Assessment of the validity of the original/current baseline and update of the baseline at the renewal of the crediting period.	Version 03.0.1 of 02/03/2012	UNFCCC website
/24/	CDM Executive Board	TOOL12: Methodological tool: Project and leakage emissions from transportation of freight.	Version 01.1.0 of 23/11/2012	UNFCCC website
/25/	CDM Executive Board	Guideline: Application of materiality in verifications.	Version 2 of 20/02/2015	UNFCCC website
/26/	CDM Executive Board	Standard for application of the global warming potentials to clean development mechanism project activities and programmes of activities for the second commitment period of the Kyoto protocol.	Version 01.0, EB69, annex 3	UNFCCC website
/27/	Intergovernmental Panel on Climate	Fourth Assessment Report: Climate Change 2007. Available at:	Assessed on 17/12/2020	Web link

	Change (IPCC)	https://www.ipcc.ch/site/assets/uploads/2018/02/ar4-wg1-chapter2-1.pdf		
/28/	Interministerial Commission in Global Climate Change (DNA of Brazil)	Carbon Emission Factor for the National Grid. Available at: https://www.mctic.gov.br/mctic/opencms/ciencia/SEPED/clima/textogeral/missao_despacho.html .	Assessed on 17/12/2020	Web link
/29/	ANEEL	ANEEL technical transmission and distribution losses report (2008 – 2019). Available at: https://www.aneel.gov.br/metodologia-distribuicao/-/asset_publisher/e2INtBH4EC4e/content/perdas/654800?inheritRedirect=false&redirect=http%3A%2F%2Fwww.aneel.gov.br%2Fmetodologia-distribuicao%3Fp_p_id%3D101_IINSTANCE_e2INtBH4EC4e%26p_p_lifecycle%3D0%26p_p_state%3Dnormal%26p_p_mode%3Dview%26p_p_col_id%3Dcolumn-2%26p_p_col_pos%3D3%26p_p_col_count%3D4 .	06/2020	Project participant
/30/	GNR Fortaleza Valorização de Biogás Ltda	Daily raw data spreadsheet downloaded from the supervisory system.	Assessed on 22/12/2020	Project participant
/31/	ABB Automation Products GmbH	Flow meters calibration certificates: <ul style="list-style-type: none"> Serial number # V14224-002961 (FIT215) – Calibration certificate 244100803XX001; Serial number # V14224-002969 (FIT206) – Calibration certificate 244100803XX003; Serial number # V14224-002962 (FIT510)– Calibration certificate 244100803XX002. 	05/12/2017 valid until 04/12/2020 05/12/2017 valid until 04/12/2020 05/12/2017 valid until 04/12/2020	Project participant
/32/	ABB Ltda Delmar Analytical do Brasil	Gas analyser (PGC-1000) calibration certificates. Serial number # T170268182. Calibration during the commissioning; Calibration certificate 027/2018; Calibration certificate 026/2019; Calibration certificate 010/2020; Calibration certificate 053/2020; Calibration certificate 065/2020.	10/11/2017 valid until 09/11/2018 23/10/2018 valid until 22/10/2019 07/05/2019 valid until 06/11/2019 06/02/2020 valid until 05/08/2020 11/08/2020 valid until 10/02/2021 14/10/2020 valid until 13/04/2021	Project participant
/33/	Escala Produtos e Serviços de Calibração Ltda M&M Instrumentação	Temperature meter calibration certificate. <ul style="list-style-type: none"> Serial number # TI.3243 (TE 210)– Calibration certificate 178659; Serial number # TI.3243 (TE 210)– Calibration certificate 	14/07/2017 valid until 13/07/2020 11/11/2020 valid until	Project participant

		15397/20.	10/11/2023	
/34/	Elmec Capristano M&M Instrumentação	Pressure meter calibration certificate. • Serial number # 2593164 (PIT 210) - Calibration certificate PR-0333; Serial number # 2593164 (PIT 210) - Calibration certificate 15395/20.	06/09/2017 valid until 05/09/2020 04/11/2020 valid until 03/11/2023	Project participant
/35/	Intergovernmental Panel on Climate Change (IPCC)	CO ₂ emission factor. Available at: https://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/2_Volume2/V2_1_Ch1_Introduction.pdf	-	Web link
/36/	3C Services	Electricity meter calibration certificate. Serial number # MW-1709A919-02 - Calibration certificate 11321/Z-18.	18/02/2018	Project participant
/37/	ABB Measurement & Analytics	Data sheet of flow meter model FMT500-IG: ABB FMT500-IG.pdf.	-	Project participant
/38/	Wärme	Manufacture's specifications for temperature meter: WATT-2100 – CAT. LOGO.pdf. E-mail from manufacturer about calibration frequency.	- 08/02/2021	Project participant
/39/	ABB Measurement & Analytics	Manufacture's specifications: Manual of gas analyser PGC1000: PGC1000.pdf. E-mail from manufacturer regarding to calibration frequency.	- 26/01/2021	Project participant
/40/	Schneider	Technical description of electricity meter: Catálogo ION8650.pdf.	-	Project participant
/41/	Enel – Companhia Energética do Ceará	Electricity invoices.	01/2018 – 12/2019	Project participant
/42/	Thera Trading Comercializadora de Energia Ltda	Electricity invoices.	03/2020, 04/2020, 06/2020 – 08/2020	Project participant
/43/	Electra Comercializadora de Energia Ltda	Electricity invoices.	01/2020 – 09/2020	Project participant
/44/	Chamber of Electric Energy Commercialization (CCEE)	CCEE reports with electricity consumption.	01/2020 – 09/2020	Project participant
/45/	KBS Certification Services Pvt.	Verification contract between KBS Certification Services Pvt. and GNR Fortaleza Valorização de Biogás Ltda.	27/08/2020	KBS Certification Services Pvt.
/46/	CDM Executive Board	CDM Executive Board agrees to relax mandatory site visits by DOEs for a period of three months (23 March to 23 June 2020) because of COVID-19.	-	Other
/47/	Brazilian Energy Balance	Net calorific value. https://www.epe.gov.br/sites-pt/publicacoes-dados-abertos/publicacoes/PublicacoesArquivos/publicacao-479/topico-528/BEN2020_sp.pdf .	2020	Web link
/48/	Ceará state Environmental	Environmental license No. 70/2015 valid until 09/12/2016.	10/12/2015	Project participant

	Superintendence (SEMACE)	Environmental license for the landfill expansion No. 122/2019 valid until 21/07/2023.	22/07/2019	
/49/	GNR Fortaleza Valorização de Biogás Ltda	Log diaries with information about incidents that occurred during the monitoring period.	12/2017 – 09/2020	Project participant
/50/	Rosemount	Manufacture's specifications of the pressure meter: ficha-de-dados-do-produto-rosemount-3051-transmissor-de-pressão-pt-76818.pdf	-	Project participant
/51/	GNR Fortaleza Valorização de Biogás Ltda	Sales invoices of Biomethane issued by GNR to CEGAS Gás Natural.	01/2018 – 07/2020	Project participant
/52/	John Zink	Flare technical proposal and technical description.	29/04/2014	Project participant
/53/	-	Invoices for GLP consumption: Cacaugás Ltda Cezár Cacau Comércio de GLP Ltda No. 72366 Cezár Cacau Comércio de GLP Ltda No. 72367 Cezár Cacau Comércio de GLP Ltda No. 000.004.169 Cezár Cacau Comércio de GLP Ltda No. 000.004.353	26/07/2018 31/05/2019 31/05/2019 11/06/2020 07/07/2020	Project participant
/54/	ECOSAM	Environmental Impact Assessment of the landfill expansion.	06/2011	Project participant
/55/	Ceará state Environmental Superintendence (SEMACE)	Environmental license for the upgrading plant No. 2/2018 valid until 01/01/2021.	02/01/2018	Project participant
/56/	CEGAS Gás Natural	CEGAS report.	12/2017	Project participant
/57/	CEGAS Gás Natural	E-mail with the amount of biomethane sold to CEGAS from 05/01/2019 to 23/09/2020.	21/10/2020	Project participant
/58/	INMETRO	Resolution regarding to volumetric measurement of natural gas. RESOLUÇÃO CONJUNTA ANP/INMETRO No 1 DE 10/06/2013 http://www.inmetro.gov.br/legislacao/rtac/pdf/RTAC001995.pdf .	10/06/2013	Web link
/59/	GNR Fortaleza Valorização de Biogás Ltda	E-mail with the amount of waste deposited at the project site.	28/12/2020	Project participant
/60/	ONS	Grid Procedures: Module 12. Procedure for energy meter class: Sub-module 12.2 v2019.08. Available at: http://www.ons.org.br/%2FProcedimentosDeRede%2FMódulo%2012%2FSubmódulo%2012.2%2FSubmódulo%2012.2%202019.08.pdf . Procedure for calibration: Sub-module 12.3 v2016.12. Available at: http://www.ons.org.br/%2FProcedimentosDeRede%2FMódulo%2012%2FSubmódulo%2012.3%2FSubmódulo%2012.3%202016.12.pdf .	04/09/2019 16/12/2016	Publicly available
/61/	GNR Fortaleza Valorização de	Statistical analysis for deviation 1: Análise histórica estatística CH4	13/05/2021	Project participant

	Biogás Ltda.	MR.xlsx		
/62/	GNR Fortaleza Valorização de Biogás Ltda.	Maximum temperature during the monitoring period (deviation 3): Maximum LFG temp v2.xlsx	03/05/2021	Project participant
/63/	GNR Fortaleza Valorização de Biogás Ltda	Daily raw data spreadsheet downloaded from the supervisory system for the period from 22/12/2017 (15h:24m) to 21/09/2018 (10h:51m) and from 22/10/2020 (08h:21m) to 01/05/2021 (00h:00m).	Assessed on 14/05/2020	Project participant

Appendix 4. Clarification requests, corrective action requests and forward action requests

Table 1. ~~CLs from this validation~~

CL ID	xx	Section no.	Date: DD/MM/YYYY
Description of CL			
Project participant response			Date: DD/MM/YYYY
Documentation provided by project participant			
DOE assessment			Date: DD/MM/YYYY

Table 2. CARs from this validation

CAR ID	01	Section no.	D.2	Date: 25/01/2021
Description of CAR				
Section B.2.1 of MR - Regarding the measurement of the volumetric fraction of CH ₄ in the LFG, the following should be clarified:				
<ul style="list-style-type: none"> Explain how the volumetric fraction of CH₄ in the biomethane was determined since the gas analyser was not operational. Clarify the position of the flow meters in Figure 4 of the Monitoring Report. It is not clear if the flow meter located in position A is the same located in position E. It is stated in the MR that the fraction of CH₄ in the biomethane is described in the invoices. However, in the invoices presented during the remote audit there are no information about fraction of CH₄. 				
Project participant response				Date: 08/02/2021
Section B.2.1 was revised to clarify that the gas analyser is composed by two sensors measuring the methane fraction in both the LFG and biomethane, and that during the period when the deviation applies only the sensor measuring the methane fraction in the biomethane was operational. Figure 4 of the monitoring report was revised since the equipment location indicated in position A and E is the same. The source of data used related to the parameter fraction of methane was revised in section B.2.1. of the Monitoring Report.				
Documentation provided by project participant				
Revised version of the Monitoring Report (version 2) Revised version of the PDD (version 5)				
DOE assessment				Date: 09/02/2021
KBS verified the revised MR and confirmed that information regarding to measurement of the volumetric fraction of CH ₄ in the LFG was clearly described in section B.2.1. Thus, this CAR is closed.				

CAR ID	02	Section no.	D.2	Date: 25/01/2021
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Description of CAR	
<p>Section B.2.1 of MR - Further clarification should be provided regarding the selection of Option B of the "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" to calculate project and baseline emissions. According to the revised PDD, Option C is applied to calculate $F_{CH_4, sent_flare, y}$ (LFG flared) and Option A is applied to calculate $F_{CH_4, NG}$ and $F_{CH_4, sent_flare, y}$ (upgraded gas that does not reach specifications to be sent to the natural gas pipeline).</p> <p>In addition, PP is requested to demonstrate that the value adopted of 70°C is conservative.</p>	
Project participant response	Date: 08/02/2021
<p>The PDD was revised to include other options for determining the mass flow of gas containing methane since during monitoring period it was identified that there were times when other options not listed in the PDD should be used.</p> <p>Calculations and documents were reviewed to consider as 78°C as the maximum temperature of the LFG from historical monitored data. For the months where deviation 3 was applied, in the absence of LFG temperature data, the maximum LFG temperature, as per historical record, was adopted.</p>	
Documentation provided by project participant	
<p>Revised version of the registered PDD (version 5)</p> <p>Revised version of the Monitoring Report (version 2)</p> <p>Revised monthly and aggregated CERs calculation spreadsheets</p> <p>Excel spreadsheet with the historical records of LFG temperature analysis</p>	
DOE assessment	Date: 09/02/2021
<p>KBS verified the revised MR and PDD and confirmed that the options described for determining the mass flow of gas containing methane are correct. As a consequence of the revision in the PDD, a permanent change to the registered monitoring plan was included in the validation opinion to be submitted with this verification report.</p> <p>However, it is wrongly stated in the MR and PDD that option C was included as an option to determine the mass flow of gases containing methane since this option was included in the registered PDD.</p> <p>In addition, KBS verified the raw data downloaded from the supervisory during the remote audit and confirmed that 78°C was the highest temperature during the monitoring period and consider conservative to adopt this value for the months which the temperature was not monitored.</p> <p>This CAR is open.</p>	
Project participant response	Date: 15/02/2021
<p>The registered version of the PDD indicated that Option A would be applicable to $F_{CH_4, NG, y}$ and Option C to $F_{CH_4, sent_flare, y}$. The PDD was revised to clearly indicate that the three options may be applicable to both gases streams monitored by the project depending on the operational conditions. As a consequence Option B and C were listed as additional options to determine $F_{CH_4, NG, y}$, and Option A and B as additional options to determine $F_{CH_4, sent_flare, y}$.</p> <p>The Monitoring Report was revised to indicate that Options A and B were indeed used during the monitored period. In addition, section B.2.5 of the MR and Appendix 7 of the revised PDD were amended to increase clarity.</p>	
Documentation provided by project participant	
<p>Revised version of the Monitoring Report (version 3)</p> <p>Revised version of the registered PDD (version 5)</p>	
DOE assessment	Date: 15/02/2021
<p>KBS confirmed that the information regarding the determination of the mass flow of gases containing methane was correctly revised in the MR and PDD.</p> <p>This CAR is closed.</p>	

Table 3. FARs from this validation

FAR ID	xx	Section no.		Date: DD/MM/YYYY
Description of FAR				
Project participant response				Date: DD/MM/YYYY
Documentation provided by project participant				
DOE assessment				Date: DD/MM/YYYY

Document information

<i>Version</i>	<i>Date</i>	<i>Description</i>
03.0	31 May 2019	Revision to: <ul style="list-style-type: none">• Ensure consistency with version 02.0 of the “CDM validation and verification standard for project activities” (CDM-EB93-A05-STAN);• Make editorial improvements.
02.0	31 October 2017	Revision to align with the requirements in the “CDM validation and verification standard for project activities” (version 01.0).
01.0	23 March 2015	Initial publication.
Decision Class: Regulatory Document Type: Form Business Function: Registration Keywords: post-registration change, project activities, validation report		