



CHOL CHAROEN GROUP WASTEWATER TREATMENT WITH BIOGAS SYSTEM I (KHONKAEN)



Document Prepared By

LGAI Technological Center S.A. (Applus+ Certification)

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Summary:

Verification purpose: LGAI Technological Center S.A. (Applus+ Certification) (Hereafter referred as Applus+ Certification) has been appointed by “Kean Chareon Co., Ltd.” to perform the 4th verification (01-April-2021 to 31-October-2022) of the “Chol Charoen Group Wastewater Treatment with Biogas System I (Khonkaen)” (VCS ID 427). The main purpose of this verification activity is to have an independent third-party assessment of the monitoring report to ensure a thorough assessment of the project activity implementation against the applicable VCS requirements.

The project activity involves the installation two anaerobic covered lagoons continues to flow to a series of remaining 9 open lagoons. The implementing system enables recovery of biogas that would have been released into the atmosphere and utilise it for thermal and electricity generation. In the case of thermal energy generation, the captured biogas has been co-fired in existing heat generating devices for the process of drying the wet starch (displacing fuel oil under the previous system). In addition, the power produced by this captured biogas was not only facilitated the electricity requirement of the plant, but also be fed to national grid under the pending power purchase agreement with the Provincial Electricity Authority (PEA).

The monitoring period for this VCS verification is 01-April-2021 to 31-October-2022 (including both days) and the project activity achieved 101,550 tCO_{2e} emission reductions during this monitoring period.

The scope of the verification is the independent and objective review of the Monitoring Report^{6/}. The MR^{6/} is reviewed against the relevant criteria (see above) and decisions by the CDM Executive Board and VCS executive board, including the approved baseline and monitoring methodology. The verification was based on the guidance given in the CDM validation and verification standard for project activities, version 03.0, review against registered PD^{4/} and final validation report, VCS program guideline version 4.3 and standard version 4.4.

A risk-based approach has been followed to perform this verification activity. In the course of verification, 01 Corrective Action request (CAR) and 01 Clarification Requests (CLs) were raised and successfully closed. No FAR was raised during this verification. The review of the Monitoring report and additional documents related to baseline and monitoring methodology; the subsequent background investigation, follow-up interviews and PP have provided LGAI Technological Center S.A. (Applus+ Certification) with sufficient evidence to verify the fulfilment of the stated criteria of VCS.

The assessment team has employed a risk-based approach to assess the completeness and accuracy of the claims and conservativeness of the assumptions in the MR^{6/}. The main focus of the assessment team is to identify the significant risks for the project implementation and the generation of VERs. The verification is not meant to provide any consulting towards the project participants. However, stated requests for clarifications and/or corrective actions may have provided input for improvement of the monitoring report combined.

The only purpose of the verification is its usage during the issuance process as part of the VCS project cycle. Therefore, LGAI Technological Center S.A. (Applus+ Certification) can't be held liable by any party for decisions made or not made based on the verification opinion, which will go beyond that purpose.

The verification has been planned and organized to achieve a Reasonable Level of assurance as per the requirement of VCS. No sampling procedure applied for document verifications. The entire documents checked verification conducted to arrive at positive verification conclusions.

CONTENTS

1	Introduction	6
1.1	Objective	6
1.2	Scope and Criteria	6
1.3	Level of Assurance.....	7
1.4	Summary Description of the Project	7
2	Verification Process.....	8
2.1	Method and Criteria.....	8
2.2	Document Review	10
2.3	Interviews.....	10
2.4	Site Visits.....	12
2.5	Resolution of Findings	12
2.5.1	Forward Action Requests	13
2.6	Eligibility for Validation Activities	13
3	Validation Findings.....	13
3.1	Participation under Other GHG Programs	13
3.2	Methodology Deviations.....	14
3.3	Project Description Deviations.....	15
3.4	Grouped Project	17
4	Verification Findings.....	17
4.1	Project Implementation Status	17
4.2	Safeguards	21
4.2.1	No Net Harm	21
4.2.2	Local Stakeholder Consultation	21
4.3	AFOLU-Specific Safeguards	21
4.4	Accuracy of GHG Emission Reduction and Removal Calculations	21
4.5	Quality of Evidence to Determine GHG Emission Reductions and Removals	63
4.6	Non-Permanence Risk Analysis.....	64
5	Verification OPINION.....	64

APPENDIX 1: Documents Reviewed or Referenced (Verification)	67
APPENDIX 2: CORRECTIVE ACTION REQUESTS, CLARIFICATION REQUESTS AND FORWARD ACTION REQUESTS (CAR/CL/FAR)	69
APPENDIX 3: COMPETENCE OF TEAM MEMBERS AND TECHNICAL REVIEWERS.....	73
APPENDIX 4: ABBREVIATIONS	74

1 INTRODUCTION

1.1 Objective

LGAI Technological Center S.A. (Applus+ Certification) (Hereafter referred as Applus+ Certification) has been appointed by “Kean Chareon Co., Ltd.” to perform the 4th verification of the “Chol Charoen Group Wastewater Treatment with Biogas System I (Khonkaen)” under VCS guideline version 4.3 and VCS standard version 4.4. The objective of this verification activity is to have an independent third party for the assessment of the project design, Monitoring Report and Final Verification report and to ensure a thorough assessment of the proposed project activity against the applicable CDM and VCS requirements. In particular;

- the project's monitoring plan is assessed against “AMS-I.D version 14”
- the project's baseline is assessed against “AMS-I.D version 14”
- the project's monitoring plan is assessed against “AMS-III.H version 13”
- the project's baseline is assessed against “AMS-III.H version 13”
- the project's monitoring plan is assessed against “AMS-I.C version 15”
- the project's baseline is assessed against “AMS-I.C version 15”
- the projects compliance with the requirements of Article 12 of the Kyoto Protocol, the CDM Modalities and Procedures as agreed in the Marrakech Accords under decision 3/CMP.1, the annexes to this decision, subsequent decisions and guidance made by COP/MOP & CDM Executive Board and other relevant rules, including the Host Country legislation and sustainability criteria along with VCS guideline v.4.3 and VCS standard v.4.4/^{10/}.
- CDM validation and verification standard for project activities, Version 03.0/^{16/}
- VCS program guideline v.4.3/^{10/}
- VCS standard version v.4.4/^{10/}

Verification is a requirement for all VCS projects and is seen as necessary to provide assurance to stakeholders of the quality.

1.2 Scope and Criteria

The scope is defined as an independent and objective review of the Monitoring report MR/^{6/}prepared as per the registered PD/^{4/}and registered approved methodology AMS I.D. Version 12. The MR is reviewed against the criteria stated in Article 12 of the Kyoto Protocol, the CDM modalities and procedures as agreed in the Marrakech Accords and the relevant decisions by the CDM Executive Board, VCS guideline v.4.3, VCS standard v.4.4 including the approved applied methodology AMS I.D. Version 14/^{16/}. The verification was based on the requirements in the CDM validation and verification standard for project activities, Version 03.0, and VCS program

guideline version 4.3 and standard version 4.4/¹⁰/.

The verification is not meant to provide any consulting towards the project participants. However, stated requests for clarifications and/or corrective actions may have provided input for improvement of the Monitoring report. In line with Guidelines for Application of materiality in verifications Version 02, the verification team has conducted a complete verification of all the information presented in the monitoring report and data monitored as presented in the emission reduction calculation spread sheet. It follows the paper trail back to the raw data such as meter reading records and invoices. There are no material errors, overestimation of Emission Reductions, omission or misstatement. Verification team conducted onsite audit to verify metering/monitoring arrangement. The verification team has reviewed all the documents like commissioning certificates/¹/, technical specification/¹⁷/, O&M practices/⁸/, Invoices/¹⁰/, grievance register/¹³/ etc.

1.3 Level of Assurance

Applus+ Certification has planned and performed the verification by obtaining evidence and other information and explanations that assessment team considers necessary to give reasonable assurance that reported estimated GHG emission reductions are fairly stated. All documentary evidences were checked, onsite audit was conducted and technical details including metering/monitoring arrangement verified to arrive at a verification conclusion by the assessment team.

In our opinion, the estimated GHG emissions reductions were calculated correctly on the basis of the approved baseline and monitoring methodology “AMS I.D. Version 14”, AMS-I.C. version 21, & AMS-III.H. version 19 of the VCS standard v.4.4.

1.4 Summary Description of the Project

The project activity involves installation and operation of a methane recovery and utilization system (two anaerobic covered lagoon facilities (converted from open lagoon) at Kean Charoen Co. Ltd. a tapioca starch factory in Khonkaen, Thailand. Prior to project implementation, the waste water was treated in cascading open anaerobic lagoons. The minimum depth of these ponds being more than 2m and the average atmospheric temperature in the region about 28oC, these conditions resulted in anaerobic environment within the ponds resulting in methane generation from the organic content of the wastewater, characterized by its COD, which was released into the atmosphere. The project system has been in operation since 2nd October 2006 (project start date). The starch factory has a mean daily production capacity of 175 tonnes of dried starch generating 2,000 m3 of wastewater per operational day. The use of covered lagoon technology to treat wastewater enables not only the avoidance of release of methane into the atmosphere but also capturing of methane produced and meeting the effluent standards. The captured methane (or biogas) is utilized as fuel in two dual-fired boilers with thermal capacity of 4.07 MWth and 6.16 MWth (Prior to the year 2020, the existing boiler of 3.78 MWth was in use

which is replaced with this new boiler). The change in boiler capacity is accepted due to the fact that the baseline scenario does not change due to the change in boiler capacity and emission reductions are claimed considering deviation explained in section 3.6 of the VCS-PD which is linked to amount of starch produced and historical value of fuel oil consumed per ton of starch produced. Therefore the capacity change will not have impact on conservativeness in emission reduction estimation. Excess biogas is also used in two gas-based power generators of capacity 952 kWe each. An open flaring system is available in the plant. This is an automatic flare system that will operate when the pressure is higher than 3 mbar. There is also a flame arrestor to ensure the safe operation of the flare system. The capacity of auxiliary drives is 458 kW. The details have been checked from previous verification report/15/. The project site is located at Kean Charoen Co. Ltd. in Kranuan district, Khonkaen province situated in the Northeast of Thailand approximately 450 km from Bangkok. The project coordinates are 16° 48.498'N and 103° 05.148'E. The project is already registered under VCS (VCS Ref. No: 427) and the project was fully operational during the second crediting period started from 15/07/2019 to 14/07/2029.

The monitoring period this VCS verification covered from 01-April-2021 to 31-October-2022 (inclusive of both dates) and the project activity is achieved 116,994 tCO₂e emission reductions during this monitoring period. Verification team checked the commissioning dates of WTG with the commissioning Certificates/^{1/} and found correct. The project is implemented as per the description in the registered PD/^{4/}. No event observed during the current monitoring period which can alter or deviate from the methodology requirement.

2 VERIFICATIONPROCESS

2.1 Method and Criteria

Verification Process: The project assessment is based on the “CDM validation and verification standard for project activities, Version 03.0, “VCS program guidelines v.4.3 and VCS standard v.4.4” and is conducted using standard auditing techniques to assess the correctness of the information provided by the project participants. Before the assessment begins, members of the team covering the technical scope(s), sectoral scope(s), and relevant host country experience for evaluating the VCS project activity are appointed.

Once the project is received by the assessment team, the members of the assessment team carried out: -

1. A desk review of the Monitoring report against the registered PD/^{4/}and final validation report;
2. A physical site visit and Follow-up interviews with project participant;
3. The resolution of outstanding issues and the issuance of the final verification report and opinion.

The prepared verification report and other supporting documents then undergo an internal quality control at the HQ (Accredited office) before being submitted to the VCS executive board.

In order to ensure transparency, assumptions must be clear and stated explicitly and background material must also be referenced. Applus+ Certification has developed a specific checklist customized for the project. The checklist demonstrates, in a transparent manner, the project criteria (requirements), discussion on each criterion by the assessment team, and the results from validating the identified criteria.

Appointment of the assessment team

According to the sectoral scope / technical area and experience in the sectoral or national business environment, Applus+Certification has composed a project assessment team in accordance with the appointment rules in the internal Quality Management System of Applus+ Certification.

The composition of audit team shall be approved by the Applus+Certification ensuring that the required skills are covered by the team.

The four qualification levels for team members that are assigned by formal appointment rules are as presented below:

- Lead Auditor (LA).
- Auditor (A) / Auditor in Training (AiT).
- Technical Expert (TE).
- Technical Reviewer (TR).

The sectoral scope / technical area knowledge linked to the applied methodology/ies shall be covered by the assessment team.

Name	Role	SS Coverage	TA Coverage	Financial Aspect	Host country Experience
Vivek Kumar Ahirwar	LA/TE	YES	YES	NA	YES
Simon Shen	TR/TE	YES	YES	NA	NA

The detail regarding the assessment team is provided below in this report as Appendix 3

Document review

The Monitoring report 01 submitted by the PP was reviewed against the approved methodology, registered PD^{4/}, final validation report and other relevant criteria to verify the correctness, credibility, and interpretation of the presented information.

Furthermore, a cross-check between information provided and information from other sources has been done. A complete list of all documents and evidence material reviewed is included in this report below in Appendix 1.

Follow-up interviews

An onsite audit is conducted by Applus+ Certification. Audit team performed physical inspection of project site and interviews with project stakeholders to confirm selected information and to resolve issues identified in the document review. The detail is provided in this report.

Resolution of Clarification and Corrective Action Request

The objective of this phase of the Verification was to resolve the requests for corrective actions and clarification and any other outstanding issues which need to be clarified for Applus+ Certification positive conclusion on the Monitoring report. The Corrective Action Requests and Clarification Requests raised by Applus+ Certification were resolved during communications between the Client and Applus+ Certification to guarantee the transparency of the verification process, the concerns raised and responses given are summarized below in the Appendix 2.

The final MR02/⁶/ submitted by PP serves as the basis for the final assessment presented. Additional changes to the project during the verification process are not considered to be significant with respect to the main CDM/VCS objectives. The two CDM/VCS main objectives are the reduction of anthropogenic GHG emissions and the contribution of sustainable development to the host country.

Internal quality control

As final step of a verification of the final documentation including the verification report and the checklist have to undergo an internal quality control by the technical review committee, i.e. each report has to be finally approved either by the head of the technical review committee or the deputy. In case one of these two persons is part of the assessment team approval can only be given by the other one to avoid any conflict of Interest.

After confirmation of the PP the positive verification opinion and relevant documents are submitted to the VCS board through the VCS web-platform.

2.2 Document Review

The details of the document observed during the verification process are listed below in Appendix 1 of this report.

2.3 Interviews

An Onsite audit was conducted on from 02/02/2023 to 03/02/2023.

During the onsite audit, the PP representatives were questioned about the implementation of the project activity. Several topics like the verification of commissioning date of meters, the generation, recording, and monitoring of the data and the error accountability were discussed. To cross check the information provided by PP, various documents like technical specifications,

commissioning certificates^{1/}, Power Purchase Agreement PPA^{9/}, Generation sheets^{11/}, invoice^{11/}, calibration certificates^{5/} etc. were also verified.

The names of the persons interviewed during onsite audit are given below;

No.	Interviewee			Date	Subject	Team member
	Last name	First name	Affiliation			
1.	SUWANN ASIM	PREECHA	KEAN CHAREON	02/02/2023 to 03/02/2023	Project implementation, O&M, JMR, Calibration, Sustainable monitoring, LSC etc. Management practices, trainings, salaries etc.	Vivek Kumar Ahirwar
2.	SOMCH OB	KWANRUE AN	KEAN CHAREON		Management practices, data storage, QA/QC	
3.	ITTISAK SAKUL	PANCHANI T	JR. PROJECT COORDINATOR, SWISS CARBON VALUE LTD		Monitoring Report, QA/QC Emission Reductions calculation	
4.	RUKWONGTRAKOOL	SUWIPA	SWISS CARBON VALUE LTD.			
5.	RAYA	SIRINUT	SR. PROJECT COORDINATOR, SWISS CARBON VALUE LTD.			
6.	WITTHAYANUKOOL	APIRAT	Senior Project Coordinator, SWISS CARBON VALUE LTD.			
7.	SANGUANPIYAPAN	KORAKOJ	SR. PROJECT MANAGER, SWISS CARBON VALUE LTD.			
8.	CHAINGAM	SANGUANSAK	Local Villager			
9.	SAENGPHD	SUTHIDA	Local Villager			
10.	RAKSAWONG	PRAGUD	Local Villager			
11.	KAEWKERDMEE	NISHACHOL	Local Villager			

2.4 Site Visits

Duration of Onsite Audit: 02/02/2023- to- 03/02/2023			
Activity performed on-site	Site location	Date	Team member
Assessment team checked the implementation of the project, Baseline emission, Emission reduction calculation, technical description of the project and Monitoring. Assessment team also checked that whether the monitoring plan as described in the VCS PD & VCS Monitoring period ^{4/} is actually practised onsite. Also assessment team checked any change in host country criteria which may affect the baseline of the project activity.	Project Site	02/02/2023- to- 03/02/2023	Vivek Kumar Ahirwar

2.5 Resolution of Findings

The objective of the Verification was to resolve the requests for corrective actions and clarification and any other outstanding issues from validation which need to be clarified for Applus+ Certification's positive conclusion on the Monitoring report. The Corrective Action Requests and Clarification Requests raised by Applus+ Certification were resolved during communications between the Client and Applus+ Certification to guarantee the transparency of the verification process, the concerns raised and responses given are summarized below in the Appendix 2.

The final MR (Version 02)^{6/} submitted by PP serves as the basis for the final assessment presented. Additional changes to the project during the verification process are not considered to be significant with respect to the main CDM/VCS objectives. The two CDM/VCS main objectives are the reduction of anthropogenic GHG emissions and the contribution of sustainable development to the host country.

Areas of validation and verification findings	No. of CL	No. of CAR	No. of FAR
Project design document and Monitoring report	00	00	00
Description of project activity	01	01	00
Application of selected baseline and monitoring methodology and selected standardized baseline			
Applicability of methodology and standardized baseline	00	00	00
Deviation from methodology	00	00	00
Clarification on applicability of methodology, tool and/or standardized baseline	00	00	00
Project boundary	00	00	00
Establishment and description of baseline scenario	00	00	00
Demonstration of additionality	00	00	00

Areas of validation and verification findings	No. of CL	No. of CAR	No. of FAR
Emission reductions	00	00	00
Calibration details	00	00	00
Monitoring plan	00	00	00
No Net harm assessment	00	00	00
Local stakeholder consultation	00	00	00
Others (REC)	00	00	00
Total	01	01	00

The list findings and the resolution is presented in Appendix 2 of this report

2.5.1 Forward Action Requests

This is 4th periodic verification of the project activity and no FAR was raised from validation or previous verification.

2.6 Eligibility for Validation Activities

This section is not applicable for present verification, as Applus+ holds the necessary accreditation to perform validation activities under this Sectoral Scope.

3 VALIDATION FINDINGS

3.1 Participation under Other GHG Programs

The project is registered only under VCS and not registered in any other GHG program.

3.2 Methodology Deviations

Deviations applied for second crediting period

This approach was deviated in Paragraph 34 of the methodology AMS-I.C version 21. It was proposed and validated by the validation and verification body during the validation of the project activity. The deviation was accepted, and the detail was addressed in Section 3.6 of the updated PD.

$$BE_{thermal,CO2,y} = (EG_{thermal,y} / \eta_{BL,thermal}) \times EF_{FF,CO2}$$

Where:

$EG_{thermal,CO2,y}$ Net quantity of steam/heat supplied by the project activity during the year y in TJ

$EF_{FF,CO2}$ CO₂ emission factor per unit of energy of the fuel that would have been used in the baseline plant in tCO₂/TJ, obtained from reliable local or national data if available, alternatively, IPCC default emission factors can be used.

$\eta_{BL,thermal}$ Efficiency of the plant using fossil fuel that would have been used in the absence of the project activity

Since the monitoring mechanism was not available for the measurement of the baseline input/output thermal energy, a conservative approach has been adopted as explained in the validated PD.

Explanation of the deviation

A quantity of dry starch that is produced during a particular year, a minimum required quantity of fossil fuel (fuel oil) can be estimated from a quantity of fossil fuel used per unit of dry starch, historically. For the same year, if the data for fossil fuel consumed is available, then the remaining energy must be supplied by biogas. This is a conservative approach to estimate the fuel oil that, in the absence of the project activity, would be used in the starch drying process. It must be noted that the efficiency of the boiler when used in dual-fuel mode is lower than at regular single-fuel conditions (HFO only). This drop in efficiency leads to a lower biogas to HFO displacement rate.

On the basis of historical records fossil fuel used per tonne of starch production is determined. For the subsequent monitoring, the starch production is monitored and used to estimate the amount of fossil fuel that would be used in absence of project activity. This represents baseline consumption of fossil fuel and takes into account the historical efficiency of the fossil fuel heat generating device. In a particular year the actual amount of fossil fuel used is subtracted from baseline fossil fuel consumption (calculated) value to estimate the amount of fossil fuel replaced. This assumption is conservative as all the effect of efficiency loss is borne by biogas and not by fossil fuel.

$$BE_{thermal,CO2,y} = (Q_{starch,y} * Q_{FO,starch} - q_{FO,y}) * D_{FO} * NCV_{FO} * EF_{CO2} / 10^6$$

Deviation 1

Where:

$Q_{starch,y}$ Quantity of dry starch produced in year “y” (tonnes)

$Q_{FO,starch}$ Quantity of fossil fuel per unit of dry starch (liter/tonne)

$q_{FO,y}$ Quantity of fossil fuel consumed at the project site in year “y” (litres)

D_{FO} Density of fossil fuel (kg/litre)

NCV_{FO} Net Calorific value of the fuel oil (TJ/ton)

It must be noted that the deviation does not only estimate baseline emissions on the amount of heat/steam generated by the boiler, it also takes into account CO2 emissions from on-site consumption of fossil fuels due to the project activity. In other words, it represents the emission reduction from the heat generation component.

3.3 Project Description Deviations

Project Participant had sought deviation during the validation report as described below:

Deviation 1:-

This approach is deviated according to the FAR M3 of the validation report during the first crediting period. Since the replacement of first boiler (boiler 1) was addressed during the validation of the project activity, the FAR M3 was raised in the validation report. The first boiler was replaced during the first verification and has been used since then, therefore, the same deviation from the first verification is also applied for this verification.

Explanation of the deviation

Boiler 1 was replaced by the newer and bigger boiler one. The capacity of thermal energy output was changed from 3.488 to 4.070 MW_{th}. As per the description in FAR M3 of the validation report, if an existing boiler is replaced with a new one during any verification no emission reduction shall be granted for heat displacement. Hence the heat displacement at this boiler was neglected from the emission reductions.

Compliance with the deviation

The deviated approach was adopted by considering only the thermal energy supplied from the second hot oil boiler (boiler 2) for the thermal energy displacement of AMS-I.C.

This is the conservative approach as per VCS guidelines because the emission reductions achieved from AMS-I.C was reduced.

Description of deviation

The thermal energy supplied and displaced at boiler 2 was calculated as per the steps below;

1. Determine the fuel oil consumption of each boiler in liters

Fuel oil usage	2021	2022
Boiler 1	1,198	0
Boiler 2	58,127	124,243

2. Determine the biogas consumption of each boiler in Nm³

Biogas usage	2021	2022
Boiler 1	275,832	162,609
Boiler 2	1,426,358	1,917,319

3. Calculate the thermal energy supplied from each boiler in GJ

Thermal energy	2021	2022
Boiler 1	53,417	3,403
Boiler 2	2,341,541	4,981,223
Total	2,394,958	4,984,626

4. Calculate the percentage of thermal energy supplied from each boiler

Percentage	2021	2022
Boiler 1	2%	0%
Boiler 2	98%	100%

5. The BE_{thermal} calculation as per the description in Deviation 1 of the registered PD was considered only for the fuel oil displacement in the boiler 2. Then the equation for Deviation 1 was revised to:

$$BE_{thermal,CO2,y} = (Q_{starch} * Q_{FO,starch} * \%B2 - q_{FO,y,Boiler2}) * D_{FO} * NCV_{FO} * EF_{CO2}/10^6$$

Parameter	Description
Q _{starch,y}	Quantity of dry starch produced in year “y” (tons)
Q _{FO,starch}	Quantity of fossil fuel per unit of dry starch (liter/ton)
q _{FO,y,boiler2}	Quantity of fossil fuel consumed by hot oil boiler no.2 in year “y” (liters)
D _{FO}	Density of fossil fuel (kg/liter)
NCV _{FO}	Net Calorific value of the fuel oil (TJ/ton)

%B2	The percentage of thermal energy supplied from the boiler 2 from step 4 above
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Deviation 2:

Background

The project activity registered with two electricity generation sets; the first set (no.'s 1 and 2) has 2 generators and the capacity of 952 kW_{el} each. The second generator set (no.'s 3 and 4) with 2 generators capacity of 450 kW_{el} which are not included in this project boundary. During the previous monitoring period, 03/03/2020 to 31/03/2021, it was noted that there was the replacement of the gas engine. The first gas engine set has been replaced by the new gas engine with the installed capacity of 1.5 MW_{el}. The new gas engine was commissioning on 09/01/2021. The reason of the replacement was due to lower performance of the existing engines.

Explanation of the deviation

The approach is deviated as the change of the monitoring point for electricity generation by the project activity; EG_{PJ,y} and the installed capacity of the gas engine is lower than what have been written in the registered PD.

Compliance with the deviation

As per the registered PD, it was mentioned that the installed capacity of the gas engine set 1 is (952*2) approximately 2 MW_{el}. The new gas engine which took place the generator set 1 has the installed capacity of 1.5 MW_{el} which is lower than what have been than the registered PD and within the operation license limit. The change does not have an impact on the applicability of the methodology, additionality or the appropriateness of the baseline scenario. The above-mentioned deviations are of permanent nature and do not have any impact on the project applicability, baseline scenario, and additionality.

3.4 Grouped Project

The project is not a grouped project - thus not applicable

4 VERIFICATION FINDINGS

4.1 Project Implementation Status

Implementation of the project activity has been assessed through document review, off-site interview and video call with project proponent. The project activity involves the installation and operation of a methane recovery and utilization system (covered lagoon system). The captured methane (biogas) is utilized as fuel in dual fire boilers replacing fossil fuel (i.e. HFO) and gas engines for electricity generation. As per the registered VCS PD, there are two dual fired boilers of 3.488 MW_{th} and 3.78 MW_{th} capacities. However, from first verification onwards, the boiler

with capacity 3.488 MWth was replaced with a new boiler of capacity 4.070 MWth. On a conservative side PP decided not to claim emission reduction from the new boiler as explained in section 3.3 above. The capacity of each boiler confirmed from photographic evidence and boiler inspection certificate /20/. According to the VCS PD, the captured biogas is also utilised in two gas engines each having a capacity of 952 kWe. From first verification onwards it was noted that two additional gas engines of 450 kWe have also been installed. The baseline emissions on account of biogas utilisation in these two gas engines have not been included in the emission reduction calculation. This is confirmed based on the review of ER sheet and previous verifications. The photographic evidence and log sheets are used to cross check the gas generators. The project boundary is the physical, geographical site where the wastewater treatment takes place in baseline and project situation. It covers all facilities affected by the project activity including sites where the processing, transportation and application or disposal of waste products as well as biogas takes place. Based on document review, on-site interview, it is confirmed that all the emission sources within the boundary have been considered appropriately. Monitoring of all parameters during the monitoring period is followed as per registered monitoring plan except the deviations described in section 3.2 above. Verification team confirmed from the registered PD/⁴/ and previous verification reports that the location of the project activity including the coordinates is same as mentioned in the registered VCS PD/⁴/.

The project site is located at Kean Charoen Co. Ltd. in Kranuan district, Khonkaen province situated in the Northeast of Thailand approximately 450 km from Bangkok. The project coordinates are 16° 48.498'N and 103° 05.148'E. The project is already registered under VCS (VCS Ref. No: 427¹) and the project was fully operational during the second crediting period from 15-July-2019 to 14-July-2029.

The PP has provided the Project's Audit History in section 1.1 of the MR as same has been verified by the assessment team with VCS registry data based and found to be correct.

Audit Type	Period	Program	VVB Name	Number of years
Validation	19/06/2009	VCS	TÜV NORD CERT GmbH	-
Verification	03/12/2009 to 31/12/2011	VCS	Germanischer Lloyd Certification GmbH	2 years, 28 days
Verification	01/01/2012 to 11/05/2016	VCS	KBS Certification Services Pvt. Ltd.	4 years, 4 months, 10 days

¹Verra Search Page

Verification	12/05/2016 to 31/12/2018	VCS	KBS Certification Services Pvt. Ltd.	2 years, 7 months, 19 days
Verification	01/01/2019 to 14/07/2019	VCS	Carbon Check India Pvt. Ltd.	6 months, 13 days
Validation	15/04/2020	VCS	Carbon Check India Pvt. Ltd	-
Verification	15/07/2019 to 31/12/2019	VCS	Carbon Check India Pvt. Ltd.	5 months, 16 days
Verification	01/01/2020 to 02/03/2020	VCS	4K Earth Science Private Limited	2 months, 1 days
Verification	03/03/2020 to 31/03/2021	VCS	4K Earth Science Private Limited	1 years, 28 days
Total				11 years , 3 months, 28 days

VVB concluded that the project is implemented as per the requirement of the registered VCS MR/⁶/and approved monitoring plan. During the current monitoring period, it was observed that no unforeseen incident/event evolved which can impact the operation of the project activity which was verified from breakdown records. The project undergone continuous operation and only scheduled maintenance is observed as per the manufacture's specification as evident from records.

VVB confirmed that there is no proposed or actual change to the project design during this monitoring period. The project design as mentioned in the registered PD/⁴/ is implemented and thus the same is acceptable to the assessment team. All required monitoring equipment's and procedures as mentioned in the registered PD/⁴/are available and implemented in an appropriate manner.

The organisational role and responsibility as mentioned in the registered PD/⁴/ is followed onsite. All the emergency preparedness as mentioned in the registered PD/⁴/is followed onsite and no discrepancies were found regarding the same. Meters are calibrated as per calibration frequency in registered VCS PD/⁴/. All the emergency preparedness as mentioned in the registered VCSPD/⁴/ is followed onsite and no discrepancies were found regarding the same. Thus, completeness of the monitoring plan confirmed and there are no any material discrepancies between the actual monitoring system and the plan provided in the registered PD/⁴/.

Assessment team confirms following during the verification onsite audit:

1. Start date of the project activity is 02-October-2006 as mentioned in the registered VCS MR/⁶/.

2. An undertaking letter has been submitted by PP for no double counting with any other GHG program. PP also has given a written declaration that project has not claimed other form of GHG credit for the concerned monitoring period.
3. VVB team confirms that this is the 4th verification under VCS and covers the activity from 01-April-2021 to 31-October-2022 (inclusive of both dates). The project activity adopts renewable crediting period of 10 years period and can be renewed for maximum 2 times. 15-July-2019 is the start date and 14-July-2029 will be end date of the crediting period.

The GHG credits from 01-April-2021 to 31-October-2022 will be claimed under VCS only. At any point of time during the crediting period, the project proponent will abide by the “No Double Counting”.

4. Assessment team checked and found that the Project proponent of the project activity is as below for the current monitoring period:

Organization name	Kean Chareon Co., Ltd.
Contact person	Mr. Ung Mengchua
Title	Project Representative
Address	1004/201 Rama 3 Road, Bangpongpan, Yannawa, 10120
Telephone	+ 66 2 294 5315-6, 2945646
Email	sales@thaitapiocastarch.com

5. Assessment team also checked the details of other entity and found correct. The details are as below:

Organization name	South Pole Carbon Asset Management Ltd.
Role in the Project	Project developer for development of emission reduction through the Voluntary Carbon Standard
Contact person	John Davis
Title	CEO
Address	Technoparkstrasse 1, Zurich, Switzerland, 8005
Telephone	+41 43 501 35 50
Email	registration@southpole.com

6. The quantified emission reduction calculation for the monitoring period is correct and conservative. Assessment team also compared actual VER with the estimated VER and found that the actual VCUs is 116,994 tCO₂e which is 4% lesser than the estimated emission reductions 121,523 tCO₂e during this monitoring period due to the actual emission reductions during this monitoring period was higher than the ex-ante figure. The justification has been provided as follows. When comparing the actual monitored data with the ex-ante figures, it was found that COD load is higher than the estimation resulting in higher biogas generation. The justification for the increase may come from the higher availability of cassava roots which subjects to seasonal variations. Thus, acceptable to VVB.

4.2 Safeguards

4.2.1 No Net Harm

The project involves treatment of wastewater and capture of biogas from wastewater treatment system. Generated biogas is used in boiler and gas engine which replaces HFO consumption. Therefore, the project results in avoidance of methane emissions and CO₂ emissions which otherwise would have been there without the project activity. Therefore, there is no negative environmental impact from the project activity. In addition, due to the project activity, jobs are created in local level as verified during off-site interview and raw materials are procured from local area which has improved socio-economic impacts in the project area. Therefore, there is no net harm from the project activity.

4.2.2 Local Stakeholder Consultation

Local stakeholder consultation has been conducted at the time of project registration and the same has been described in Section 2.2 of revised monitoring report. For on-going stakeholder's communication, the PP has kept grievance register in plant site office seeking complaints/grievances from local community as a part of ongoing communication with stakeholders in line with clause 3.18.4 of VCS Standard, v.4.4.

Assessment team checked the grievance register provided by PP and found that no grievance/feedback was received during the current monitoring period. Thus, verification team is of the opinion that the ongoing stakeholder mechanism is adequate and appropriate.

4.3 AFOLU-Specific Safeguards

This section is not applicable as this project activity is a non-AFOLU project activity.

4.4 Accuracy of GHG Emission Reduction and Removal Calculations

The verification team assessed whether the data and calculations of GHG emission reductions achieved resulting from the VCS MR /6/. The verification team has checked whether calculations of baseline GHG emissions, project GHG emissions and leakage GHG emissions have been carried out in accordance with the formulae and methods described in the monitoring plan of the VCS PD/4/.

Data parameters fixed ex-ante and available at validation are given below:

DATA/PARAMETER Unit	Source of data	Reported value for the project period	VVB Observation
Global Warming Potential for Methane (GWPC _{H4}) in tCO ₂ e/tCH ₄	Data based on registered VCS PD /02/	28	VVB team verified, as per VCS Standard V4.4, published on

			December 21, 2021, Clause 3.15.4 PP used GWP of 28 in this monitoring report. Hence, correct value is considered.
Methane producing capacity of the wastewater (Bo,ww); kg CH ₄ /kg COD	Data based on registered PD /02/ and validation report	0.25	The value is ex-ante fixed for 10 years crediting period as per the registered PD, which has been justified and validated by validation VVB to follow the applied methodology and tool.
Model correction factor to account for model uncertainties (UFBL)	Data based on registered PD /02/ and validation report /11/	0.89	The value is ex-ante fixed for 10 years crediting period as per the registered PD, which has been justified and validated by validation VVB to follow the applied methodology and tool /02/, /11/.
Model correction factor to account for model uncertainties (UFPJ)	Data based on registered PD /02/ and validation report /11/	1.12	The value is ex-ante fixed for 10 years crediting period as per the registered PD, which has been justified and validated by

			validation VVB to follow the applied methodology and tool /02/, /11/
Methane correction factor for baseline wastewater treatment systems l ($MCF_{ww,treatment,BL,Lagoon}$)	Data based on registered PD /02/ and validation report /11/	0.8	The value is ex-ante fixed for 10 years crediting period as per the registered PD, which has been justified and validated by validation VVB to follow the applied methodology and tool /02/, /11/.
Methane correction factor for project wastewater treatment systems equipped with biogas recovery ($MCF_{ww,treatment,PJ,CL}$)	Data based on registered PD /02/ and validation report /11/	0.8	The value is ex-ante fixed for 10 years crediting period as per the registered PD, which has been justified and validated by validation VVB to follow the applied methodology and tool /02/, /11/
Methane correction factor for project secondary treatment systems k ($MCF_{ww,treatment,PJ,Lagoon}$)	Data based on registered PD /02/ and validation report /11/	0.8	The value is ex-ante fixed for 10 years crediting period as per the registered PD, which has been justified and validated by validation VVB to follow the applied methodology and tool /02/, /11/

$\eta_{\text{COD,BL,I}}$ or COD removal efficiency-baseline Chemical oxygen demand removal efficiency of baseline treatment system; %	Data based on registered PD /02/ and validation report /11/	87.16%	The value is ex-ante fixed for 10 years crediting period as per the registered PD, which has been justified and validated by validation VVB to follow the applied methodology and tool /02/, /11/.
CFE_{ww} Capture efficiency of the biogas recovery equipment in the wastewater treatment systems (CFE_{ww}	Data based on registered PD /02/ and validation report /11/	0.9	The value is ex-ante fixed for 10 years crediting period as per the registered PD, which has been justified and validated by validation VVB to follow the applied methodology and tool /02/, /11/.
$\text{EF}_{\text{grid,y}}$ CO2 emission factor for grid power (EF_{y}); tCO2/MWh	Data based on registered PD /02/ and validation report /11/	0.5637	The value is ex-ante fixed for 10 years crediting period as per the registered PD, which has been justified and validated by validation VVB to follow the applied methodology and tool /02/, /11/.
$\text{EF}_{\text{HFO,CO2}}$ Emission factor of fossil fuel replaced –	Data based on registered PD /02/	77.4	The value is ex-ante fixed for 10 years crediting

Residual Fuel oil (EFCO ₂); tCO ₂ /TJ	and validation report /11		period as per the registered PD, which has been justified and validated by validation VVB to follow the applied methodology and tool /02/, /11/.
NCV _{HFO} NCV of fuel oil i.e. fossil fuel displaced by biogas (NCVFO); GJ/tonne	Data based on registered PD /02/ and validation report /11/	42.763	The value is ex-ante fixed for 10 years crediting period as per the registered PD, which has been justified and validated by validation VVB to follow the applied methodology and tool /02/, /11/.
NCV of biogas (NCVbiogas); MJ/Nm ³	Data based on registered PD /02/ and validation report /11	20.93	The value is ex-ante fixed for 10 years crediting period as per the registered PD, which has been justified and validated by validation VVB to follow the applied methodology and tool /02/, /11/.
dry starch historically (QFO,starch); L/tonne	Data based on registered PD /02/ and validation report /11/	39.6	per the registered PD, which has been justified and validated by validation VVB to follow the applied

			methodology and tool /02/, /11/.
ρ_{HFO} Density of fuel oil Thai local value (PTT)	Data based on registered PD	0.93	per the registered PD, which has been justified and validated by validation VVB
Density of methane gas at reference conditions (DCH ₄); kg/m ³	Data based on registered PD /02/ and validation report /11/	0.716	The value is ex-ante fixed for 10 years crediting period as per the registered PD, which has been justified and validated by validation VVB to follow the applied methodology and tool /02/, /11/.
Density of fuel oil (DFO); Kg/litre	Data based on registered PD /02/ and validation report /11/	0.93	The value is ex-ante fixed for 10 years crediting period as per the registered PD, which has been justified and validated by validation VVB to follow the applied methodology and tool /02/, /11/.
Destruction efficiency of the electricity generator (DE; %)	Data based on registered PD /02/ and validation report /11/	100%	The value is ex-ante fixed for 10 years crediting period as per the registered PD, which has been justified and validated by

			validation VVB to follow the applied methodology and tool /02/, /11/.
Total electrical capacity of the equipment installed in the project activity (Pel); kW	Data based on registered PD /02/ and validation report /11/	458	The value is fixed ex-ante as per registered PD was 277 kW which was found to be 458 kW during first verification and accordingly used for subsequent verifications.

Data parameters monitored:

Data/Parameter	VVB Assessment		
Data Unit	Qy,ww; m³		
Description	Volume of wastewater treated in the year y		
Source of data to be used	Measured – Volumetric flow meters (FM1 & FM2)		
Value of monitored parameter for the monitoring period	Period	Total value (m3)	
	01-April-2021 to 31-December-2021	630,648	
	01-January-2022 to 31-October-2022	665,287	
Monitoring equipment			
	Meter tag	FM1	
	Serial number	N4065620000	
	Brand	Endress Hauser	
	Type	PROMAG 10L	
	Installation	30/06/2020 onwards	
Meter tag	FM2		

	Serial number	N308AD20000	
	Brand	Endress Hauser	
	Type	PROMAG 10L	
	Installation	01/09/2020 onwards	
Accuracy of the monitoring equipment	±0.50% (all flow meters)		
Measuring/Reading/Recording frequency	Once in 3 years		
Calculation method (if applicable)	Not applicable		
Calibration			
Calibration frequency/interval Is the calibration interval in line with the monitoring plan of the VCS PD	Calibration frequency is defined least once in every 3 years. This is consistent with registered monitoring plan and with calibration certificate submitted by project proponent.		
Does the calibration cover the monitoring period? Has the calibration frequency been respected	The monitoring period is from 01-April-2021 to 31-October-2022. Hence, VVB team verified that, the calibration covers the monitoring period. The calibration frequency has been checked with calibrations records and found that the calibration frequency has been respected.		
Calibration certificates	Serial no	Calibration details	
	(FM1) N4065620000	Cal. Date	Validity
		23/10/2020	22/10/2023
		14/09/2022	13/9/2025
	(FM2) N308AD20000	Cal. Date	Validity
		30/01/2021	29/01/2024
14/09/2022		13/9/2025	
Whether calibration done by an accredited person or institution?	Endress+Hauser is the manufacturer of the flow meters and accredited to do calibration.		

Data/Parameter	COD _{ww,untreated,y} ; mg/l		
Data Unit	t COD/m ³		
Description	The chemical oxygen demand of the wastewater entering the covered lagoon reactor system		
Source of data to be used	Measured – Colorimetric analysis		
Value of monitored parameter for the monitoring period	Monitoring period	Average value*	
		Lower	Higher
	01-April-2021 to 31-December-2021	0.0466	0.0562
	01-january-2022 to 31-October-2022	0.0426	0.0477
	The values mentioned in the monitoring report and ER sheet have been verified with log book reports /13 (c)/. The reported values in the MR and ER sheet were found to be consistent with the lab analysis reports and the operator log sheet information. The wastewater samples are sent to an external laboratory once in a year as per the monitoring plan. The verification team confirms that the COD values determined by the internal laboratory are close to that of external laboratory results		
Monitoring equipment	Spectrophotometer:		
	Brand	Hanna	
	Type	HI 83214	
	Serial No.	H19945I	
Accuracy of the monitoring equipment	VCS PD does not specify the accuracy of monitoring equipment. However, the PP has installed latest Spectrophotometer with an accuracy class of 10 mg/l (HR) & 1 mg/l (LR).		
Measuring/Reading/Recording frequency	VVB team conform that, As per registered monitoring plan it is required to be done on		

	daily basis. Wastewater samples are collected and the COD measurement is carried out on every operational day and the results are recorded in lab book.		
Calculation method (if applicable)	Values as recorded from measurement method is taken and no calculation method is applied		
Calibration			
Calibration frequency/interval Is the calibration interval in line with the monitoring plan of the VCS PD	Calibration frequency is defined least once in every 3 years. This is consistent with registered monitoring plan and previous verifications and hence accepted.		
Does the calibration cover the monitoring period? Has the calibration frequency been respected	VVB team verified that, the calibration covers the monitoring period. The calibration frequency has been checked with calibrations records and found that the calibration frequency has been respected.		
Calibration certificates	Serial no.	Calibration details	
	H19945I	Cal. Date	Validity
		12/12/2018	11/12/2021
		05/05/2021	04/05/2024
Whether calibration done by an accredited person or institution?	HANNA Instruments (Thailand) Ltd. Which is accredited laboratory to do the calibration		

Data/Parameter	VVB Assessment		
Data Unit	COD _{ww,treated,yt} COD/m ³		
Description	The chemical oxygen demand of the wastewater coming out of the last lagoon		
Source of data to be used	Measured – Colorimetric method		
Value of monitored parameter for the monitoring period	Monitoring period	Average value*	
		Lower	Higher

	01-April-2021 to 31-December-2021	0.0006	0.0007						
	01-January-2022 to 31-October-2022	0.0004	0.0005						
	VVB team verified that, the reported values in the MR and ER sheet were found to be consistent with the lab analysis reports and the operator log sheet information. The wastewater samples are sent to an external laboratory once in a year as per the monitoring plan. The verification team confirms that the COD values determined by the internal laboratory are close to that of external laboratory results.								
Monitoring equipment	Spectrophotometer: <table><tr><td>Brand</td><td>Hanna</td></tr><tr><td>Type</td><td>HI 83214</td></tr><tr><td>Serial No.</td><td>H19945I</td></tr></table>			Brand	Hanna	Type	HI 83214	Serial No.	H19945I
Brand	Hanna								
Type	HI 83214								
Serial No.	H19945I								
Accuracy of the monitoring equipment	VCS PD does not specify the accuracy of monitoring equipment. However, the PP has installed latest Spectrophotometer with an accuracy class of 10 mg/l (HR) & 1 mg/l (LR).								
Measuring/Reading/Recording frequency	VVB team verified that, As per registered monitoring plan it is required to be done on daily basis. Wastewater samples are collected and the COD measurement is carried out on every operational day and the results are recorded in lab book. The Colorimetric method is well documented and well accepted by international standards.								
Calculation method (if applicable)	Values as recorded from measurement method are taken and no calculation method is applied.								
Calibration									

Calibration frequency/interval Is the calibration interval in line with the monitoring plan of the VCS PD	Calibration frequency is defined least once in every 3 years. This is consistent with registered monitoring plan and previous verifications and hence accepted.		
Does the calibration cover the monitoring period? Has the calibration frequency been respected	VVB team would verify that, the calibration covers the monitoring period. The calibration frequency has been checked with calibrations records and found that the calibration frequency has been respected		
Calibration certificates	Serial no.	Calibration details	
	H19945I	Cal. Date	Validity
		12/12/2018	11/12/2021
		05/05/2021	04/05/2024
Whether calibration done by an accredited person or institution?	HANNA Instruments (Thailand) Ltd. This is accredited laboratory to do the calibration.		

Data/Parameter	VVB Assessment		
Data Unit	COD _{discharge,PJ,yt} COD/m ³		
Description	The chemical oxygen demand of water after the secondary treatment process, before being reused.		
Source of data to be used	Measured – Colorimetric analysis		
Value of monitored parameter for the monitoring period	Monitoring period	Average value*	
		Lower	Higher
	01-April-2021 to 31-December-2021	0.0001	0.0001
	01-January-2022 to 31-October-2022	0.0001	0.0001

	Reported values in the MR and ER sheet were found to be consistent with the lab analysis reports and the operator log sheet information. The wastewater samples are sent to an external laboratory once in a year as per the monitoring plan. The verification team confirms that the COD values determined by the internal laboratory are close to that of external laboratory results						
Monitoring equipment	Spectrophotometer: <table border="1"> <tr> <td>Brand</td><td>Hanna</td></tr> <tr> <td>Type</td><td>HI 83214</td></tr> <tr> <td>Serial No.</td><td>H19945I</td></tr> </table>	Brand	Hanna	Type	HI 83214	Serial No.	H19945I
Brand	Hanna						
Type	HI 83214						
Serial No.	H19945I						
Accuracy of the monitoring equipment	PP has installed latest Spectrophotometer with an accuracy class of 10 mg/l (HR) & 1 mg/l (LR). The verification team is of the opinion that the accuracy of the meter represents good monitoring practice.						
Measuring/Reading/Recording frequency	As per registered monitoring plan it is required to be done on daily basis. Wastewater samples are collected and the COD measurement is carried out on every operational day and the results are recorded in log book. The Colorimetric method is well documented and well accepted by international standards.						
Calculation method (if applicable)	Values as recorded from measurement method are taken and no calculation method is applied.						
Calibration							
Calibration frequency/interval is the calibration interval in line with the monitoring plan of the VCS PD	Calibration frequency is defined least once in every 3 years. This is consistent with calibration certificate and previous verifications and hence accepted.						

Does the calibration cover the monitoring period? Has the calibration frequency been respected	The calibration covers the monitoring period. The calibration frequency has been checked with calibrations records and found that the calibration frequency has been respected.		
Calibration certificates	Serial no.	Calibration details	
	H19945I	Cal. Date	Validity
		12/12/2018	11/12/2021
		05/05/2021	04/05/2024
	VVB team verified that, PP has submitted the calibration certificate and it is found to be consistent and error free.		
Whether calibration done by an accredited person or institution?	HANNA Instruments (Thailand) Ltd. This is accredited laboratory to do the calibration.		

Data/Parameter	VVB Assessment	
Data Unit	$S_{final,PJ,y}$ Tons	
Description	Amount of dry matter in the sludge	
Source of data to be used	Weighing equipment that is available at the site is used. Plant records every time sludge is removed from the system.	
Value of monitored parameter for the monitoring period	Monitoring period	Total value (tons)
	01-April-2021 to 31-December-2021	0
	01-January-2022 to 31-October-2022	0
	VVB team verified that, weighbridge was maintained by the project proponent and it was calibrated as per monitoring records and it is found it consistent and error free.	
Monitoring equipment	Meter tag	Weighbridge
	Serial number	0008666
	Brand	Commandor

	Type	HP-05K	
	Accuracy	±20 kg	
Accuracy of the monitoring equipment	The accuracy of the meters is as per industry standard.		
Measuring/Reading/Recording frequency	Continuous monitoring and daily recording for emission reduction calculation.		
Calculation method (if applicable)	Values as recorded in flow meter are taken and no calculation method is applied.		
Calibration			
Calibration frequency/interval Is the calibration interval in line with the monitoring plan of the VCS PD	The weighbridge meter is calibrated at least once every 2 years as per registered monitoring plan		
Does the calibration cover the monitoring period? Has the calibration frequency been respected	Hence, calibration cover the monitoring period		
Calibration certificates	Serial no.	Calibration details	
	0008666	Cal. Date	Validity
		04/06/2019	03/06/2021
		21/04/2021	21/04/2024
	Monitoring equipment details are provided above and it is found consistent and as per calibration certificate and accepted.		
Whether calibration done by an accredited person or institution?	-		

Data/Parameter	VVB Assessment
Data Unit	BG _{burnt,y} Nm ³
Description	Amount of biogas combusted for gainful use
Source of data to be used	Calculated from a summation of total biogas utilized in boilers, generation sets
Value of monitored parameter for the monitoring period	VVB team verified that, the amount of biogas combusted was the summation of the volume of biogas

	sent to boiler 2 and gas engine as boiler 1 was excluded from the estimation of emission reductions as per Deviation 1 of the project description deviation.												
	<table><tr><th>Monitoring period</th><th>Applied value*</th></tr><tr><td>01-April-2021 to 31-December-2021</td><td>3,709,885</td></tr><tr><td>01-January-2022 to 31-October-2022</td><td>4,947,331</td></tr></table>		Monitoring period	Applied value*	01-April-2021 to 31-December-2021	3,709,885	01-January-2022 to 31-October-2022	4,947,331					
	Monitoring period	Applied value*											
	01-April-2021 to 31-December-2021	3,709,885											
	01-January-2022 to 31-October-2022	4,947,331											
	BG to boiler2 (GM4)												
	<table><tr><th>Monitoring period</th><th>Applied value*</th></tr><tr><td>01-April-2021 to 31-December-2021</td><td>1,428,909</td></tr><tr><td>01-January-2022 to 31-October-2022</td><td>1,917,319</td></tr></table>		Monitoring period	Applied value*	01-April-2021 to 31-December-2021	1,428,909	01-January-2022 to 31-October-2022	1,917,319					
	Monitoring period	Applied value*											
	01-April-2021 to 31-December-2021	1,428,909											
	01-January-2022 to 31-October-2022	1,917,319											
BG to engines (GM3)													
<table><tr><th>Monitoring period</th><th>Applied value*</th></tr><tr><td>01-April-2021 to 31-December-2021</td><td>2,280,946</td></tr><tr><td>01-January-2022 to 31-October-2022</td><td>3,030,012</td></tr></table>		Monitoring period	Applied value*	01-April-2021 to 31-December-2021	2,280,946	01-January-2022 to 31-October-2022	3,030,012						
Monitoring period	Applied value*												
01-April-2021 to 31-December-2021	2,280,946												
01-January-2022 to 31-October-2022	3,030,012												
There are 3 gas meters installed for measurement of biogas combusted (GM 1-boiler 1, GM 4-boiler 2 and GM 3-generators). However, as per deviation, the biogas value from boiler 1 (GM 1) was excluded from the biogas combusted for a conservative estimation of baseline emissions. Monitored values of GM 4 and GM 3 mentioned in the monitoring report and ER sheet have been verified with the daily reports /13(d),(e)/. The reported values in the MR and ER sheet were found to be consistent with the daily reports and the operator log sheet information.													
Monitoring equipment													
<table><tr><td>Meter location</td><td>Boiler 2</td></tr><tr><td>Meter tag</td><td>GM4</td></tr><tr><td>Serial number</td><td>N1-V905-9663007</td></tr><tr><td>Brand</td><td>Siemens</td></tr><tr><td>Type</td><td>7MF4433-1BA22-1AC96-Z</td></tr><tr><td>Accuracy</td><td>±0.075%</td></tr></table>		Meter location	Boiler 2	Meter tag	GM4	Serial number	N1-V905-9663007	Brand	Siemens	Type	7MF4433-1BA22-1AC96-Z	Accuracy	±0.075%
Meter location	Boiler 2												
Meter tag	GM4												
Serial number	N1-V905-9663007												
Brand	Siemens												
Type	7MF4433-1BA22-1AC96-Z												
Accuracy	±0.075%												

	Meter location	Generator	
	Meter tag	GM3	
	Serial number	5314	
	Brand	FOX	
	Type	FT2	
	Accuracy	1%R + 0.2%FS	
Accuracy of the monitoring equipment	The accuracy of the meters is as per industry standard.		
Measuring/Reading/Recording frequency	Continuous monitoring and daily recording for emission reduction calculation.		
Calculation method (if applicable)	Values as recorded in flow meter are taken and no calculation method is applied.		
Calibration			
Calibration frequency/interval Is the calibration interval in line with the monitoring plan of the VCS PD	The flow meter is calibrated at least once every 3 years as per registered monitoring plan.		
Does the calibration cover the monitoring period? Has the calibration frequency been respected	There was a delay in calibration of the Boiler 2 (GM4) , from 01/04/2021 to 14/06/2021. The values have been adjusted according to the maximum error as per the instrument specification. Same has been checked in ER calculation sheet and found to be correct, hence accepted.		
Calibration certificates	VVB team verified that, calibration details are found consistent with submitted calibration certificate.		
	Serial no.	Calibration details	
	(GM4)	Cal. Date	Validity
		15/06/2021	14/06/2024
		23/07/2022	22/07/2025
	N1-V905-9663007		
	(GM3)	Cal. Date	Validity
15/06/2021		14/06/2024	
23/07/2022		22/07/2025	
5314			

Whether calibration done by an accredited person or institution?	-
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Data/Parameter	VVB Assessment			
Data Unit	WCH ₄ ,y%			
Description	Methane content in biogas			
Source of data to be used	Measured – Gas analyzer system to monitor % of methane in biogas			
Value of monitored parameter for the monitoring period	Monitoring period		Methane content	
			Lower	Upper
	01-April-2021 to 31-December-2021	57.96	59.09	
	01-January-2022 to 31-October-2022	61.72	62.56	
	During the monitoring period, as the online monitoring equipment was not available for continuous measurement, the portable gas analyzer was used for periodic measurement and the measured values were applied at a 95% confidence level. The lower and upper values were used for the calculation of the baseline and project emissions in a conservative manner.			
Monitoring equipment	Meter tag	MS		
	Serial number	G503004		
	Brand	Geotech		
	Type	BIOGAS 5000		
	Accuracy	0.5%		
Accuracy of the monitoring equipment	The accuracy of gas analyser is 0.5% as per the specification of the equipment			
Measuring/Reading/Recording frequency	Periodic using a portable gas analyser. Measurement follows 95% confidence interval which is consistent with the applied methodology.			
Calculation method (if applicable)	Values as recorded in monitoring device are taken and no calculation method is applied.			

Calibration			
Calibration frequency/interval Is the calibration interval in line with the monitoring plan of the VCS PD	The analyser is calibrated at least once every 3 years as per registered monitoring plan.		
Does the calibration cover the monitoring period? Has the calibration frequency been respected	VVB team verified that, the monitoring period is from 01-April-2021 to 31-October-2022. The gas analyser was calibrated on 30-March-2021. Hence calibration covers the monitoring period.		
Calibration certificates	VVB team verified that, calibration details are found consistent with submitted calibration certificate.		
	Serial no.	Calibration details	
	G503004	Cal. Date	Validity
		12/06/2018	11/06/2021
30/03/2021		29/03/2024	
Whether calibration done by an accredited person or institution?	-		

Data/Parameter	VVB Assessment		
Data Unit	BG _{burnt, flared} , Nm ³		
Description	Amount of biogas that is flared		
Source of data to be used	Measured using biogas flow meter: GM2		
Value of monitored parameter for the monitoring period	Monitoring period		Applied value
	01-April-2021	to 31-December-2021	0
	01-January-2022	to 31-October-2022	0
	During the monitoring period no flaring was recorded as verified with the daily reports. The reported values in the MR and ER sheet were found to be consistent with the daily reports and the operator log sheet information.		
Monitoring equipment	Meter tag	GM2	
	Serial number	7568	

	Brand	FOX	
	Type	FT2-12I	
	Accuracy	1%R + 0.2%FS	
Accuracy of the monitoring equipment	The accuracy of the meter is as per industry standard.		
Measuring/Reading/Recording frequency	Continuous monitoring and daily recording.		
Calculation method (if applicable)	Values as recorded in flow meter are taken and no calculation method is applied.		
Calibration			
Calibration frequency/interval Is the calibration interval in line with the monitoring plan of the VCS PD	The flow meter is calibrated at least once every 3 years as per registered monitoring plan.		
Does the calibration cover the monitoring period? Has the calibration frequency been respected	VVB team verified that, the monitoring period is from 01-April-2021 to 31-October-2022. The gas analyser was calibrated on 30-April-2020. Hence calibration covers the monitoring period.		
Calibration certificates	VVB team verified that, calibration details are found consistent with submitted calibration certificate.		
	Serial no.	Calibration details	
	7568	Cal. Date	Validity
		28/04/2020	27/04/2023
Whether calibration done by an accredited person or institution?	-		

Data/Parameter	VVB Assessment	
Data Unit	q _{F0,y} Liters/y	
Description	Quantity of fossil fuel used in boiler in year y	
Source of data to be used	Measured by continuous Fuel oil meter	
Value of monitored parameter for the monitoring period	Monitoring period	Total value (liters)*

	01-April-2021 to 31-December-2021		68,125
	01-January-2022 to 31-October-2022		124,243
	There are 2 boilers at the starch factory. However, as per Deviation 1 of the project description deviation, the value from boiler 1 was excluded from the emission reduction. In recording this parameter, plant's operators would first manually archive the monitored data onto log sheets then transfer to the computer for electronic storage. The archive was done on a daily basis. In case the oil meter values are not available for reason such as faulty meter, the same should be estimated in a conservative manner.		
Monitoring equipment	Meter location	Boiler 2	
	Meter tag	OM2	
	Serial number	5449943	
	Brand	CONTOIL	
	Type	VZF20RC 130/16	
	Accuracy	±1%	
Accuracy of the monitoring equipment	±1% as per equipment specification.		
Measuring/Reading/Recording frequency	Defined frequency is continuous measurement and daily recording.		
Calculation method (if applicable)	Values as recorded in oil meter method are taken and no calculation method is applied.		
Calibration			
Calibration frequency/interval Is the calibration interval in line with the monitoring plan of the VCS PD	Calibration frequency is once in three years.		
Does the calibration cover the monitoring period? Has the calibration frequency been respected	Monitoring period is from 01-April-2021 to 31-October-2022. Flow meter was calibrated on 03-June-2021.		

Calibration certificates	VVB team verified that, calibration details are found consistent with submitted calibration certificate.		
	Serial no.	Calibration details	
	5449943	Cal. Date	Validity
		03/06/2021	06/02/2023
26/07/2022		25/07/2025	
Whether calibration done by an accredited person or institution?	-		

Data/Parameter	VVB Assessment		
Data Unit	Q _{starch,y} Tons		
Description	Quantity of dry starch produced		
Source of data to be used	Based on operational log sheet at the plant		
Value of monitored parameter for the monitoring period	Monitoring period		Applied value*
	01-April-2021 to 31-December-2021		49,395
	01-January-2022 to 31-October-2022		56,707
Monitoring equipment	Meter tag	Weighbridge	
	Serial number	0008666	
	Brand	Commandor	
	Type	HP-05K	
	Accuracy	±20 kg	
Accuracy of the monitoring equipment	±20 kg accuracy class is as per industry standard.		
Measuring/Reading/Recording frequency	Defined frequency is daily measurement and daily recording.		
Calculation method (if applicable)	Values as recorded in weighing scale are taken and no calculation method is applied.		
Calibration			

Calibration frequency/interval Is the calibration interval in line with the monitoring plan of the VCS PD	Calibration frequency is once in 2 years.										
Does the calibration cover the monitoring period? Has the calibration frequency been respected	The monitoring period is from 01-April-2021 to 31-October-2022. The weighing scales were calibrated on 04-June-2019 and on 04-June-2021. Therefore, calibration cover the monitoring period										
Calibration certificates	VVB team verified that, calibration details are found consistent with submitted calibration certificate. <table><tr><td>Serial no.</td><td colspan="2">Calibration details</td></tr><tr><td rowspan="3">0008666</td><td>Cal. Date</td><td>Validity</td></tr><tr><td>04/06/2019</td><td>03/06/2021</td></tr><tr><td>21/04/2021</td><td>21/04/2024</td></tr></table>	Serial no.	Calibration details		0008666	Cal. Date	Validity	04/06/2019	03/06/2021	21/04/2021	21/04/2024
Serial no.	Calibration details										
0008666	Cal. Date	Validity									
	04/06/2019	03/06/2021									
	21/04/2021	21/04/2024									
Whether calibration done by an accredited person or institution?	-										

Data/Parameter	VVB Assessment	
Data Unit	EGPJ,yMWh/y	
Description	Net electricity production by the generators during year y	
Source of data to be used	Measured – Electricity meters installed at the generation sets	
Value of monitored parameter for the monitoring period	Monitoring period	Applied value*
	01-April-2021 to 31-December-2021	4,410
	01-January-2022 to 31-October-2022	3,747
Monitoring equipment	<i>Meter tag</i>	EM1
	<i>Serial number</i>	62560 1 00N0030
	<i>Brand</i>	CARLO GAVAZZI
	<i>Type</i>	WM3-06
	<i>Accuracy</i>	±0.5%
	<i>Meter tag</i>	EM2

	Serial number	62560 1 00N0034
	Brand	CARLO GAVAZZI
	Type	WM3-06
	Accuracy	±0.5%
	Meter tag	EM
	Serial number	N/A
	Brand	B&R Automation
	Model	X20CM0985-1 ²
	Accuracy	5.0%
Accuracy of the monitoring equipment	±0.5% for EM1 and EM2 Where as 5.0% for EM	
Measuring/Reading/Recording frequency	Continuous monitoring and daily recording.	
Calculation method (if applicable)	Since no value is considered during the monitoring period and no calculation method is applicable.	
Calibration		
Calibration frequency/interval Is the calibration interval in line with the monitoring plan of the VCS PD	Calibration frequency is once in a three years.	
Does the calibration cover the monitoring period? Has the calibration frequency been respected	Energy meter are calibrated as per the guideline.	
Calibration certificates	VVB team verified that, calibration details of <i>EM</i> are found consistent with submitted calibration certificate. However, calibration details of EM 1 and EM 2 are not found as same is not available with the PP. The EM (B&R Automation) is bundled with a new gas engine generator which was	

² https://download.br-automation.com/BRP44400000000000000643756/X20CM0985-1-en_V1.45.pdf?px-hash=33b15f49ee5a3460f1d006151bfd6a21&px-time=1625215958

	commissioned on 09/01/2021. Therefore, the calibration schedule is set to be on 08/01/2024. The PP has applied the appropriate error factor in calculation of GHG ERRs in ER sheet and only values from EM is taken into account for the ER calculation. Values from EM1 and EM2 are not taken into ER calculation as the meters were not calibrated; this is found to be correct, hence accepted.
Whether calibration done by an accredited person or institution?	-

Data/Parameter	VVB Assessment		
Data Unit	EC _y MWh/y		
Description	Electricity consumption by wastewater treatment plant in year y		
Source of data to be used	Maximum rated consumption was calculated by multiplying total electrical capacity with operational hour and an additional factor of 20%.		
Value of monitored parameter for the monitoring period	Monitoring period		Applied value
	01-April-2021 to 31-December-2021		2,691
	01-January-2022 to 31-October-2022		3,007
Monitoring equipment	A default approach is applied and hence no monitoring equipment is needed.		
Accuracy of the monitoring equipment	A default approach is applied and hence no monitoring equipment is needed.		
Measuring/Reading/Recording frequency	A default approach is applied and hence no monitoring is done.		
Calculation method (if applicable)	Maximum rated consumption is calculated by multiplying total electrical capacity with actual operational days and 24 hours each day and 10% additional factor to be conservative.		
Calibration			

Calibration frequency/interval Is the calibration interval in line with the monitoring plan of the VCS PD	Since, no monitoring equipment is used, no calibration is applicable.
Does the calibration cover the monitoring period? Has the calibration frequency been respected	Since, no monitoring equipment is used, no calibration is applicable.
Calibration certificates	Since, no monitoring equipment is used, no calibration is applicable.
Whether calibration done by an accredited person or institution?	Since, no monitoring equipment is used, no calibration is applicable.

Data/Parameter	VVB Assessment		
Data Unit	F _{RG,mNm³}		
Description	Volumetric flow of the residual gas on dry basis at normal conditions in the minute <i>m</i> .		
Source of data to be used	Measured using biogas flow meter: GM2		
Value of monitored parameter for the monitoring period	Monitoring period		Applied value
	01-April-2021 to 31-December-2021		0
	01-January-2022 to 31-October-2022		0
Monitoring equipment	Meter tag	GM2	
	Serial number	7568	
	Brand	FOX	
	Type	FT2-12I	
	Accuracy	1%R + 0.2%FS	
Accuracy of the monitoring equipment	1%R + 0.2%FS		
Measuring/Reading/Recording frequency	The accuracy of the meters is as per industry standard.		
Calculation method (if applicable)	Values as recorded in flow meter are taken and no calculation method is applied.		
Calibration			

Calibration frequency/interval Is the calibration interval in line with the monitoring plan of the VCS PD	The flow meter is calibrated at least once every 3 years as per registered monitoring plan.		
Does the calibration cover the monitoring period? Has the calibration frequency been respected	VVB team verified that, calibration cover the complete current monitoring period		
Calibration certificates	VVB team verified that, calibration details are found consistent with submitted calibration certificate.		
	Serial no.		
	7568	Cal. Date	Validity
		28/04/2020	27/04/2023
Whether calibration done by an accredited person or institution?	--		

Data/Parameter	VVB Assessment	
Data Unit	Flame _m Flame on or Flame off	
Description	Flame detection of flare in the minute m	
Source of data to be used	Plant data	
Value of monitored parameter for the monitoring period	Monitoring period	Applied value
	01-April-2021 to 31-December-2021	0
	01-January-2022 to 31-October-2022	0
Monitoring equipment	Default approach is applied and no monitoring equipment is applicable.	
Accuracy of the monitoring equipment	Default approach is applied and no monitoring equipment is applicable	
Measuring/Reading/Recording frequency	Default approach is applied and no monitoring equipment is applicable.	
Calculation method (if applicable)	Values as recorded in flow meter are taken and no calculation method is applied.	

Calibration	
Calibration frequency/interval Is the calibration interval in line with the monitoring plan of the VCS PD	Default value is applied
Does the calibration cover the monitoring period? Has the calibration frequency been respected	Since a default value is applied, no calibration is applicable for the parameter.
Calibration certificates	Since a default value is applied, no calibration is applicable for the parameter.
Whether calibration done by an accredited person or institution?	Since a default value is applied, no calibration is applicable for the parameter.

Data/Parameter	VVB Assessment	
Data Unit	$\eta_{\text{flare},m}\%$	
Description	Flare efficiency in the minute m	
Source of data to be used	Default value for open flares as per tool “project emission from flaring”	
Value of monitored parameter for the monitoring period	Monitoring period	Applied value
	01-April-2021 to 31-December-2021	0
	01-January-2022 to 31-October-2022	0
	The flare efficiency of 50% in the minute m is applied when the flare is detected in the minute m (Flame_m). If these conditions are not met, 0% default value should be used for this period.	
Monitoring equipment	There was no detail of the flame detector available.	
Accuracy of the monitoring equipment	Default approach is applied and no monitoring equipment is applicable.	
Measuring/Reading/Recording frequency	Maintenance of flare system shall be conducted periodically as per supplier’s specifications to ensure optimal operation	

Calculation method (if applicable)	Default approach is applied and no monitoring equipment is applicable.
Calibration	
Calibration frequency/interval Is the calibration interval in line with the monitoring plan of the VCS PD	Since a default value is applied, no calibration is applicable for the parameter.
Does the calibration cover the monitoring period? Has the calibration frequency been respected	Since a default value is applied, no calibration is applicable for the parameter.
Calibration certificates	Since a default value is applied, no calibration is applicable for the parameter.
Whether calibration done by an accredited person or institution?	Since a default value is applied, no calibration is applicable for the parameter.

Baseline Emissions for AMS-III.H

$$BE_y = BE_{power,y} + BE_{ww,treatment,y} + BE_{s,treatment,y} + BE_{ww,discharge,y} + BE_{s,final,y} \quad (1)$$

Where:

BE_y Baseline emissions in year y (tCO₂e)

$BE_{power,y}$ Baseline emissions from electricity or fuel consumption in year y (tCO₂e)

$BE_{ww,treatment,y}$ Baseline emissions from the wastewater treatment systems affected by the project activity in year y (tCO₂e)

$BE_{s,treatment,y}$ Baseline emissions from the sludge treatment systems affected by the project activity in year y (tCO₂e)

$BE_{ww,discharge,y}$ Baseline methane emissions from degradable organic carbon in treated wastewater discharged into sea/river/lake in year y (tCO₂e)

$BE_{s,final,y}$ Baseline methane emissions from anaerobic decay of the final sludge produced in year y (t CO₂e). If the sludge is controlled combusted, disposed in a landfill with biogas recovery, or used for soil application in the baseline scenario, this term shall be neglected

$BE_{power,y}$:

The baseline emissions from electricity and fossil fuel consumption were not considered. The power consumed in a baseline case was negligible and disregarded for conservative estimation

of baseline emissions. No fossil fuels were consumed in the operation of the open anaerobic lagoons in the baseline scenario, therefore, the baseline emissions from fuel consumption were zero as.

Therefore, $BE_{power,y}$ was zero.

$BE_{ww,treatment,y}$:

Methane emissions from the baseline wastewater treatment systems affected by the project were determined using the COD removal efficiency of the baseline plant:

$$BE_{ww,treatment,y} = \sum (Q_{ww,i,y} \times COD_{inflow,i,y} \times \eta_{COD,BL,i} \times MCF_{ww,treatment,BL,i}) \times B_{o,ww} \times UF_{BL} \times GWP_{CH4}$$

Where:

$Q_{ww,i,y}$ Volume of wastewater treated in a baseline wastewater treatment system i in year y (m^3)

$COD_{inflow,i,y}$ Chemical oxygen demand of the wastewater inflow to the baseline treatment system i in year y (t/m^3). Average value may be used through sampling with the confidence/precision level 90/10

$\eta_{COD,BL,i}$ COD removal efficiency of the baseline treatment system i

$MCF_{ww,treatment,BL,i}$ Methane correction factor for baseline wastewater treatment systems i
i Index for the baseline wastewater treatment system

$B_{o,ww}$ Methane producing capacity of the wastewater (IPCC value of $0.25 \text{ kgCH}_4/\text{kg COD}$)

UF_{BL} Model correction factor to account for model uncertainties (0.89)

GWP_{CH4} Global Warming Potential for methane

$BE_{ww,discharge,y}$:

In the baseline scenario, treated wastewater was not discharged into a sea/lake/river, therefore methane emissions from degradable organic carbon in treated wastewater discharged ($BE_{ww, discharge,y}$) was taken as zero.

$BE_{s,treatment,y}$ and $BE_{s,final,y}$:

The generated sludge in the baseline scenario is close to zero in which it is anyway used aerobically for soil application. There is no sludge treatment system, therefore, baseline methane emissions produced from sludge treatment and anaerobic decay of the final sludge ($BE_{s, treatment, y}$ and $BE_{s, final, y}$) were neglected from baseline emissions.

Baseline Emissions for AMS-I.D

Baseline emissions from electricity generation ($BE_{elec, y}$)

As per AMS-I. D. Paragraph 22, the baseline was the MWh produced by the renewable generating unit multiplied by an emission coefficient as follows:

$$BE_{elec, y} = EG_{PJ, y} \times EF_{grid, y} \quad (2)$$

Where:

BE_y Baseline emissions in year y (t CO₂)

$EG_{PJ, y}$ Quantity of net electricity generation that is produced and fed into the grid as a result of the implementation of the CDM project activity in year y (MWh)

$EF_{grid, y}$ Combined margin CO₂ emission factor for grid connected power generation in year y (t CO₂/MWh)

Since the calibration of the monitoring equipment for measuring the parameter $EG_{PJ, y}$ was not conducted in line with the registered monitoring plan and the record was not found, the data was excluded from the calculation of the baseline emission from electricity generation. This was conservative approach.

Therefore, $BE_y = BE_{elec, y} = 0$.

Baseline Emissions for AMS-I.C

Emissions from steam/heat displacement by the project activity ($BE_{heat, y}$)

According to Paragraph 34 of AMS I.C., the baseline emissions are estimated based on the amount of heat/steam delivered by the equipment (as per equation below).

$$BE_{\text{thermal},\text{CO}_2,y} = (EG_{\text{thermal},y} / \eta_{\text{BL},\text{thermal}}) * EF_{\text{CO}_2} \quad (3)$$

Where:

$EG_{\text{thermal},y}$ The net quantity of steam/heat supplied by the project activity during the year y (TJ)

$\eta_{\text{BL},\text{thermal}}$ The efficiency of the plant using fossil fuel that would have been used in the absence of the project activity.

EF_{CO_2} The CO₂ emission factor per unit of energy of the fuel that would have been used in the baseline plant in (tCO₂/TJ), obtained from reliable local or national data if available, otherwise, IPCC default emission factors are used.

However, the deviation explained in Section 3.2 took into account the baseline efficiencies and a simplified approach was explained to estimate the baseline emissions, the approach was based on historical consumption of fuel oil per ton of starch generation. The deviation addresses the coherence with Paragraph 24 (c) and 34 of the methodology. In addition, since the boiler no.1 was replaced and the thermal capacity was increased. Deviation 1 of the project description deviation provided in Section 3.2 was established based on conservative approach for the emission reduction of heat component. Thus, the following deviated equation was applied. It must be noted that the deviation did not only estimates the baseline emissions on the amount of heat/steam generated by the boiler, it also took into account CO₂ emissions from on-site consumption of fossil fuels due to the project activity. In other words, it represents the emission reduction from the heat generation component.

$$BE_{\text{thermal},\text{CO}_2,y} = (Q_{\text{starch}} * Q_{\text{FO},\text{starch}} * \%B2 - q_{\text{FO},y,\text{Boiler2}}) * D_{\text{FO}} * NCV_{\text{FO}} * EF_{\text{CO}_2} / 10^6 \quad (4)$$

Where:

$Q_{\text{starch},y}$ Quantity of dry starch produced in year y (tons)

$Q_{\text{FO},\text{starch}}$ Quantity of fossil fuel per unit of dry starch (liter/ton)

$q_{\text{FO},y,\text{boiler2}}$ Quantity of fossil fuel consumed by hot oil boiler no.2 in year y (liters)

D_{FO} Density of fossil fuel (kg/liter)

NCV_{FO} Net Calorific value of the fuel oil (TJ/ton)

$\%B2$ The percentage of thermal energy supplied from the boiler 2 from step 4 under section 3.2.2

During this monitoring period, additional approach based on the amount of biogas utilization has been compared with the historical consumption of fuel oil.

$$BE_{\text{thermal,CO2,y}} = BG_{\text{burnt, combusted,y}} * w_{\text{CH4}} * \rho_{\text{CH4}} * BE * NCV_{\text{biogas}} * EF_{\text{CO2}}/10^6 \quad (5)$$

Where:

$BG_{\text{burnt,combusted,y}}$ Biogas flared/combusted in year y (m³)

$w_{\text{CH4,y}}$ Methane content of the biogas in the year y (volume fraction)

ρ_{CH4} Density of methane at the temperature and pressure of the biogas in the year y (t/m³)

BE Boiler efficiency (%)

NCV_{biogas} Net Colorific Value of the biogas (TJ/tonne)

Table 1: Detail of baseline emissions calculation for the monitoring period 01/04/2021 to 31/10/2022

AMS-III.H		2nd CP - 2021	2nd CP - 2022
Parameter	Unit	01/04/2021 to 31/12/2021	01/01/2022 to 31/10/2022
COD Approach			
$Q_{\text{ww, y_lower value}}$	m ³	630,648	665,287
$COD_{\text{removed, i, lower}}$	tonnes/m ³	0.0406	0.0371
$MCF_{\text{ww,treatment, BL}}$	-	0.8	0.8
$B_{\text{o, ww}}$	kg _{COD} CH ₄ /kg	0.25	0.25
UF_{BL}	-	0.89	0.89
GWP_{CH4}	-	28.00	28.00

BE_{ww, treatment, y}	tCO₂e	127,551	123,043
BE _{power, y}	tCO ₂ e	0	0
BE _{s, treatment, y}	tCO ₂ e	0	0
BE _{ww, discharge, y}	tCO ₂ e	0	0
BE _{s, final, y}	tCO ₂ e	0	0
BE_{y, ex post}	tCO₂e	127,551	123,043

MD_y Approach	Unit	01/04/2021 to 31/12/2021	01/01/2022 to 31/10/2022
BG _{combusted, lower}	Nm ³	3,709,855.10	4,947,331.00
BG _{TOFlare, lower}	Nm ³	0	0
FE	-	0	0
DE	-	100%	100%
D _{CH4}	kg/m ³	0.72	0.72
W _{CH4-lower}	%	58%	62%
MD_y	tCO₂e	43,104	61,214

AMS-I.C		2nd CP - 2021	2nd CP - 2022
Parameter	Unit	01/04/2021 to 31/12/2021	01/01/2022 to 31/10/2022
Q _{starch, lower}	Tonnes	49,395	56,707
Q _{F0, starch}	liters	68,125	124,243

D _{F0}	kg/liter	0.93	0.93
NCV _{F0}	TJ/tonne	0.04	0.04
EF _{CO2}	t CO ₂ /TJ	39.60	39.60
Q _{F0,starch}	liters/ton	0.050	0.050
NCV _{biogas}	TJ/tonne	77.40	77.40
EG thermal _(historical data)	TJ	73.59	84.30
EG thermal _(biogas delivered)	TJ	69.28	98.38
BE thermal, CO₂, y	tCO₂e	5,361	6,525

NOTE: BE_{thermal, CO₂, y} = ER_{heat, y}

AMS-I.D		2nd CP - 2021	2nd CP - 2022
Parameter	Unit	01/04/2021 to 31/12/2021	01/01/2022 to 31/10/2022
EG _{PJ,y}	MWh	4,410	3,747
EF _y	tCO ₂ /MWh	0.56	0.56
BE gen, y	tCO₂e	2,485	2,111

NOTE: BE_{gen, y} = ER_{power, y}

$$PE_y = PE_{power,y} + PE_{ww,treatment,y} + PE_{s,treatment,y} + PE_{ww,discharge,y} + PE_{s,final,y} + PE_{fugitive,y} + PE_{biomass,y} + PE_{flaring,y} \quad (6)$$

Where:

PE_y	Project activity emissions in year y (tCO ₂ e)
$PE_{power,y}$	Emissions from electricity or fuel consumption in year y (tCO ₂ e)
$PE_{ww,treatment,y}$	Methane emissions from wastewater treatment systems affected by the project activity, and not equipped with biogas recovery, in year y (tCO ₂ e)
$PE_{s,treatment,y}$	Methane emissions from sludge treatment systems affected by the project activity, and not equipped with biogas recovery, in year y (tCO ₂ e)
$PE_{ww,discharge,y}$	Methane emissions from degradable organic carbon in treated wastewater in year y (tCO ₂ e)
$PE_{s,final,y}$	Methane emissions from anaerobic decay of the final sludge produced in year y (tCO ₂ e)
$PE_{fugitive,y}$	Methane emissions from biogas release in capture systems in year y (tCO ₂ e)
$PE_{biomass,y}$	Methane emissions due to incomplete flaring in year y (tCO ₂ e)
$PE_{flaring,y}$	Methane emissions from biomass stored under anaerobic conditions

$PE_{power,y}$:

Emissions from electricity consumption by the project activity facilities were calculated based on the Paragraph 26 of AMS-III.H., whereas $PE_{power,y}$ were estimated according to the “Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation”, version 03.0 as given below.

$$PE_{power,y} = \sum EC_{PJ,j,y} \times EF_{EL,j,y} \times (1 + TDL_{j,y})$$

Where:

$EC_{PJ,j,y}$	Electricity consumption by the project activity (MWh)
$EF_{EL,j,y}$	Thailand National Grid emission factor (tCO ₂ e/MWh)
$TDL_{j,y}$	Average technical transmission and distribution losses for providing electricity to source j in year y
j	Source of electricity consumption in the project

In the absence of an electric meter for the electricity consumption of the project activity, a maximum rated consumption was used to calculate the emissions from PE_{power} as follows:

$$PE_{power,y} = \sum P_{el} \times (100\% + TDL_{j,y}) \times 8,760 \times EF_{EL,j,y} / 1000$$

Where:

P_{el} Total electrical capacity of the equipments installed in the project activity (kW)
– for reference, this is 458 kW for this project activity.

Taking into account the distribution losses, 20% was applied to the total electricity consumption for the sake of simplicity and conservative. The calculated electricity consumption was based on an assumption that the electrical appliances were running for the entire monitoring period duration.

$PE_{ww,treatment,y}$:

Methane emissions from wastewater treatment systems affected by the project activity were calculated as per the Paragraph 27, AMS-III.H. The following equation was used.

$$PE_{ww,treatment,y} = \sum (Q_{ww,k,y} \times COD_{inflow,k,y} \times \eta_{PJ,k,y} \times MCF_{ww,treatment,PJ,k}) \times B_{o,ww} \times UF_{PJ} \times GWP_{CH4}$$

Where:

$Q_{ww,k,y}$	Volume of wastewater treated in a baseline wastewater treatment system k in year y (m ³)
$COD_{inflow,k,y}$	Chemical oxygen demand of the wastewater inflow to the project treatment system k in year y (t/m ³).
$\eta_{PJ,k,y}$	COD removal efficiency of the baseline treatment system k
$MCF_{ww,treatment,PJ,k}$	Methane correction factor for the project wastewater treatment systems k
k	Index for project wastewater treatment system
$B_{o,ww}$	Methane producing capacity of the wastewater (IPCC value of 0.25 kgCH ₄ /kg COD)
UF_{PJ}	Model correction factor to account for model uncertainties (1.12)
GWP_{CH4}	Global Warming Potential for methane

$PE_{s,treatment,y}$:

The project activity did not include sludge treatment system, therefore the emission from sludge treatment system were omitted.

$PE_{ww,discharge,y}$:

In the project activity, the treated wastewater was discharged in existing open lagoons and there was no discharge to a river, sea or lake. Hence, emissions from this component were included in the assessment.

$PE_{s,final,y}$:

During the monitoring period, in the project activity, the final sludge produced was not removed from the wastewater treatment system, therefore, $PE_{s,final,y} = 0$.

$PE_{fugitive,y}$:

Project activity emissions from methane release in capture systems were determined as per Paragraph 40 (a) of AMS-III.H., as given below.

$$PE_{fugitive,y} = PE_{fugitive,ww,y} + PE_{fugitive,s,y}$$

Where:

$PE_{fugitive,ww,y}$	Fugitive emissions through capture inefficiencies in the anaerobic wastewater treatment systems in the year y (t CO ₂ e)
$PE_{fugitive,s,y}$	Fugitive emissions through capture inefficiencies in the anaerobic sludge treatment systems in the year y (t CO ₂ e)

These emissions are calculated as follow:

$$PE_{fugitive,ww,y} = (1 - CFE_{ww}) \times MEP_{ww,treatment,y} \times GWP_{CH4}$$

Where:

CFE_{ww}	Capture efficiency of the biogas recovery equipment in the wastewater treatment systems (a default value of 0.9 shall be used)
$MEP_{ww,treatment,y}$	Methane emission potential of wastewater treatment systems equipped with biogas recovery system in year y (t)

$$MEP_{ww,treatment,y} = Q_{ww,y} \times B_{0,ww} \times UF_{PJ} \times \sum COD_{removed,PJ,k,y} \times MCF_{ww,treatment,PJ,k}$$

Where:

$COD_{removed,PJ,k,y}$	The chemical oxygen demand removed by the treatment system k of the project activity equipped with biogas recovery in the year y (t/m ³)
$MCF_{ww,treatment,PJ,k}$	Methane correction factor for the project wastewater treatment system k equipped with biogas recovery equipment
UF_{PJ}	Model correction factor to account for model uncertainties (1.12)

$PE_{fugitive,s,y}$:

There was no sludge treatment envisaged in the project activity, therefore, the emissions from sludge treatment was omitted.

$PE_{biomass,y}$:

Biomass storage was not envisaged in the project activity. Therefore, methane emissions from biomass stored under anaerobic conditions which did not take place in the baseline situation were omitted.

$PE_{flaring,y}$:

Methane emissions due to incomplete flaring in year y are calculated as per the “Tool to determine project emissions from flaring gases containing methane” (tCO₂e). During this monitoring period since the relevant parameters were not monitored and recorded properly, 0% of the flare efficiency was applied for the calculation of project emissions from flaring gases. However, there was no biogas flared during the monitoring period.

$$PE_{\text{flare},y} = GWP_{\text{CH}_4} * \sum_{m=1}^{525600} F_{\text{CH}_4,\text{RG},m} * (1 - \eta_{\text{flare},m}) * 10^{-3}$$

Where:

$PE_{\text{flare},y}$	Project emissions from flaring of the residual gas in year y (tCO ₂ e)
GWP_{CH_4}	Global warming potential of methane valid for the commitment period (tCO ₂ e/tCH ₄)
$F_{\text{CH}_4,\text{RG},m}$	Mass flow of methane in the residue gas in the minute m (kg)
$\eta_{\text{flare},m}$	Flare efficiency in minute m

Table2: Detail of project emissions calculation for the monitoring period 01/04/2021 to 31/10/2022

AMS-III.H		2nd CP - 2021	2nd CP - 2022
Parameter	Unit	01/04/2021 to 31/12/2021	01/01/2022 to 31/10/2022
EC _{PJ,y}	MWh	2,691	3,007
EF _y	t CO ₂ /MWh	0.564	0.564
PE_{power, y}	tCO₂e	1,517	1,696
Q _{ww, higher}	m ³	630,648	665,287
COD _{removed, PJ,lagoon,y}	tonne/m ³	0.00059	0.00036
MCF _{ww, treatment, PJ, k}	-	0.80	0.80
B _{o, ww}	kg CH ₄ /kg COD	0.25	0.25
UF _{PJ}	-	1.12	1.12
GWP _{CH4}	-	28.00	28.00
PE_{ww, treatment, y}	tCO₂e	2,324	1,521
COD _{removed, PJ,CL, higher}	tonne/m ³	0.0459	0.0421
MCF _{ww, treatment, PJ, CL}	-	0.80	0.80
MEP _{ww, treatment, higher}	tonnes	6,479	6,275
CFE _{ww}	-	0.90	0.90
PE _{fugitive, ww, y}	tCO ₂ e	18,142.33	17,570.69
PE _{fugitive, s, y}	tCO ₂ e	0	0
PE_{fugitive, y}	tCO₂e	18,143	17,571
Q _{biogas, flare, y = FV_{RG,h}}	Nm ³	0.00	0.00
f _{VCH4, RG,h = W_{CH4,higher}}	%	59%	63%
ρ _{CH4,n = D_{CH4}}	-	1.00	1.00
TM _{RG,h}	kg	-	-
η _{flare}	%	0.00	0.00
PE_{flaring, y}	tCO₂e	0.00	0.00
PE _{s, treatment, y}	tCO ₂ e	0	0
PE _{ww, discharge, y}	tCO ₂ e	0	0
PE _{s, final, y}	tCO ₂ e	0	0
PE _{biomass, y}	tCO ₂ e	0	0
PE_{y, ex post}	tCO₂e	21,984	20,788

AMS-I.C		2nd CP - 2021	2nd CP - 2022
Parameter	Unit	01/04/2021 to 31/12/2021	01/01/2022 to 31/10/2022
FC _{HFO}	ton/yr	63	116
NCV _{HFO}	TJ/tonne	0.0428	0.0428
EF _{HFO}	tCO ₂ e/TJ	77.40	77.40
PE_{FC,y}	tCO₂e	210	383

As per the paragraph 44 of AMS III.H version 19.0, paragraph 81 of AMS-I.C, version 21.0, and paragraph 43 of AMS-I.D, version 18, emission reduction achieved in this project activity using formulas mentioned in baseline, project & leakage emissions sections above. Emission reductions are calculated as follows;

$$ER_{y, \text{ex-post}} = BE_{y, \text{ex-post}} - (PE_{y, \text{ex-post}} + LE_{y, \text{ex-post}})$$

According to the equation above, the emission reduction as per the paragraph 44 of AMS III.H version 19.0, paragraph 81 of AMS-I.C, version 21.0, and paragraph 43 of AMS-I.D, version 18 achieved on any year are as following;

Parameter	Details	Quantification
ER _{y, ex-post}	Emission reductions achieved by the project activity based on monitored values for year y (tCO ₂ e)	For AMS-III.H COD approach AMS-I.D& AMS-I.C 01-April-2021 to 31-December-2021 = 113,203 01-January-2022 to 31-October-2022 = 110,508 For AMS-III.H MD approach AMS-I.D& AMS-I.C 01-April-2021 to 31-December= 49,223 01-January-2022 to 31-October-2022= 67,771
BE _{y, ex-post}	Baseline emissions calculated based on monitored values of each methodology BE _y (AMS-I.C.), BE _y (AMS-I.D.), & BE _y (AMS-III.H COD approach)	AMS-I.D 01-April-2021 to 31-December= 2,485 01-January-2022 to 31-October-2022=2,111 AMS-I.C 01-April-2021 to 31-December= 5,361 01-January-2022 to 31-October-2022= 6,525 AMS-III.H (COD approach) 01-April-2021 to 31-December= 127,551 01-January-2022 to 31-October-2022=123,043
BE - MD _y approach	Methane captured and destroyed/gainfully used by the project activity in the year y BE _y (AMS-III.H MD _y approach)	01-April-2021 to 31-December= 43,104 01-January-2022 to 31-October-2022= 61,214
PE _{y, ex-post}	Project emissions calculated as per paragraph ex post monitored values	For AMS-III.H COD approach AMS-I.D& AMS-I.C 01-April-2021 to 31-December= 22,194 01-January-2022 to 31-October-2022= 21,171 For AMS-III.H MD_y approach AMS-I.D& AMS-I.C 01-April-2021 to 31-December= 1,727 01-January-2022 to 31-October-2022= 2,079

Comparing the result of the emission reduction calculation as per requirement of AMS-III.H paragraph 45 is as follows.

- ER achieved from AMS-III.H COD approach is equal to 105,567 tCO₂e in 2021 and 102,255 tCO₂e in 2022.
- ER achieved from AMS-III.H MD approach is equal to 41,758 tCO₂e in 2021 and 59,518 tCO₂e in 2022.

The most conservative value of the ER under AMS-III.H is based on MD approach for both monitoring periods. Furthermore, the PP has considered the maximum limit of emission reduction under applied methodology AMS-III.H as 60,000 tCO₂e/year allowed, In calendar year of last monitoring period from 01/01/2021 to 31/03/2021, the PP has already claimed 24,339 tCO₂e. Therefore, for period of 01/04/2021 to 31/12/2021, the PP has capped at 60,000 – 24,339 = 35,661 tCO₂e as per small-scale methodology. For year 2022 (from 01/01/2022 to 31/10/2022) shall also capped at 50,000 tCO₂e proportional to the maximum ER of 60,000 tCO₂e per year. Therefore, the annual cap for small-scale methodologies, ER from AMS-III.H during 2021-01-01 to 2021-04-30 and 2022-01-01 to 2022-10-31 shall be revised to 35,661 tCO₂e and 50,000 tCO₂e respectively. Then the revised values are added with the emission reduction achieved under AMS-I.C and AMS-I.D which could be outlined as follow; 7,636 tCO₂e in 2021 and 8,253 tCO₂e in 2022. The total emission reduction project claims during this monitoring period; 01-April-2021 to 31-October-2022, is **101,550 tCO₂e**.

CL 01 and CAR 01 was raised during the verification process and closed successfully. Please refer Appendix 2 of this report for the detail closure of the CAR

4.5 Quality of Evidence to Determine GHG Emission Reductions and Removals

Verification team has checked the calibration certificates^{/5/} and confirmed that meters used to monitor the parameter, meters are found calibrated as per calibration frequency. No delayed calibrations were observed. All the meters are of accuracy class as per the requirement of the registered PD. The same is checked during on-site visit and calibration certificates^{/5/}.

Project activity is in continuous operation no major breakdown was found during the current monitoring period. No unforced error was observed. No sampling procedure applied for monitoring of the data parameter and entire documents were checked by the assessment team to arrive at positive verification conclusions. The monitoring plan is followed at the project site.

The meters were calibrated by third party entity to carry out the testing of the meters which is as per the host country regulation and thus traceability of the Calibration is also confirmed by the verification team. There is no delay in calibration of meters. Thus, verification team concluded that the evidences are sufficient in quantity, and appropriate for the quality, to determine the GHG reductions and removals.

VVB team verified that, CAR 01 was raised and closed successfully, kindly refer appendix 4 for further clarification.

4.6 Non-Permanence Risk Analysis

No.	Risk that could lead to material errors, omissions or misstatements	Assessment of the risk		Response to the risk in the verification plan and/or sampling plan
		Risk level	Justification	
NA	NA	NA	NA	NA

5 VERIFICATION OPINION

Applus+ Certification has been engaged by Kean Chareon Co., Ltd. to perform the 4th verification of the “Chol Charoen Group Wastewater Treatment with Biogas System I (Khonkaen)”.

The project participants are responsible for the preparation of the GHG emissions data and the reported GHG emissions reductions on the basis set out within the project’s monitoring plan in the registered VCS PD/^{4/} and the applied methodology AMS-III.H. version 19/^{17/}, AMS-I.C. version 21/^{17/}, AMS I.D. Version 18/^{17/}.

Our verification approach was based on the requirements as defined under the Kyoto Protocol, Marrakesh accord, as well as those defined by the CDM Executive Board. Our approach is risk-based, drawing on an understanding of the risks associated with reporting GHG emissions data and the controls in place to mitigate these. Further, the verification has been planned and organized to achieve a Reasonable Level of assurance as per the requirement of VCS. No sampling procedure applied for document verifications. The entire documents checked/Power plant verification conducted to arrive at positive verification conclusions. The verification team can confirm that:

- the project is operated as planned and described in the project document;
- the monitoring plan is as per the applied methodology/^{17/};
- the monitoring process in Monitoring Report is as per the VCS PD/^{4/}
- the development and maintenance of records and reporting procedures are in accordance with the monitoring plan;
- the installed equipment being essential for generating emission reduction runs reliably and is calibrated appropriately;
- the monitoring system is in place and generates GHG emission reductions data;
- the GHG emission reductions are calculated without material misstatements.
- A Reasonable Level of assurance was achieved as planned, during verification process.
- Project has been implemented in accordance with the project description and subsequently validated variations

Verification period: 01-April-2021 to 31-October-2022 (inclusive of both days)

Verified GHG emission reductions and removals in the above verification period, broken down by calendar year:

Year	Estimated emission reduction as per the PD (tCO ₂ e)	Baseline emissions or removals (tCO ₂ e)	Project emissions or removals (tCO ₂ e)	Leakage emissions (tCO ₂ e)	Net GHG emission reductions or removals (tCO ₂ e)
2021(01-April-2021 to 31-December--2020	14,555	50,950	1,727	0	49,223 (capped at 43,297)
2022 (01-January-2022 to 31-October-2022)	16,090	69,850	2,079	0	67,771 (capped at 58,253)
Total	30,645	120,800	3,806	0	116,994 (capped at 101,550)

Estimated ex-ante GHG emission reductions and removals and the achieved emission reductions and removals for this monitoring period:

Year	Ex-ante emissions reductions/ removals	Achieved emissions reductions/ removals	Percent difference	Justification for the difference
2021 (01-April-2021– 31-December-2021	14,555	43,297	197.47%	The quantified emission reduction calculation for the monitoring period is correct and conservative. Assessment team also compared actual VER with the estimated VER and found that the actual VCUs is 101,550 tCO ₂ e which is 231.37% higher than the estimated emission reductions 30,645 tCO ₂ e during this monitoring period due to the actual emission reductions during this monitoring period was higher than the ex-ante figure. The justification has been provided as follows. When comparing the actual monitored data with the ex-ante figures, it was found that COD load is higher than the estimation resulting in higher biogas generation. The justification for the increase may come from the higher availability of cassava roots which subjects to seasonal variations. At the time of the PD development and validation, conservative values were used and verified by the validating
2022 (01-January-2022 to 31-October-2022)	16,090	58,253	262.04%	

				VVB. The higher emission reduction achieved during this monitoring period is not permanent. It may happen that due to the variation in the raw material, the project may achieve lower emission reduction in the future. Thus, acceptable to VVB.
<i>Total</i>	30,645	101,550	+231.37%	-

APPENDIX 1: DOCUMENTS REVIEWED OR REFERENCED (VERIFICATION)

No.	Author	Title	References to the document	Provider
1.	Kean Chareon Co.	Commissioning Certificate of project	-	Project Participant
2.	Kean Chareon Co.	Contract of the project participant with the VVB	Contract document signed between PP and VVB	Project Participant
3.	Kean Chareon Co.	The operational lifetime of the project activity from the manufacturer = (Technical specifications) SCHERRER INDUSTRIES: Technical Specifications of Boiler 1 & Boiler 2	Manufacturer technical specifications	Project Participant
4.	Kean Chareon Co.	VCS PD Verra Search Page https://registry.verra.org/app/projectDetail/VCS/427	NA	Project Participant
5.	Kean Chareon Co.	Calibration Certificates of Wastewater Flow meter Spectrophotometer Biogas flow meter Weighing scale Portable gas analyser	-	Project Participant
6.	Kean Chareon Co.	MR version 01(Initial) MR version 02 MR version 02.1 MR version 02.3 (Final)	31-January-2023 26-October-2023 06-December-2023 07-June-2024	Project Participant
7.	Kean Chareon Co.	Emission reduction sheet version 01 Emission reduction sheet version 02 Emission reduction sheet version 03	31-January-2023 18-October-2023 07-June-2024	Project Participant
8.	Kean Chareon Co.	O & M Agreement (Amended)	-	Project Participant
9.	Kean Chareon Co.	Provincial Electricity Authority (PEA): Power purchase agreement between Kean Charoen Co. Ltd. and PEA for power purchase from renewable energy (biogas based electricity)	dated 20/02/2009	Project Participant
10.	VERRA	Tools/ guidelines used in the project activity • VCS standard V.4.4 • VCS Program Guide V.4.3	VCS web site	VERRA

No.	Author	Title	References to the document	Provider
11.	Kean Chareon Co.	Daily monitoring log sheets by Kean Chareon Co., Ltd: a) Wastewater flow meter readings b) Methane content c) COD measurement of wastewater d) Biogas consumption in boiler e) Biogas consumption in generator f) Biogas consumption for flare g) Quantity of starch produced h) Quantity of furnace oil consumed	01-April-2019 to 31-Oct-2022	Project Participant
12.	Kean Chareon Co.	Declaration regarding no participation in other GHG program for the concerned monitoring period	-	Project Participant
13.	Kean Chareon Co.	Breakdown details for the monitoring period	-	Project Participant
14.	Kean Chareon Co.	Employment records for plant persons	-	Project Participant
15.	Kean Chareon Co.	Grievance Register maintained at site	-	Project Participant
16.	UNFCCC	CDM validation and verification standard for project activities, Version 03.0	-	UNFCCC
17.	UNFCCC	Applied Methodology • AMS-I.D version 14” • AMS-III.H version 13 • “AMS-I.C version 15”	-	UNFCCC
18.	Applus	Onsite photographs	-	VVB

APPENDIX 2: CORRECTIVE ACTION REQUESTS, CLARIFICATION REQUESTS AND FORWARD ACTION REQUESTS (CAR/CL/FAR)

Table 3. Remaining FAR from validation and/or previous verification

FAR ID	N/A	Section no.	N/A	Date : N/A
Description of FAR				
NA.				
Project participant response				Date :DD-Month-YYYY
N/A				
Documentation provided by project participant				
N/A				
VVB assessment				Date: DD-Month-YYYY
N/A				

Table 4. CL from this verification

CL ID	01	Section no.	MR	Date :12/02/2023
Description of CL				
- The PP is requested to provide Declaration confirming project registered under other GHG schemes along with there would not be double counting of credits. - PP requested to submit supporting company policies/CSR documents for Elimination of All Forms of Discrimination against Women. - Supporting documents: - No. of trainings provided to the employees; technical & soft skills - Employment generated due to project activity - The employment records/Salary slips - Records of hazardous waste inventory & disposal(if any) - Project Grievance register/ Or supporting documents for ongoing communication with the local stakeholder - PP shall provide copy of HR and HSE Policy of the company.				
Project participant response				Date:18/10/2023
- The required documents are provided as stated below - The PP has no written policy regarding Elimination of All Forms of Discrimination against Women. However, the employment record shows significant percentage of female employees in the project, which suggests that there is no discrimination against women by the project. - The required documents are provided as stated below				

Documentation provided by project participant	
1. Declaration letter on no double counting for the project 2. Employment records 3. Documents as follows: 3.1. Training Documents 3.2. Employment Records 3.3. Project Grievance register 3.4. Company's HR and HSE Policy Documents	
VVB assessment	Date: 26/10/2023
1. PP submit the declaration regarding no double accounting to the VVB team and it is found consistent and thus accepted by VVB team. 2. PP submit company policies/CSR documents. 3. Project proponent had submitted the following documents: - • PP submit the trainings records to the VVB team. • Evidence has submitted the employment evidences for current monitoring period. • VVB conform that, PP has submitted the employment records/Salary slips for current verification period. • PP has submitted the records of hazardous waste inventory. • PP submit the grievance register to verify any complaint records by the employee or stakeholder if they have, VVB team verified that, there is no complaint found, thus found grievance register error free. • PP submit the HR & HSE policy of the company to the verification team. CL 01 is closed.	

Table 3. CAR from this verification

CAR ID	01	Section no.	MR	Date : 12/02/2023
Description of CAR				
• GWPC₄ value is considered as 28 tCO₂e/CH₄ in MR and ER sheet whereas the same is mentioned as 25 tCO₂e/CH₄ in registered PDD version 02 dated 23/11/2017; please clarify this deviation in applied value in MR? • The denotation/nomenclature of parameters "MCF_{ww}, treatment, BL, Lagoon" , EFHFO, CO₂ , NCVHFO and DCH₄ is not correctly mentioned in ER sheet. Please clarify? • Why value of parameter Q_{ww}, y mentioned lower and higher value in ER sheet and how this is in line with monitoring plan? • COD_{out}, CL₂, y for date 30-Oct-2022 and 31-Oct-2022 is not correct in ER sheet as per record verified at logbook during site visit, please clarify? • OM₂ (qFO, y) value of 16-Dec-2021 to 17-Dec-2021 is not correct in ER sheet as per record verified at logbook during site visit, please clarify? • The value of EG_y for 27-Aug-2022 to 29-Aug-2022 is not correct in ER sheet as per record verified at logbook during site visit, please clarify? • All value of W CH₄B₂ is not correct in ER sheet as per record verified at logbook during site visit, please clarify? • All value of Q_{starch}, y is not correct in ER sheet as per record verified at logbook during site visit, please clarify? • The PP is requested to provide Emission Reduction Calculation sheet corresponding to the MR. • The PP has not reported all parameters are reported frequency defined in updated PDD, please clarify? •				

Project participant response	Date:DD/MM/YYYY
1. According to VCS Standard V4.4, published on December 21, 2021, Clause 3.15.4 has stated that Projects that complete validation on or before 31 July 2021 may use GWP values from AR4 for ex-ante emission reduction estimates, though such projects shall use GWP values from AR5 for ex-post calculations. Therefore, we have used GWP of 28 in this monitoring report. 2. The denotation/nomenclature of the identified parameters has been updated in the ER sheet to be consistent with the PDD. 3. The higher and lower values of the Qww,y are the values that apply meter accuracy percentage in case there is a calibration gap to ensure the emission reduction is conservatively calculated. During this monitoring period, the flow meter was timely calibrated as per the plan; hence, there was no need to apply the meter accuracy percentage to the Qww,y values. This is why Qww,y (higher) and Qww,y(lower) values are the same. 4. CODout,CL2,y value for 31-Oct-2022 was a typo. CODout,CL2,y 30-Oct-2022 was not used for calculation and was recorded in the ER sheet as "No starch production" since there was no starch production on that date. The ER sheet has been revised to correct the CODout,CL2,y value for 31-Oct-2022. 5. OM2 (qFO,y) values for 16-Dec-2021 and 17-Dec-2021 were typos. The ER sheet has been revised to correct the qFO,y values for 16-Dec-2021 and 17-Dec-2021 6. EGy values from 27-Aug-2022 to 29-Aug-2022 were typos. The values entered in ER sheet actually belong to values for 27-Oct-2022 to 29-Oct-2022. The ER sheet has been revised to correct EGy values on the aforementioned dates. 7. W CH4B2 values from 2-Jun-2022 to 31-Oct-2022 were rounded to integers. The ER sheet has been revised to replace rounded values with actual values according to the logbook. 8. Qstarch,y values from 1-Mar-2022 to 31-Oct-2022 were rounded to integers. The ER sheet has been revised to replace rounded values with actual values according to the logbook. 9. The Emission Reduction sheet has been updated to incorporate all of the above findings. 10. All monitored data/parameters are reported with the frequency as defined in the updated PDD. The monitored data/parameters are summarized in section 4.2 'Data and Parameters Monitored' of the revised Monitoring Report and are also present in the revised ER Calculation Sheet.	
Documentation provided by project participant	
11. Revised Emission Reduction Calculation Sheet 12. Revised Monitoring Report	
VVB assessment	Date: 26/10/2023

1. VVB team verified, as per VCS Standard V4.4, published on December 21, 2021, Clause 3.15.4 PP used GWP of 28 in this monitoring report.
2. PP has updated the denotation/nomenclature of the identified parameters has been updated in the ER sheet and VVB team found it consistent.
3. VVB team conform that, during current monitoring period, the flow meter was timely calibrated as per the plan; and there was no need to apply the meter accuracy percentage to the Q_{ww,y} values. This is why Q_{ww,y} (higher) and Q_{ww,y}(lower) values are the same, and found it consistent.
4. VVB team found that, ER sheet has been revised and value of the COD_{out,CL2,y} value has been updated for 31-Oct-2022.
5. VVB team verified that, PP has updated the ER sheet the value of q_{FO,y} has been updated in monitoring report and emission reduction sheet.
6. E_{Gy} values updated in ER sheet and VVB team found it consistent and error free. Thus, accepted by VVB team.
7. W CH₄B₂ values has been updated and value is round up in emission reduction sheet. ER sheet has been revised according to the logbook.
8. Q_{starch,y} values were rounded. ER sheet has been updating the rounded values with actual values according to the logbook.
9. The Emission Reduction sheet has been updated to incorporate all of the above findings.
10. VVB team verified that, monitored parameters are summarized in section 4.2 'revised Monitoring Report, VVB team verified that, it is found consistent and accepted by VVB team same is reflecting in section 4.4 of the verification report and also find in the revised ER Calculation Sheet, it is found it error free.

Thus, CAR is closed.

Table 4. FAR from this verification

FAR ID	N/A	Section No.	N/A	Date: N/A
Description of FAR				
N/A				
Project participant response				Date:DD-Month-YYYY
N/A				
Documentation provided by project participant				
N/A				
VVB assessment				Date:DD-Month-YYYY
N/A				

APPENDIX 3: COMPETENCE OF TEAM MEMBERS AND TECHNICAL REVIEWERS

According to the sectoral scope / technical area and experience in the sectoral or national business environment, Applus+ Certification has composed a project assessment team in accordance with the appointment rules in the internal Quality Management System of Applus+ Certification.

The composition of audit team shall be approved by the Applus+ Certification ensuring that the required skills are covered by the team.

The four qualification levels for team members that are assigned by formal appointment rules are as presented below:

- Lead Auditor (LA).
- Auditor (A) / Auditor in Training (AiT).
- Technical Expert (TE).
- Technical Reviewer (TR).

The sectoral scope / technical area knowledge linked to the applied methodology/ies shall be covered by the assessment team.

Name	Qualification	Coverage of scope	Coverage of technical Area	Financial aspect	Host country Experience	Attendance to the On-Site Assessment
Vivek Kumar Ahirwar	Lead Auditor (LA) & Technical Expert (TE)	Yes (3)	Yes (3.1)	N/A	Yes	Yes
Simon Shen	Technical Reviewer (TR)	Yes (3)	Yes (3.1)	N/A	N/A	N/A

The curriculum vitae of the DOE's team members are provided below:

Vivek Kumar Ahirwar is a BEE-Certified Energy Auditor by Govt of India with over eight years of relevant experience in energy efficiency, energy audit, thermal and electrical energy generation technology from renewable source and energy conservation in energy intensive industries, designated consumers and commercial buildings, implementation of energy conservation building codes, research, process and green building projects. He is a certified lead auditor for ISO 14001 EMS and 14064. He has experience under various categories of projects stating from renewable to waste to supercritical projects and WCD. He has successfully audited more than 100 GHG (CDM/VCS/GS) projects in different states across the India. He has done Master in Technology (Energy Management) from a premier institute, School of Energy& Environmental Studies, DAVV, Indore (M.P.), India and Bachelor of Engineering (Mechanical Engineering) from Govt. Engineering college, Rewa, RGPV, India.

Simon Shen (Master Degree in Thermal Energy Engineering, Bachelor Degree in Environmental Engineering) is a Lead Auditor appointed by Applus+ LGAI for the GHG project assessment. He is based in Shanghai. He has several years of work experience in environmental protection field. Before he joined Applus+ LGAI, he had been worked for TÜV SÜD as a GHG Validator/Verifier and ISO 9001/14001 Lead Auditor for 3.5 years.

APPENDIX 4: ABBREVIATIONS

Abbreviations	Full texts
BM	Build Margin
CAR	Corrective Action Request
CDM	Clean Development Mechanism
CER	Certified Emission Reduction(s)
CEA	Central Electricity Authority
CL	Clarification request
CM	Combined Margin
CMS	Central Monitoring system
CO ₂	Carbon dioxide
CO ₂ e	Carbon dioxide equivalent
DNA	Designated National Authority
DR	Document Review
EF	Emission Factor
EIA	Environmental Impact Assessment
ER	Emission Reductions
FAR	Forward Action Request
GHG	Greenhouse gas(es)
GWP	Global Warming potential
PP	Project Participant