



**Verified Carbon
Standard**

VALIDATION REPORT THE RENEWAL OF THE CREDITING PERIOD

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



Document Prepared by Carbon Check India Pvt. Ltd.

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Report Title	Validation report the Renewal of the crediting period 'Chol Charoen Group Wastewater Treatment With Biogas System I (Khonkaen)'
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Summary:

Carbon Check (India) Pvt. Ltd., has been appointed by South Pole Carbon Asset Management Ltd., to validate the renewal of the crediting period of the project “Chol Charoen Group Wastewater Treatment With Biogas System I (Khonkaen)” in Thailand, with regard to the relevant requirements for VCS activities. The project activity involves installation and operation of a methane recovery and utilization system (two anaerobic covered lagoon facility (converted from open lagoon) wastewater treatment facility at Kean Charoen Co. Ltd. The system is in operation since 2nd October 2006. The treatment system generates and recovers biogas for energy generation purposes, avoiding methane emissions to the atmosphere.

The objective of the validation is to have an independent evaluation of a project activity by an accredited validation entity against the requirements of the VCS standard version 4.0 and GHG program applied, on the basis of the project design document. The validation scope is to review the VCS PD against VCS Version 4.0 requirements.

Validation was conducted using Carbon Check procedures in line with the requirements specified in the VCS standard version 4.0, CDM M&P, the latest version of the CDM Validation and Verification Standard, and relevant decisions of the COP/MOP and the CDM EB and applying standard auditing techniques. The validation consisted of desk review, off-site assessment and the resolution of outstanding issues and the issuance of the final validation report.

During this validation, 01 Corrective Action Request (CAR) and 3 Clarification Requests (CLs) were identified related to operation, GHG emission reduction estimation, monitoring and baseline scenario of the VCS project activity in relation to all relevant VCS requirements for the project activity and the applied baseline and monitoring methodology, and these CARs and CLs are successfully closed after necessary corrections/clarifications by the client. The same has been discussed in Appendix B of this verification report.

In conclusion, it is Carbon Check's opinion that the project activity “Chol Charoen Group Wastewater Treatment With Biogas System I (Khonkaen)” in Thailand, VCS project ID 427, as described in the VCS-PD version 3 of 14/05/2020, meets all relevant requirements for VCS activities and all relevant host Party criteria and correctly applies the baseline and monitoring methodology “AMS-III.H, ‘Methane Recovery in Wastewater Treatment’”, version 19.0, AMS-I.C, ‘Thermal energy for user with or without electricity’ version 21 and AMS-I.D ‘Grid connected renewable electricity generation’ version 18.

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1 INTRODUCTION

1.1 Objective

South Pole Carbon Asset Management Ltd. has appointed the VVB Carbon Check (India) Pvt. Ltd., (hereafter referred as CCIPL) to carry out the validation of renewal of crediting period of the project "Chol Charoen Group Wastewater Treatment With Biogas System I (Khonkaen)" project in Thailand.

This report summarizes the findings of the validation of the project, performed on the basis of VCS Requirements and UNFCCC criteria for applied methodology, tools, as well as criteria given to provide for consistent project operations, monitoring and reporting.

The objective of the validation is to have an independent evaluation of a project activity by an accredited validation/verification entity against the requirements of the VCS Version 4.0 and GHG program applied, on the basis of the project design document. In particular, the validity of project's baseline and regulatory surplus are validated in order to confirm the compliance as outlined under paragraph 3.8.9 of VCS standard version 4.0. Validation is a requirement for all VCS projects and is seen as necessary to provide assurance to stakeholders of the quality of the project and its intended generation of Voluntary Carbon Units (VCUs).

1.2 Scope and Criteria

The validation scope is to review the VCS PD against the UNFCCC criteria for CDM and VCS Version 4.0 Requirements.

Validity of the original baseline scenario reviewing the following criteria:

- Evaluation of the impact of new relevant national and/or sectoral policies and circumstances on the validity of the baseline scenario.
- Assessment of the GHG emissions associated with original baseline scenario using the latest version of the CDM Tool to assess the validity of the original/current baseline.
- If the original baseline scenario is no longer valid, whether current baseline scenario is established in accordance with the VCS rules.
- The project description, containing updated information with respect to the baseline, the estimated GHG emission reductions or removals and the monitoring plan, submitted for validation is based upon the latest approved

version of the methodology or its replacement. Where the project does not meet the requirements of the latest approved version of the methodology or its replacement, the project proponent shall select another applicable approved methodology (which may be a new methodology or methodology revision it has had approved via the methodology approval process), or shall apply a methodology deviation (where a methodology deviation is appropriate). Failing this, the project shall not be eligible for renewal of its project crediting period.

UNFCCC criteria for CDM refer to Article 12 of the Kyoto Protocol, the CDM modalities and procedures, the procedures for registration of program of activity as a single CDM and the subsequent decisions by the CDM Executive Board.

Validation is not meant to provide any consultancy towards the project participants. However, stated requests for clarifications and/or corrective actions may have provided input for improvement of the project design.

1.3 Level of Assurance

All the revisions of the validation report before being submitted to the client were subjected to an independent internal technical review to confirm that all validation activities had been completed according to the pertinent Carbon Check instructions, with **reasonable level of assurance**.

The technical review performed by a technical reviewer(s) qualified in accordance with Carbon Check's qualification scheme VCS VER validation and verification. The validation team and the technical reviewers consist of the following personnel:

Role/Qualification	Last Name	First Name	Country
VCS Team Leader & Technical Expert (TA 13.1, TA 1.1, TA 1.2)	Buragohain	Champok	India
Technical Reviewer	Anand	Amit	India

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 facility (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 28°C, 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 MW_{th} and 6.16 MW_{th} (Prior to the year 2020, the existing boiler of 3.78 MW_{th} 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 kW_e 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 first crediting period from 15/07/2009 to 14/07/2019.

2 VALIDATION PROCESS

2.1 Method and Criteria

Validation was conducted using Carbon Check procedures in line with the VCS Version 4.0 requirements and the requirements specified in the CDM M&P, the latest version of the CDM Validation and Verification Standard, and relevant decisions of the COP/MOP and the CDM EB and applying standard auditing techniques.

The validation consisted of the following three phases:

- Document review;
- Off-site assessment through interview and video calling;
- The resolution of outstanding issues and the issuance of the final validation report and certification.

2.2 Document Review

The validation is performed primarily as a document review of the registered VCS PD /01/, the updated VCS PD version 01 of 16/03/2020, version 02 of 01/04/2020 and version 03 of 14/05/2020 /02/, in particular the applicability of the methodology, the baseline determination, the additionality of the project activity, the monitoring plan, the emission reduction calculations provided in the form of a spreadsheet "VCS427_Chol Charoen I (Khon Kaen)_Ex ante ER_CP2_v1_16032020" of 16/03/2020, 'VCS427_Chol Charoen I (Khon Kaen)_Ex ante ER_CP2_v2_01042020' of 01/04/2020 and version 03 'VCS427_Chol Charoen I (Khon Kaen)_Ex ante ER_CP2_v3_14052020' of 14/05/2020 /03/, were assessed as part of the validation. In addition, the validation report applicable for the first crediting period /14/, previous verification report /15/ were reviewed.

The following table lists the documentation that was reviewed during the validation:

Ref. No.	Reference Documents
/1/	South Pole Carbon Asset Management Ltd.: Registered VCS PD for "Chol Charoen Group Wastewater Treatment With Biogas System I (Khonkaen)" in Thailand, version 3.1 of 13/11/2009
/2/	South Pole Carbon Asset Management Ltd.: Updated VCS PD for "Chol Charoen Group Wastewater Treatment With Biogas System I (Khonkaen)" in Thailand, version 01 of 16/03/2020, version 02 of 01/04/2020, version 03 of 14/05/2020
/3/	South Pole Carbon Asset Management Ltd: Emission reduction calculation Spreadsheet "VCS427_Chol Charoen I (Khon Kaen)_Ex ante

	ER_CP2_v1_16032020", version 01 of 16/03/2020, version 02 (VCS427_Chol Charoen I (Khon Kaen)_Ex ante ER_CP2_v2_01042020) of 01/04/2020 and version 03 (VCS427_Chol Charoen I (Khon Kaen)_Ex ante ER_CP2_v3_14052020) of 14/05/2020
/4/	VCS Verified Carbon Standard: VCS Program Guide, VCS Version 4.0 of 19/09/2019
/5/	VCS Verified Carbon Standard: VCS Standard, VCS Version 4.0 of 19/09/2019
/6/	VCS Verified Carbon Standard: VCS Validation Report Template VCS Version 4.0 of 19/09/2019
/7/	VCS Verified Carbon Standard: VCS Project Description Template VCS Version 4.0 of 19/09/2019
/8/	VCS Verified Carbon Standard: VCS Validation and Verification Manual VCS Version 3.2 of 19/10/2016
/9/	CDM Executive Board: Clean Development Mechanism Project Standard for project activities, version 02 of 29/11/2018
/10/	CDM Executive Board: Clean Development Mechanism Validation and Verification Standard for project activities, version 02 of 29/11/2018
/11/	CDM Executive Board: Small-scale Methodology; AMS-III.H: Methane recovery in wastewater treatment, Version 19.0 of 14/06/2019
/12/	CDM Executive Board: Small-scale Methodology AMS-I.C 'Thermal energy production with or without electricity', Version 21.0 of 14/06/2019
/13/	CDM Executive Board: Small-scale Methodology AMS-I.D 'Grid connected renewable electricity generation', Version 18.0 of 28/11/2014
/14/	TUV Nord: Validation report for 'Chol Charoen Group Wastewater Treatment With Biogas System I (Khonkaen)' in Thailand (Report no: 53208409-09/309), dated 17/11/2009
/15/	KBS: Verification report (VCS.19.VER.002) for the project Chol Charoen Group Wastewater Treatment With Biogas System I (Khonkaen) covering monitoring period 12/05/2016 to 31/12/2018 dated 12/06/2019
/16/	VCS Board: VCS webpage for the project 'Chol Charoen Group Wastewater Treatment With Biogas System I (Khonkaen)' Website https://www.vcsprojectdatabase.org/#/project_details/427 in English language retrieved on 19/03/2020
/17/	Website: https://registry.goldstandard.org/projects?q=&page=1 Argument: Gold Standard Registry Language: English, Retrieved on: 19/03/2020
/18/	Website: http://cdm.unfccc.int/Projects/projsearch.html Argument: UNFCCC CDM project search Language: English, retrieved on 19/03/2020
/19/	GUASCOR S.A: Technical Specifications of Generator 1 & Generator 2
/20/	Industrial Ministry: Operational license issued to Kean Charoen Co. Ltd. for starch production valid until 01/01/2024

/21/	Agreement between Kean Charoen Co. Ltd. and South Pole Carbon Asset Management Ltd. dated 14 March 2008
/22/	SCHERRER INDUSTRIES: Technical Specifications of Boiler 1 & Boiler 2
/23/	Ministry of Industry: Factory Act B.E. 2535 "Notification of Ministry of Industry regarding Industrial Effluent Standards B.E. 2560"
/24/	Kean Charoen Co. Ltd.: Operational manual of two wastewater treatment system dated 01/12/2008
/25/	CDM Executive Board: Methodological Tool: Assessment of the validity of the original/current baseline and update of the baseline at the renewal of the crediting period, version 03.0.1
/26/	Ministry of Natural Resources and Environment: Thailand Grid Emission Factor for GHG Reduction Project/Activity announced on 28/09/2007
/27/	UNFCCC: Methodological tool "project emissions from flaring" version 03
/28/	UNFCCC: CDM Executive Board agrees to relax mandatory site visits by DOEs for a period of three months (23 March to 23 June 2020) because of COVID-19; Website 'https://cdm.unfccc.int/newsroom/latestnews/releases/2020/01041_index.html' in English language retrieved on 03/04/2020
/29/	South Pole Carbon Asset Management Ltd.: E-mail communicated between South Pole Carbon Asset Management Ltd. and VERRA regarding site visit exclusion due to COVID-19 impact dated 31/03/2020
/30/	Provincial Electricity Authority (PEA): Power purchase agreement between Kean Charoen Co. Ltd. and PEA dated 20/02/2009 for power purchase from renewable energy (biogas based electricity)
/31/	Chaowanee Thai Biogas Limited Partnership: Confirmation letter on life of wastewater treatment system and biogas utilization dated 04/04/2020

2.3 Interviews

The key personnel interviewed and the main topics of the interviews are summarized in the table below:

	Date	Name and Role	Organization	Topic
/a/	15/04/2020	Ms. Suwipa Rukwongtrakool - Project Manager	South Pole Carbon Asset Management Ltd.	Updated VCS PD, emission reduction calculations, monitoring plan, VCS rules, application of methodology etc.
/b/	15/04/2020	Preecha Suwannasim, Factory Manager	Kean Charoen Co.,Ltd.	General information of project implementation
/c/	15/04/2020	Kwanruean Somchob, Head of	Kean Charoen Co.,Ltd.	Biogas operation, monitoring data

		Biogas Department		management, calibration procedures, quality management, training
/d/	15/04/2020	Tanachai Nontarat, Operator of Biogas Department	Kean Charoen Co.,Ltd.	Data recording, wastewater analysis, biogas system check and maintenance
/e/	15/04/2020	Ubon Chaibon, Operator of Power Department	Kean Charoen Co.,Ltd.	Data recording, power generation system check and maintenance

2.4 Site Inspections

Site visit for the subject project activity was avoided due to travel restrictions imposed in the host country due to COVID-19 impact. The validation body noted VERRA guideline on travel due to COVID-19 (<https://verra.org/covid-19-travel-guidance/>) and e-mail communication between project participant and VERRA dated 31/03/2020 clarifies that VERRA standard do not mandate site visit to be conducted in person **/29/**. The validating body also noted CDM Executive Board's decision to relax mandatory site visits by DOEs for a period of three months (23 March to 23 June 2020) because of COVID-19 **/28/**. The alternative means used for the purpose of validation are demonstrated as follow:

The validation team has carried out off site interviews (over phone call and video call) in order to assess the information included in the project documentation and to gain additional information regarding the compliance of the project with the relevant criteria applicable for Renewal Crediting Period. During the desk review, the relevant documents, including the registered VCS-PD and corresponding validation reports for the 1st crediting period, the previous periodic monitoring report and verification reports, the picture of nameplate of the main equipment, the picture of monitoring meters and other relevant background documents were provided and assessed. The project description in the VCS-PD for the renewable crediting period was already verified from these documents. Validation team can confirm the project design, construction, operation and monitoring plan were not changed for 2nd crediting period. And the baseline scenario information also can be confirmed as it was defined by the applied methodology AMS-III.H (version 19), AMS-I.C (version 21) and AMS-I.D (version 18).

The validation report and previous verification reports were checked, comparing the relevant evidence and off-site interview with the PP representative and operation

staff through telephone and video call, Carbon Check team has confirmed that the project is implemented in line with the PDD and the monitoring system is in line with the latest approved VS-PD and latest MR. There is no change of the project design, construction, operation and monitoring plan. Therefore, a reasonable level of assurance was achieved without an in-person site visit.

2.5 Resolution of Findings

The objective of this phase of the validation is to resolve any outstanding issues, which need to be clarified for Carbon Check's positive conclusion on the project design.

To guarantee transparency a validation protocol has been customized for the project. The protocol shows in a transparent manner the requirements, means of validation and the results from validating the identified criteria. The validation protocol consists of three tables. The completed validation protocol is enclosed in Appendix B to this report.

A corrective action request (CAR) is raised if one of the following occurs:

- The project participants have made mistakes that will influence the ability of the project activity to achieve real, measurable additional emission reductions.
- The VCS Version 4.0 requirements have not been met.
- There is a risk that the emission reductions cannot be monitored or calculated.

A clarification request (CL) is raised if information is insufficient or not clear enough to determine whether the applicable VCS Version 4.0 requirements have been met.

In summary, 3 CLs and 1 CAR were raised which have been discussed in detail under Appendix B of this report. All CAR and CLs are successfully closed.

2.5.1 Forward Action Requests

No Forward Action Requests raised.

3 VALIDATION FINDINGS

3.1 Project Details

Project type, technologies and measures implemented, and eligibility of the project:

The project applies UNFCCC approved methodology AMS-III.H, version 19 and AMS-I.C version 21 and AMS-I.D version 18 **/11/, /12/,/13/** which is used under UNFCCC CDM and therefore an approved GHG programme. The project type and eligibility as per applied methodologies are discussed as below:

Project type and eligibility: In the absence of the project activity, wastewater from the starch processing plant would have been treated in 11 open anaerobic lagoons without biogas recovery. The project involves methane avoidance through treatment of wastewater with covered lagoon (2 open anaerobic lagoon converted) and recovering biogas for thermal and electrical energy generation. Therefore, the project is categorized both under sectoral scope 13 (Waste handling and disposal) and sectoral scope 01 (Energy industries (renewable -/ non-renewable sources) and correctly applied methodology AMS-III.H, AMS-I.C and AMS-I.D.

Technology and measures: The project wastewater treatment system is designed to treat wastewater up to 177,375 m³ per day coming out of the starch production process **/24/**. The capacity of wastewater generation and treatment is based on average starch production in baseline scenario (year 2005-2008) and design wastewater generation. This is consistent with registered VCS-PD applicable in the first crediting period. COD removal efficiency is 87.16% which is consistent with the registered VCS-PDD validation report **/01/, /14/**. Expected biogas generation is 12,009 m³/day as per registered VCS-PDD **/01/**.

The recovered biogas is used in two thermal oil boilers to replace fuel oil and generation of electricity in two gas engines. Any excess biogas or during emergency biogas shall be flared in an open flare. The arrangements are consistent with registered VCS-PDD and are applicable for second crediting period as well.

Therefore, emissions reductions from methane avoidance is claimed as per procedure outlined in applied methodology AMS-III.H (version 19) and emission reductions achieved from substitution of fossil fuel in thermal boiler is claimed as per procedure outlined in applied methodology AMS-I.C (version 21) and generation of electricity is claimed as replacement of grid electricity as per procedure outlined in AMS-I.D (version 18).

Project proponent:

Kean Charoen Co. Ltd. is the owner of the project which has been cross checked from the valid operational license copies /20/, validation report and previous verification report /14/, /15/. Hence, project proponent is as per VCS Program Definitions, v4.0 and accepted by validation team. The other entity involved in the project activity is South Pole Carbon Asset Management Ltd. as buyer of the carbon credit generated from the project activity which has been cross checked from the emission reduction purchase agreement copy executed between Kean Charoen Co. Ltd. and South Pole Carbon Asset Management Ltd. /21/.

Project start date:

The project start date is same as mentioned in registered VCS-PD /01/. The project start date is 02/10/2006, the date on which biogas was used in boiler. The date represents the first date of generating emission reductions and hence start date is correct as per VCS rule.

Project crediting period:

The project was registered under VCS 2007.1 and as stated in the registered VCS-PD and validation report start date of crediting period to be 15/07/2009. First duration of crediting period was 15/07/2009 to 14/07/2019. VCS 2007.1 rule says crediting period of a maximum of 10 years which may be renewed at most two times.

The assessment team has verified the project activity against the requirements of VCS standard v4.0 section 3.8.9(3) "The updated project description shall be validated in accordance with the VCS rules. In addition, the project shall be validated against the (current) scope of the VCS. Such validation report shall be issued within two years of the end of the (previous) project crediting period. Additional time is granted for projects to complete such validation where they are

switching to a new VCS methodology (new VCS methodology in this context has the same meaning as set out in Section 3.7.1) when renewing the project crediting period. Specifically, projects switching to a new VCS methodology and completing such validation within one year of the approval of the methodology by the VCSA may complete such validation within three years of the end of the (previous) project crediting period.

It is noted that previous crediting period of the project activity ended on 14/07/2019 and the validation is completed within 2 years as recommended under the above paragraph.

Therefore, the project activity in compliance with all the requirements, hence eligible for crediting period renewal. The project life is 15 years as per registered VCS-PD and validation report /01/, /14/. The project started on 02/10/2006 and 15 years of life as per registered VCS-PD will end by 01/10/2021. However, as per confirmation from Chaowanee Thai Biogas Limited Partnership (a third-party expert entity) dated 04/04/2020 the wastewater treatment system with biogas recovery at Kean Charoen Co. Ltd. can continue another 20 years of operation with regular maintenance /31/. The boiler under the project activity (6.16 MWth) commissioned in the year 2020 has a default life of 20 years from date of commissioning and hence can continue the second crediting period. Generators with its operation hours so far are expected to run the second crediting period. Therefore, the second crediting period is possible up to the lifetime of the project activity.

The first crediting period was from 15/07/2009 to 14/07/2019 and the second crediting period is from 15/07/2019 to 14/07/2029.

Project scale and estimated GHG emission reductions or removals:

The estimated average annual emission reductions from the project are estimated to be on the average 19,318 tCO₂e per year over the selected 10 years crediting period.

Projects are categorized by size according to their estimated average annual emission reductions or removals according to VCS Standard /05/. Since the estimated annual emission reductions resulting from the project is less than 300,000 tCO₂e, the category of the project is defined as "Project" as per the VCS Standard /05/.

Project location:

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. This is same as registered VCS PD /01/.

Project compliance with applicable laws, statutes and other regulatory frameworks:

The project is a voluntary initiative by the project proponent and has not been implemented to meet any local / national laws or regulatory compliances. The project activity is in compliance with current laws and regulations and there are no legal and/or regulatory requirements that prevent the project implementation. Also, the validation team has confirmed that there is no such compliance requirement with an emission trading program or any binding limits on GHG emissions for the project activity in Thailand (host country) as it is a non-annex 1 country. The project has obtained valid consents for the installation and operation from the state nodal agencies and is in compliance with local laws and regulations.

Ownership and other programs:

Right of use: The ownership of the project belongs to Kean Charoen Co. Ltd. as verified from valid operational license copies /20/. Other entity South Pole Carbon Asset Management Ltd. acts as buyer of the carbon credit generated from the project activity which has been cross checked from the emission reduction purchase agreement copy executed between Kean Charoen Co. Ltd. and South Pole Carbon Asset Management Ltd. /21/.

Emissions trading programs and other binding limits: The project is not participating in other emission trading programs. The assessment team checked other emission trading programmes (UNFCCC, Gold Standard, ACX) and found that the project is not listed in any other emission trading programme.

Participation under other GHG programs:

The project is registered only under VCS project activity.

Project ID: 427.

Other forms of environmental credit sought or received: The project is not listed in any other forms of environmental credit as confirmed by project proponent.

Rejection by other GHG programs: The project has not been rejected by other GHG programme.

Additional information relevant to the project:

Eligibility criteria for grouped projects:

The project is not a grouped project in accordance with registered VCS PD.

Commercially sensitive information:

Not applicable.

Any further information:

Not applicable.

3.2 Safeguards

3.2.1 No Net Harm

The project activity involves avoidance of methane emission from wastewater treatment and biogas recovery and utilization to replace fuel oil and grid electricity. There is no negative environmental and socio-economic impact.

3.2.2 Local Stakeholder Consultation

Not applicable since this is validation for renewal of crediting period. The stakeholder consultation was conducted by PP during registration of the project activity and details with regards to the same has been outlines in the updated VCS PD.

3.2.3 Environmental Impact

The project being a renewable energy biogas based thermal project does not fall under the purview of the Environmental Impact Assessment (EIA) notification of the Ministry of Natural Resources and Environment (MORE). The government of Thailand with the type and size of projects or activities requiring EIA, which is currently regulated by Section 46 of the Enhancement and Conservation of Nation from the National Environmental Quality Act 1992.

3.2.4 Public Comments

Not applicable.

3.2.5 AFOLU-Specific Safeguards

For non-AFOLU projects, this section is not required.

3.3 Application of Methodology

3.3.1 Title and Reference

The project activity was registered using AMS-III.H 'Methane Recovery in Wastewater Treatment' version 13, AMS-I.C 'Thermal energy production with or without

electricity' version 15 and AMS-I.D 'Grid connected renewable electricity generation' version 15.

For the renewal of the crediting period, the PP has updated the applied methodologies to its latest version and below are the methodologies applied:

AMS-III.H 'Methane Recovery in Wastewater Treatment' version 19, AMS-I.C 'Thermal energy production with or without electricity' version 21 and AMS-I.D 'Grid connected renewable electricity generation', Version 18.0.

Tool referenced in the applied methodologies are:

- Project emissions from flaring", version 03.0
- Tool to calculate project or leakage CO₂ emissions from fossil fuel combustion, version 03.0
- Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation, version 03.0
- Tool to calculate the emission factor for an electricity system, version 07.0
- Tool to determine the remaining lifetime of equipment, version 01
- Assessment of the validity of the original/current baseline and update of the baseline at the renewal of the crediting period, version 03.0.1
- Tool to determine the mass flow of a greenhouse gas in a gaseous stream", version 03.0

Assessment team has checked the UNFCCC website it is confirmed that the selection of the applied methodology and methodological tool has been done correctly in line with the applicable requirements for the renewal of crediting period.

3.3.2 Applicability

All applicability conditions of applied methodology AMS-III.H 'Methane Recovery in Wastewater Treatment' version 19, AMS-I.C 'Thermal energy production with or without electricity' version 21 and AMS-I.D 'Grid connected renewable electricity generation', Version 18.0 are justified in the updated VCS-PD and further justified below:

Applicability criteria for AMS-III.H, version 19:

Criteria	Means of verification	Conclusion
This methodology comprises measures that recover biogas from biogenic organic matter in wastewater by means of one, or a combination, of the following options:	In absence of the project activity the wastewater was being treated in open lagoons. These open lagoons have depth greater than 2 meters,	Applicability condition justified.

(a) Substitution of aerobic wastewater or sludge treatment systems with anaerobic systems with biogas recovery and combustion; (b) Introduction of anaerobic sludge treatment system with biogas recovery and combustion to a wastewater treatment plant without sludge treatment; (c) Introduction of biogas recovery and combustion to a sludge treatment system; (d) Introduction of biogas recovery and combustion to an anaerobic wastewater treatment system such as anaerobic reactor, lagoon, septic tank or an on-site industrial plant; (e) Introduction of anaerobic wastewater treatment with biogas recovery and combustion, with or without anaerobic sludge treatment, to an untreated wastewater stream; (f) Introduction of a sequential stage of wastewater treatment with biogas recovery and combustion, with or without sludge treatment, to an anaerobic wastewater treatment system without biogas recovery (e.g. introduction of treatment in an anaerobic reactor with biogas recovery as a sequential treatment step for the wastewater	without aeration, and the ambient temperature on a monthly average basis being greater than 15°C. With the minimum interval between two consecutive sludge removal during the baseline scenario also being greater than 30 days, the baseline open lagoons satisfied the anaerobic conditions specified under AMS III.H. (version 19). With the project activity involving the installation of 2 covered lagoons to treat high COD wastewater generated and methane recovery. Therefore, it also satisfies the applicability criterion (f).	
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that is presently being treated in an anaerobic lagoon without methane recovery)		
In cases where baseline system is anaerobic lagoon the methodology is applicable if: a) The lagoons are ponds with a depth greater than two meters, without aeration. The value for depth is obtained from engineering design documents, or through direct measurement, or by dividing the surface area by the total volume. If the lagoon filling level varies seasonally, the average of the highest and lowest levels may be taken; b) Ambient temperature above 15°C, at least during part of the year, on a monthly average basis; c) The minimum interval between two consecutive sludge removal events shall be 30 days.	In consistent with registered project design 11 anaerobic lagoons, were used to treat wastewater in the baseline scenario and the lagoons had an average depth of 3.1 m. The project location is unchanged and in consistent with registered project the average temperature of the project area is 28 degree C. Further, no sludge has been removed from the baseline anaerobic lagoons since the date of starch factory operation. The above conditions were checked during site visit.	Applicability condition justified.
The recovered biogas from the above measures may also be utilised for the following applications instead of combustion/flaring: (a) Thermal or mechanical, electrical energy generation directly; (b) Thermal or mechanical, electrical energy generation after bottling of upgraded biogas, in this case additional guidance provided in the appendix shall be followed; or (c) Thermal or mechanical, electrical energy generation after upgrading and distribution, in this case additional guidance	In consistent with registered project design and first crediting period, the received biogas is used for thermal and electricity energy generation; This was checked during site visit. Therefore, condition (a) is applicable and rest of the conditions are not applicable.	Applicability condition justified.

provided in the appendix shall be followed: (i) Upgrading and injection of biogas into a natural gas distribution grid with no significant transmission constraints; (ii) Upgrading and transportation of biogas via a dedicated piped network to a group of end users; or (iii) Upgrading and transportation of biogas (e.g. by trucks) to distribution points for end users; (d) Hydrogen production; (e) Use as fuel in transportation applications after upgrading.		
If the recovered biogas is used for project activities covered under paragraph 4(a), that component of the project activity can use a corresponding category under Type I	The recovered biogas is used for heat and power generation as mentioned above and these components of the project activity use the categories under type 1 methodology, i.e., AMS I.C and AMS I.D	Applicability condition is justified.
For project activities covered under paragraph 4(b), if bottles with upgraded biogas are sold outside the project boundary, the end-use of the biogas shall be ensured via a contract between the bottled biogas vendor and the end-user. No emission reductions may be claimed from the displacement of fuels from the end use of bottled biogas in such situations. If, however, the end use of the bottled biogas is included in the project boundary and is monitored during the crediting period CO₂ emissions avoided by the displacement of fossil fuel can be claimed under the	The project activity does not involve any such activity and hence not applicable.	Not applicable.

corresponding Type I methodology, e.g. "AMS-I.C.: Thermal energy production with or without electricity"		
For project activities covered under paragraph 4(c)(i), emission reductions from the displacement of the use of natural gas are eligible under this methodology, provided the geographical extent of the natural gas distribution grid is within the host country boundaries	The project activity does not involve any such activity and hence not applicable.	Not applicable.
For project activities covered under paragraph 4(c)(ii), emission reductions for the displacement of the use of fuels can be claimed following the provision in the corresponding Type I methodology, e.g. AMS-I.C	The project activity satisfies paragraph 4(a). Therefore, this condition is not relevant to the project activity	Not applicable
In particular, for the case of paragraph 4(b) and (c)(iii), the physical leakage during storage and transportation of upgraded biogas, as well as the emissions from fossil fuel consumed by vehicles for transporting biogas shall be considered. Relevant procedures in paragraph 18 of the appendix of "AMS-III.H.: Methane recovery in wastewater treatment" shall be followed in this regard	The project activity satisfies paragraph 4(a). Therefore, this condition is not relevant to the project activity	Not applicable
For project activities covered under paragraph 4(b) and (c), this methodology is applicable if the upgraded methane content of the biogas is in accordance with relevant national regulations (where these exist) or, in the absence of national regulations, a minimum of 96 per cent (by volume)	The project activity satisfies paragraph 4(a). Therefore, this condition is not relevant to the project activity	Not applicable
If the recovered is utilized for the production of hydrogen (project activities covered under paragraph 3(d)), that component of the project activity shall use the corresponding methodology "AMS-III.O.: Hydrogen production	The project activity satisfies paragraph 4(a). Therefore, this condition is not relevant to the project activity	Not applicable

using methane extracted from biogas"		
If the recovered biogas is used for project activities covered under paragraph 4(e), that component of the project activity shall use corresponding methodology "AMS-III.AQ.: Introduction of Bio-CNG in transportation applications	The project activity satisfies paragraph 4(a). Therefore, this condition is not relevant to the project activity	Not applicable
New facilities (Greenfield projects) and project activities involving a change of equipment resulting in a capacity addition of the wastewater or sludge treatment system compared to the designed capacity of the baseline treatment system are only eligible to apply this methodology if they comply with the relevant requirements in the "General guidelines for SSC CDM methodologies". In addition the requirements for demonstrating the remaining lifetime of the equipment replaced, as described in the general guidelines shall be followed.	This is neither a Greenfield project, nor does it result in a capacity addition of the wastewater or sludge treatment system compared to the designed capacity of the baseline treatment system, thus this applicability criterion is of no relevance.	Not applicable.
The location of the wastewater treatment plant as well as the source generating the wastewater shall be uniquely defined and described in the PDD.	The location of wastewater treatment plant and source of generation of wastewater is clearly defined in VCS PD. This is also consistent with registered project PD. This was checked during site visit.	Applicability condition justified
Measures are limited to those that result in aggregate emissions reductions of less than or equal to 60 kt CO ₂ equivalent annually from all Type III components of the project activity.	The emission reductions estimated conservatively for the project activity is 19,318 tCO _{2e} annually and hence meets the applicability condition.	Applicability condition justified.

Applicability criteria for AMS I-C, version 21:

Criteria	Means of verification	Conclusion
This methodology comprises renewable energy technologies that supply users i.e. residential, industrial or commercial facilities with thermal energy that displaces fossil fuel use. These units include technologies such as solar thermal water heaters and dryers, solar cookers, energy derived from renewable biomass and other technologies that provide thermal energy that displaces fossil fuel.	The project activity involves the facility to capture biogas and further to utilize for heat generation. Therefore, the project activity fulfils this applicability criterion. In addition, the project activity does not involve the co-gen facility. This is consistent with registered VCS-PD.	Applicability condition justified
Biomass-based cogeneration and trigeneration systems are included in this category.	In the project activity recovered biogas is used for thermal application and electricity generation as verified during site visit and consistent with registered VCS PD.	Applicability condition not applicable.
Emission reductions from a biomass cogeneration or trigeneration system can accrue from one of the following activities: (a) Electricity supply to a grid; (b) Electricity and/or thermal energy production for on-site consumption or for consumption by other facilities; (c) Combination of (a) and (b).	In the project activity recovered biogas is used for thermal application and electricity generation as verified during site visit and consistent with registered VCS PD.	Applicability condition not applicable.
Project activities that seek to retrofit or modify an existing facility for renewable energy generation are included in this category	The recovered biogas in the project activity is used in hot oil boiler which were existed prior to the project activity. This was verified during site visit and consistent with registered VCS PD.	Applicability condition is justified.
In the case of new facilities (Greenfield projects) and project activities involving capacity additions the relevant requirements related to determination of baseline scenario provided in the "General	The biogas is used for thermal application in existing boiler and hence not a greenfield project. This was verified during site visit and	Applicability condition not applicable.

guidelines for SSC CDM methodologies" for Type-II and Type-III Greenfield/capacity expansion project activities also apply.	consistent with registered VCS PD.	
The total installed/rated thermal energy generation capacity of the project equipment is equal to or less than 45 MW thermal.	The installed capacity of thermal boilers are 10.23 MWth as verified from technical specifications of boilers /22/.	Applicability condition is justified.
For co-fired systems, the total installed thermal energy generation capacity of the project equipment, when using both fossil and renewable fuel, shall not exceed 45 MW thermal.	Even the boilers are co-fired the total installed capacity of the boilers are 10.23 MWth as verified from technical specifications of boilers /22/.	Applicability condition is justified.
<i>Applicability condition 9, 10, 11, 12, 15, 16 and 17 are not applicable as the project does not involve any biomass usage.</i>		
If electricity and/or thermal energy produced by the project activity is delivered to a third party i.e. another facility or facilities within the project boundary, a contract between the supplier and consumer(s) of the energy will have to be entered into that ensures there is no double-counting of emission reductions.	The thermal energy from the project activity is used for starch drying in the same factory within the project boundary. There is no third party of another facility involved. This is evident from the business license of project proponent /20/.	Applicability condition is justified.
If the project activity recovers and utilizes biogas for producing electricity and/or thermal energy and applies this methodology on a standalone basis i.e. without using a Type III component of a SSC methodology, any incremental emissions occurring due to the implementation of the project activity (e.g. physical leakage of the anaerobic digester, emissions due to inefficiency of the flaring), shall be taken into account either as project or leakage emissions as per relevant procedures in the	The project recovers and utilizes biogas for thermal application and applied type III component methodology (AMS-III.H). Therefore, requirements are fulfilled.	Applicability condition is justified.

tool “Emissions from solid waste disposal sites” and/or “Project emissions from flaring”. In the event that the biomass fuel (solid/liquid/gas) is sourced from an existing CDM project, then the emissions associated with the production of the fuel shall be accounted with that project.		
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Applicability criteria for AMS-I.D, version 18:

Criteria	Means of verification	Conclusion
This methodology comprises renewable energy generation units, such as photovoltaic, hydro, tidal/wave, wind, geothermal and renewable biomass: (a) Supplying electricity to a national or a regional grid; or (b) Supplying electricity to an identified consumer facility via national/regional grid through a contractual arrangement such as wheeling.	The project activity uses biogas as fuel to generate electricity. This in turn displaces fossil-fuel based grid electricity by PEA. Excess electricity is supplied to grid after internal consumption which is verified from PPA document /30/.	Applicability condition justified.
This methodology is applicable to project activities that: (a) Install a Greenfield plant; (b) Involve a capacity addition in (an) existing plant(s); (c) Involve a retrofit of (an) existing plant(s); (d) Involve a rehabilitation of (an) existing plant(s)/unit(s); or (e) Involve a replacement of (an) existing plant(s).	The project is a greenfield project as validated in the registered VCS-PD. Hence, condition is justified.	Applicability condition justified.
Hydro power plants with reservoirs that satisfy at least one of the following conditions are eligible to apply this methodology: (a) The project activity is implemented in an existing reservoir with no change in the volume of reservoir; (b) The project activity is implemented in an existing reservoir, where the volume of reservoir is increased and the power density of the project activity, as per definitions given in the project emissions section, is greater than 4 W/m²; (c) The	The project is not a hydro power project. Hence, the condition is not applicable.	Not applicable.

project activity results in new reservoirs and the power density of the power plant, as per definitions given in the project emissions section, is greater than 4 W/m ² .		
If the new unit has both renewable and non-renewable components (e.g. a wind/diesel unit), the eligibility limit of 15 MW for a small-scale CDM project activity applies only to the renewable component. If the new unit co-fires fossil fuel, the capacity of the entire unit shall not exceed the limit of 15 MW.	The generation sets used in the project activity are used only for the combustion of biogas. The renewable component has a total generation capacity of an approximate 1.904 MWe. This is verified during site visit from technical specification of the generation units.	Applicability condition justified.
Combined heat and power (co-generation) systems are not eligible under this category	The project is not a co-generation system. Hence, condition is not applicable.	Not applicable.
In the case of project activities that involve the capacity addition of renewable energy generation units at an existing renewable power generation facility, the added capacity of the units added by the project should be lower than 15 MW and should be physically distinct from the existing units	Not applicable as the project does not involve any capacity addition.	Not applicable
In the case of retrofit, rehabilitation or replacement, to qualify as a small-scale project, the total output of the retrofitted, rehabilitated or replacement power plant/unit shall not exceed the limit of 15 MW.	The project does not involve any retrofit or replacement and the capacity of the power generating unit is less than 15 MW.	Not applicable.
In the case of landfill gas, waste gas, wastewater treatment and agro-industries projects, recovered methane emissions are eligible under a relevant Type III category. If the recovered methane is used for electricity	The approved baseline and monitoring methodologies AMS-I.C. and AMS-I.D. are used for the thermal and electricity	Applicability condition is met.

generation for supply to a grid then the baseline for the electricity component shall be in accordance with procedure prescribed under this methodology. If the recovered methane is used for heat generation or cogeneration other applicable Type-I methodologies such as "AMS-I.C.: Thermal energy production with or without electricity" shall be explored.	generation components of the project activity.	
In case biomass is sourced from dedicated plantations, the applicability criteria in the tool "Project emissions from cultivation of biomass" shall apply.	Not applicable for the project activity	Not applicable

In view of the above consideration, the assessment team is able to conclude that the used methodologies and tools are applicable for the project activity.

3.3.3 Project Boundary

In line with the applied methodologies AMS-III.H, version 19, AMS-I.C, version 21 and AMS-I.D version 18 the project boundary includes the wastewater generation point (the starch factory), pre-treatment process unit, the processing site (covered lagoons) and the biogas usage points (the boilers and generators). The grid system supplying electricity to the project facility is also included under the project boundary to account project emissions. The project boundary found consistent with registered project activity in line with applied methodologies and confirmed from site visit observations. Project boundary is correctly described in the updated VCS PD.

	GHGs involved	Description
Baseline emissions	CH ₄	Emission from decomposition of organic matter in anaerobic conditions. In the absence of the project activity, the wastewater coming out of the starch factory would have been left to decay in anaerobic conditions in open lagoons.
	CO ₂	Emissions from consumption of fossil fuel in boiler which is replaced by biogas in the project activity and grid electricity displaced by electricity generated from biogas.

Project emissions	CH ₄	Decomposition of organic matter in open lagoon, Physical leakage of digester, incomplete flaring
	CO ₂	On-site electricity consumed by project activity (digester pumps and other electrical equipment), which is not generated from biogas will be accounted for.
Leakage	N/A	The project activity does not have any leakage emission as per the applied methodology.

By checking the information and evidences available and through off-site interview, the validation team can confirm that all the emission sources and gases have been included in the project boundary and the description in the PD is accurate and complete, and also that the selected sources and gases are justified for the proposed project activity.

3.3.4 Baseline Scenario

According to VCS Standard, v4.0, paragraph 3.8.9-2) the validity of the original baseline scenario shall be demonstrated when renewing the project crediting period, by means of impacts of new relevant national and/or sectoral policies and actual circumstances.

Paragraph 3.8.9, Clause (2-a) "The validity of the original baseline scenario shall be assessed. Such assessment shall include an evaluation of the impact of new relevant national and/or sectoral policies and circumstances on the validity of the baseline scenario".

VVB assessment:

The project is implemented in a starch factory and needs to follow Factory Act B.E. 2535 under which it needs to comply the "Notification of Ministry of Industry regarding Industrial Effluent Standards B.E. 2560 /23/. The notification states the limit of COD of wastewater discharged outside factory to be 120mg/l. As verified from previous verification report and monitoring report, the wastewater is treated and reused inside the factory area for various activities (plantation, cleaning etc.). It is further verified from valid plant operational license /24/. Therefore, the baseline scenario (wastewater is left to decay in anaerobic lagoon) is still valid as per the original registered PD. For the biogas capture and utilization for thermal application and electricity generation, local regulation does not prohibit the use of fossil fuel in boiler as both the boiler has

valid operational license to use both biogas and fossil fuel /24/. Thus, it can be concluded that original baseline scenario will remain valid for next crediting period.

Paragraph 3.8.9, Clause (2-b) "Where it is determined that the original baseline scenario is still valid, the GHG emissions associated with the original baseline scenario shall be reassessed using the latest version of the CDM Tool to assess the validity of the original/ current baseline and to update the baseline at the renewal of a crediting period".

VVB assessment:

The project participant has included the assessment of the validity of the original baseline in line with UNFCCC in section 3.4 of the revised VCS PD, including the assessment of original baseline as per the "Tool to assess the validity of the original/ current baseline and to update the baseline at the renewal of a crediting period, Version 3.0.1" /25/, which has been concluded to be still valid and applicable for the project

The tool consists of two steps. The first step provides an approach to evaluate whether the current baseline is still valid for the next crediting period. The second step provides an approach to update the baseline in case that the current baseline is not valid anymore for the next crediting period.

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

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

As verified above, local regulation does not prohibit the disposal of wastewater in anaerobic lagoons and therefore, in the absence of the project the baseline scenario would be in compliance of national regulations.

Step 1.2: Assess the impact of circumstances

The project activity is a treatment of wastewater in anaerobic digester and biogas recovery to use in boiler for thermal energy and in gas based generator for electricity generation. The wastewater would have been treated in anaerobic open lagoons, boilers would have used fossil fuel (HFO) and equivalent electricity would have generated in fossil fuel dominated grid. Hence methane emissions from wastewater treatment in anaerobic lagoon and CO₂ emissions from diesel consumption and grid electricity generation are appropriate baseline. There is no change observed in this

regard and it can be concluded that the conditions used to determine the baseline emissions in the previous crediting period are still valid.

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

The lifetime of the project activity is above 15 years as confirmed by a third party technical expert entity the wastewater system and biogas recovery can continue another 20 years with regular maintenance /31/; hence an investment is not the most likely scenario for the renewal crediting period under consideration.

Step 1.4: Assessment of the validity of the data and parameter

"Where emission factors, values or emission benchmarks are used and determined only once for the crediting period, they should be updated, except if the emission factors, values or emission benchmarks are based on the historical situation at the site of the project activity prior to the implementation of the project and cannot be updated because the historical situation does not exist anymore as a result of the CDM project activity".

Following data parameters are updated from registered PD:

Data/Parameter	Value in registered PD	Value in updated PD	Assessment
Global Warming Potential for Methane (GWP CH ₄)	21	25	In line with VCS 4.0 standard paragraph 3.14.4 IPCC fourth assessment report is referred for GWP of methane and correctly applied the updated value.
Methane producing capacity of the wastewater (Bo)	0.21 kg CH ₄ /kg COD	0.25 kg CH ₄ /kg COD	The updated value is in consistent with latest applied methodology AMS-III.H, version 19. Hence, accepted.
Model correction factor to account for model uncertainties (UF _{BL})	0.94	0.89	The updated value is in consistent with latest applied methodology AMS-III.H, version 19. Hence, accepted.
Model correction factor to account for model uncertainties (UF _{PJ})	1.06	1.12	The updated value is in consistent with latest applied methodology AMS-III.H, version 19. Hence, accepted.

CO ₂ emission factor for grid power (EF _y)	0.5057 tCO ₂ /MWh	0.5637 tCO ₂ /MWh	The updated value is determined by Ministry of Natural Resources and Environment, Thailand in line with UNFCCC methodological tool /26/ and hence accepted.
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Considering the guidance provided under this step, calculation of emission factor and baseline emissions are updated for the next crediting period as per step 2.

Step 2: Update the current baseline and the data and parameters

Since, the existing baseline scenario is still valid, this step is not applicable.

Finally, it can be concluded that the identified baseline scenario is justified and according to the VCS Standard v. 4.0 and the "Tool for the assessment of the validity of the original/current baseline and update of the baseline at the renewal of the crediting period v3.0.1.

3.3.5 Additionality

In accordance with the paragraph 3.8.9 clause 1 of VCS standard v 4.0, "A full reassessment of additionality is not required when renewing the project crediting period. However, regulatory surplus shall be demonstrated in accordance with the requirements set out in the VCS Program rules and the project description shall be updated accordingly".

As per the above guidelines, the assessment team has reviewed the sectoral and national policies applicable for wastewater treatment projects in host country Thailand.

Factory Act B.E. 2535, the "Notification of Ministry of Industry regarding Industrial Effluent Standards B.E. 2560 were reviewed.

In view of the above assessment, it can be concluded that the proposed project is not mandated by any law, statute or other regulatory framework, or for UNFCCC non-Annex I countries, any systematically enforced law, statute or other regulatory framework and hence continued to be voluntary.

3.3.6 Quantification of GHG Emission Reductions and Removals

Baseline Emissions:

Baseline emissions related to methane avoidance as per AMS-III.H, version 19 is calculated as below:

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

Where:

BE_y	=	Baseline emissions in year y (t CO ₂ e)
$BE_{power,y}$	=	Baseline emissions from electricity or fuel consumption in year y (t CO ₂ e)
$BE_{ww,treatment,y}$	=	Baseline emissions of the wastewater treatment systems affected by the project activity in year y (t CO ₂ e)
$BE_{s,treatment,y}$	=	Baseline emissions of the sludge treatment systems affected by the project activity in year y (t CO ₂ e)
$BE_{ww,discharge,y}$	=	Baseline methane emissions from degradable organic carbon in treated wastewater discharged into sea/river/lake in year y (t CO ₂ e). The value of this term is zero for the case 1(b)
$BE_{s,final,y}$	=	Baseline methane emissions from anaerobic decay of the final sludge produced in year y (t CO ₂ e). 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 are not considered. The power consumed in baseline case is negligible and is ignored for conservative estimation of baseline emissions. No fossil fuels have been consumed in the operation of the open anaerobic lagoons in the baseline scenario, therefore, the baseline emissions from fuel consumption are zero as. Therefore, BE_{power,y} is assumed zero and removed from further consideration.

BE_{ww,discharge,y}:

In the baseline scenario, treated wastewater is not discharged into sea/lake/river, therefore methane emissions from degradable organic carbon in treated wastewater discharged (BE_{ww,discharge,y}) in e.g. a river, sea or lake in the baseline situation is assumed to be zero.

BE_{s,treatment,y}:

There is no sludge treatment system in the baseline scenario, only a wastewater treatment system based on open anaerobic lagoons, hence baseline emissions from sludge treatment are not taken into consideration.

BE_{s,final,y}:

There is no sludge treatment system in the baseline system. Hence, BE_{s,final} is assumed zero.

Therefore, **BE_y = BE_{ww,treatment,y}**

Baseline emissions of the wastewater treatment systems affected by the project activity in year y (BE_{ww,treatment,y}) is calculated as below:

$$\begin{aligned}
 BE_{ww,treatment,y} &= \sum_i (Q_{ww,i,y} \times COD_{inflow,i,y} \times \eta_{COD,BL,i} \times MCF_{ww,treatment,BL,i}) \times B_{o,ww} \times UF_{BL} \\
 &\times GWP_{CH_4}
 \end{aligned}$$

Where:

$Q_{ww,i,y}$ = Volume of wastewater treated in baseline wastewater treatment system i in year y (m³). For ex ante estimation, forecasted wastewater generation volume or the designed capacity of the wastewater treatment facility can be used. However, the ex post emissions reduction calculation shall be based on the actual monitored volume of treated wastewater.

$COD_{inflow,i,y}$	= 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 (MCF values as per Table 2 below)
i	= Index for baseline wastewater treatment system
$B_{o,ww}$	= Methane producing capacity of the wastewater (IPCC value of 0.25 kg CH ₄ /kg COD) ¹
UF_{BL}	= Model correction factor to account for model uncertainties (0.89) ²
GWP_{CH_4}	= Global Warming Potential for methane

Volume of wastewater treated ($Q_{ww,i,y}$) is taken ex-ante to be 441,833 m³ per year considering average starch production of 38,660 tonnes per annum and wastewater generation to be 11.4 m³/ton (based on design value of 2000m³ per day and 175 ton of starch production per day)/03/. COD_{in} is taken an average historical value of 16,913 mg/liter. COD removal efficiency of the baseline treatment system ($\eta_{COD,BL,i}$) is taken considering 10 days measurement campaign and model correction factor of 0.89 as per applied methodology. Accordingly, $\eta_{COD,BL,i}$ arrived at 87.16%. Methane producing capacity of the wastewater ($B_{o,ww}$) is taken default value of 0.25 as per applied methodology. GWP_{CH_4} is also as per IPCC fourth assessment report and taken as 25. Accordingly, $BE_{ww,treatment,y}$ is estimated to be 28,982 tCO₂e per year (round down value).

Baseline Emissions as per AMS-I.C, version 21:

According to the methodology AMS-I.C (Version 21), baseline emissions shall be calculated as the sum of emissions from the production of electricity and thermal energy.

Since, the project involves only thermal energy component, therefore, $ER_{ren,y} = BE_{thermal,CO_2,y}$

$BE_{thermal,CO_2,y}$ is calculated as per applied methodology as below:

$$BE_{thermal,CO_2,y} = \left(\frac{EG_{thermal,y}}{\eta_{BL,thermal}} \right) \times EF_{FF,CO_2}$$

¹ Project activities may use the default value of 0.6 kg CH₄/kg BOD, if the parameter BOD_{5,20} is used to determine the organic content of the wastewater. In this case, baseline and project emissions calculations shall use BOD instead of COD in the equations, and the monitoring of the project activity shall be based in direct measurements of BOD_{5,20}, i.e. the estimation of BOD values based on COD measurements is not allowed.

² Reference: FCCC/SBSTA/2003/10/Add.2, page 25.

Where:

$BE_{thermal,CO_2,y}$	=	Baseline emissions from thermal energy displaced by the project activity during the year y (t CO ₂)
$EG_{thermal,y}$	=	Net quantity of thermal energy supplied by the project activity during the year y (TJ)
EF_{FF,CO_2}	=	CO ₂ emission factor of the fossil fuel that would have been used in the baseline plant obtained from reliable local or national data if available, alternatively, IPCC default emission factors can be used (t CO ₂ /TJ)
$\eta_{BL,thermal}$	=	Efficiency of the plant using fossil fuel that would have been used in the absence of the project activity

Since, the monitoring mechanism is not available for the measurement of baseline input/output thermal energy, a conservative approach for calculation of $BE_{thermal,CO_2,y}$ has been adopted by the project proponent. For verification, with 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 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 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. The drop in thermal efficiency for boilers in dual-fuel operation mode can be explained by a number of reasons as listed below:

Higher hydro/moisture loss makes boiler efficiency lower with biogas - The efficiency of a heating equipment depends on several factors; one of the important ones being the C:H ratio in the fuel; which is higher for the fuel oil and lower for biogas. Lower C:H ratio leads to higher quantity of H₂O as combustion product, which decreases the thermal efficiency of the boiler. This is typically called "hydrogen loss". In addition, the biogas has much higher moisture percentage as compared to fuel oil, thus increasing the moisture losses from the equipment, making it less efficient fuel for burning. The hydrogen sulfide content in the biogas adds to the hydrogen loss.

Higher dry flue gas loss reduces boiler efficiency lower with dual fuel firing - Air in excess of the theoretical calculations (called excess air) is always added for proper and complete combustion. In case of dual fuel firing, due to the different mixing properties of the fuel with the air, this quantity of excess air added is always higher due to the reduced probability of achieving proper air-fuel mixing due to varying

fuel properties. At the end of the combustion process, the quantity of unused air is exhausted through the flue gases thus removing away unusable heat in the boiler, such a loss being partly accounted in the dry flue gas loss (the rest is the unusable heat from the high temperature flue gas itself). This can be understood by the fact that the air enters the furnace at ambient temperature but the flue gases are typically at a much higher temperature, 200 – 300 deg.C for most low-pressure boiler systems. Thus if the quantity of excess air pumped into the furnace is higher, which is the case for most such dual fuel fired systems, the dry flue gas loss is also higher, bringing down the efficiency of the boiler. The excess air quantity adjustment is a matter of experience and over a period of time boiler operators do understand how to do this and achieve better efficiencies than what they start with. Thus it is expected that during the initial stages of operation, this loss is higher

Variation in biogas quality and quantity influences the air regulation mechanism, thus lower the efficiency of the system - The varying quantity and quality of biogas influences the air regulation mechanism continuously, never allowing it to achieve a steady state operation, thus lowering the efficiency of the system.

In addition, the energy balance for a particular year, considering amount of biogas and fossil fuel used, would easily justify the assumption that energy input required in dual fuel system is higher than in baseline system. Assuming an approximate 10% loss in efficiency, the assumption to replace 100% fuel oil usage is conservative.

On the basis of historical records fossil fuel used per tonne of starch production is determined. In future, the starch production in a particular year 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.

The deviated calculation would be:

$$BE_{\text{thermal},\text{CO}_2,y} = (Q_{\text{starch}} * Q_{\text{FO,starch}} - q_{\text{FO},y}) * D_{\text{FO}} * \text{NCV}_{\text{FO}} * \text{EF}_{\text{CO}_2} / 10^6$$

Ex-ante, amount of biogas consumed in boiler is estimated to be 1,351,045 Nm³ considering 50% of generated boiler to be sent to the boiler. Accordingly the methane utilized in boiler is 532,042 tCH₄. Annual FO replacement is estimated to be 616.25 tonnes which results thermal energy from fuel oil replacement to be 28.28 TJ. Accordingly, BE_{thermal,CO₂,y} is arrived at 2,187 tCO₂e per year.

Baseline emissions as per AMS-I,D version 18:

Emission reductions associated to the displacement of grid electricity by using captured biogas from the project activity is estimated applying AMS-I,D version 18 and equation 1 of the methodology is applied:

$$BE_{elec,y} = EG_{PJ,y} \times EF_{grid,y}$$

$EG_{PJ,y}$ 'Electricity produced by the biogas generator unit for grid electricity replacement in the year y (MWh)' to be monitored ex-post and ex-ante it is estimated to be 2,672 MWh considering estimated biogas to be supplied to the gen sets and other technical parameters. Grid-emission factor is fixed for the crediting period to be 0.5637 tCO₂/MWh. Accordingly, baseline emissions from displacement of grid electricity is 1,506 tCO₂ per year.

Project Emissions:

Project Emissions AMS-III.H:

According to AMS-III.H, the project emissions are calculated using equation (8) of the applied methodology:

$$PE_y = \left\{ \begin{array}{l} PE_{power,y} + PE_{ww,treatment,y} + PE_{s,treatment,y} + PE_{ww,discharge,y} + PE_{s,final,y} + \\ PE_{fugitive,y} + PE_{biomass,y} + PE_{flaring,y} \end{array} \right\}$$

Where:

PE_y	Project activity emissions in the year y (t CO ₂ e)
$PE_{power,y}$	Emissions from electricity or fuel consumption in the year y (t CO 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 (t CO ₂ e). These emissions shall be calculated as per equation (2) in paragraph 27 using an uncertainty factor of 1.12 and data applicable to the project situation ($MCF_{ww,treatment,PJ,k}$ and $\eta_{PJ,k,y}$) and with the following changed definition of parameters: $MCF_{ww,treatment,PJ,k}$ Methane correction factor for project wastewater treatment system k (MCF values as per Table 2 above) $\eta_{PJ,k,y}$ Chemical oxygen demand removal efficiency of the project wastewater treatment system k in year y (t/m ³), measured based on inflow COD and outflow COD in system k
$PE_{s,treatment,y}$	Methane emissions from sludge treatment systems affected by the project activity, and not equipped with biogas recovery, in year y

(t CO₂e). These emissions shall be calculated as per equations (3) and (4) in paragraphs 30 and 31, using an uncertainty factor of 1.12 and data applicable to the project situation ($S_{l,PJ,y}$, $MCF_{s,treatment,l}$) and with the following changed definition of parameters:

$S_{l,PJ,y}$ Amount of dry matter in the sludge treated by the sludge treatment system l in the project scenario in year y (t)

$MCF_{s,treatment,l}$ Methane correction factor for the project sludge treatment system l (MCF values as per Table 2 above)

$PE_{ww,discharge,y}$ Methane emissions from degradable organic carbon in treated wastewater in year y (tCO₂e). These emissions shall be calculated as per equation (6) in paragraph 33, using an uncertainty factor of 1.12 and data applicable to the project conditions ($COD_{ww,discharge,PJ,y}$, $MCF_{ww,PJ,discharge}$) and with the following changed definition of parameters:

$COD_{ww,discharge,PJ,y}$ Chemical oxygen demand of the treated wastewater discharged into the sea, river or lake in the project scenario in year y (t/m³)

$MCF_{ww,PJ,discharge}$ Methane correction factor based on the discharge pathway of the wastewater in the project scenario (e.g. into sea, river or lake) (MCF values as per Table 2)

$PE_{s,final,y}$ Methane emissions from anaerobic decay of the final sludge produced in year y (t CO₂e). These emissions shall be calculated as per equation (7) in paragraph 35, using an uncertainty factor of 1.12 and data applicable to the project conditions ($MCF_{s,PJ,final}$, $S_{final,PJ,y}$). If the sludge is controlled combusted, disposed in a landfill with biogas recovery, or used for soil application in aerobic conditions in the project activity, this term shall be neglected, and the sludge treatment and/or use and/or final disposal shall be monitored during the crediting period with the following revised definition of the parameters:

$MCF_{s,PJ,final}$ Methane correction factor of the disposal site that receives the final sludge in the project situation, estimated as per the procedures described in the methodological tool "Emissions from solid waste disposal sites"

$S_{final,PJ,y}$ Amount of dry matter in final sludge generated by the project wastewater treatment systems in the year y (t)

$PE_{fugitive,y}$ Methane emissions from biogas release in capture systems in year y , calculated as per paragraph 40 (t CO₂e)

$PE_{flaring,y}$ Methane emissions due to incomplete flaring in year y (t CO₂e). For ex ante estimation, baseline emission calculation for wastewater and/or sludge treatment (i.e. equation (2) and/or equation (3)) can be used but without the consideration of GWP for CH₄. However, the ex post emission reduction shall be calculated as per methodological tool "Project emissions from flaring"

$PE_{biomass,y}$ Methane emissions from biomass stored under anaerobic conditions. If storage of biomass under anaerobic conditions takes place in the project and does not occur in the baseline, methane

emissions due to anaerobic decay of this biomass shall be considered and be determined as per the procedure in the methodological tool "Emissions from solid waste disposal sites" (t CO₂e)

Emissions from electricity or fuel consumption in the year y (PE_{power,y}) is calculated using below formula:

$$PE_{Power,y} = EC_{PJ,j,y} * EF_{EF,j,y} * (1 + TDL_{j,y})$$

In the absence of electric meter for the electricity consumption of project activity, maximum rated consumption shall be used to calculate the emissions from PE power as per prescribed method in paragraph 49 of AMS-III.H., as follows:

$$PE_{Power,y} = (\sum P_{el} * EF_{EF,j,y} * (1 + TDL_{j,y}))$$

Rated power capacity is 458 kw consistent with registered VCS-PD and verified during site visit. Grid-emission factor is fixed for the crediting period to be 0.5637 tCO₂/MWh. Transmission and distribution loss (TDL) as per applied methodology is 20%. Accordingly, ex-ante estimated project emission from electricity consumption is 2,714 tCO₂e.

Methane emissions from wastewater treatment systems affected by the project activity, and not equipped with biogas recovery in the project situation (PE_{ww,treatment,y}) is calculated using below formula:

$$BE_{ww,treatment,y} = \sum_i (Q_{ww,i,y} \times COD_{inflow,i,y} \times \eta_{COD,BL,i} \times MCF_{ww,treatment,BL,i}) \times B_{o,ww} \times UF_{BL} \times GWP_{CH_4}$$

Where,

Methane correction factor for project wastewater treatment system k (MCF_{ww,treatment,pj,k}) is taken as 0.8 for Anaerobic deep lagoon (depth more than 2 metres) as per applied methodology. Uncertainty factor (UF_{PJ}) is taken as 1.12 as per the applied methodology. COD removal efficiency is taken considering COD in and removal efficiency. Accordingly, PE_{ww,treatment,y} is estimated to be 7,295 tCO₂e.

Methane fugitive emissions on account of inefficiencies in capture systems ($PE_{fugitive,y}$) are determined as per AMS-III.H and as follows:

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

It was seen during the site visit that there was no sludge treatment system. Hence, $PE_{fugitive,s,y}$ is considered zero.

Fugitive emissions through capture inefficiencies in the anaerobic wastewater treatment systems in the year y ($PE_{fugitive,ww,y}$) is estimated as follows:

$$PE_{fugitive,ww,y} = (1 - CEF_{ww}) * MEP_{ww,treatment,y} * GWP_{CH4}$$

Capture efficiency of the biogas recovery equipment in the wastewater treatment (CEF_{ww}) is 0.9 as per the applied methodology. Global Warming Potential for methane (GWP_{CH4}) is fixed 25 as per IPCC.

Methane emission potential of wastewater treatment systems equipped with biogas recovery system in year y ($MEP_{ww,treatment,y}$) is calculated as follows:

$$MEP_{ww,treatment,y} = Q_{ww,y} * B_{o,ww} * UF_{PJ} * \sum_k COD_{removed,PJ,k,y} * MCF_{ww,treatment,PJ,k}$$

Flow of wastewater treated in the year y ($Q_{ww,y}$) is 441,833 m3 as explained in above. Methane producing capacity of the wastewater ($B_{o,ww}$) is fixed ex-ante to be 0.25 kg CH₄/kg COD. Model correction factor to account for model uncertainties (UF_{PJ}) is fixed ex-ante to be 1.12. Methane correction factor for wastewater treatment system k equipped with biogas recovery ($MCF_{ww,treatment,PJ,k}$) is fixed ex-ante to be 0.8 as per applied methodology. $COD_{removed,PJ,k,y}$ is calculated as the difference between $COD_{ww,untreated,y}$ and $COD_{ww,treated,y}$ estimated to be 0.01353 ton/m3. $MEP_{ww,treatment,y}$ is estimated to be 1,339 tonnes and $PE_{fugitive,ww,y}$ is 3,348 tCO₂e per year.

Project Emissions from flaring in year y ($PE_{flare,y}$) is calculated as per the methodological tool "project emissions from flaring" version 03 /27/ and as follows:

$$PE_{flare,y} = GWP_{CH4} \times \sum_{m=1}^{525600} F_{CH4,RG,m} \times (1 - \eta_{flare,m}) \times 10^{-3}$$

Global Warming Potential for methane (GWP_{CH4}) is fixed 25 as per IPCC. Flare efficiency in hour 'h' ($\eta_{flare,h}$) is 50% as in case of open flare as per the tool /27/. Mass flow rate of methane in the residual gas in hour 'h' shall be calculated as per the tool 'project emissions from flaring' version 03. Ex-ante the same is considered to be zero. Density of methane at normal condition ($\rho_{CH4,n,h}$) is fixed ex-ante to be 0.716

kg/m3 as per the tool 'project emissions from flaring' version 03 and fixed for the entire crediting period. Therefore, PE_{flare} estimated ex-ante to be zero.

Project Emissions for AMS-I.D:

As per AMS-I.D., paragraph 39, for the most renewable energy project activity, $PE_y = 0$. The project emission under AMS-I.D are considered zero.

As per applied methodology leakage emissions are zero for the project activity.

Emission reductions estimated ex-ante to be: $BE_y - PE_y$

$BE_y = 32,676 \text{ tCO}_2\text{e}$ and $PE_y = 13,357 \text{ tCO}_2\text{e}$

$ER_y = 19,319 \text{ tCO}_2\text{e}$ per year.

3.3.7 Methodology Deviations

In determining $EG_{thermal,y}$, PP has applied deviation from the procedure as outlined in AMS-I.C, version 21. As per AMS-I.C, version 21, the calculation formula is:

$$BE_{thermal, CO_2,y} = (EG_{thermal, y} / \eta_{BL, thermal}) * EF_{FF, CO_2}$$

Methodology requires 'metering the thermal and/or electrical energy produced'; (i) in the case of heat energy (e.g. hot air, hot water), direct measurement of flow and temperature is required. However, direct measurement of temperature (in and out) and flow of the thermal fluid were not feasible for the project and deviation is applied to estimate $EG_{thermal}$ based on quantity of dry starch that is produced during a particular year, a minimum required quantity of fossil fuel (fuel oil) can be estimated from 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 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. Ex-post, the starch production in a particular year 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. The calculation equation would be:

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

Where:

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

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

$q_{\text{FO},y}$ = 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 estimates 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. The validation team is of the opinion that the approach followed by the PPs is appropriate and hence the deviation is accepted.

3.3.8 Monitoring Plan

The proposed project uses CDM approved methodology AMS-III.H Version 19: ‘Methane recovery in wastewater treatment’, AMS-I.C: ‘Thermal energy production with or without electricity’ version 21 and AMS-I.D ‘Grid connected renewable electricity generation’, Version 18.0. The application of monitoring methodology is assessed as correct.

The monitoring plan in the PD provides detailed information related to the collection and archiving of all relevant data needed quality control measures as required by the applied methodologies. The monitoring arrangement and responsible personal as per the monitoring plan found effective during site visit and also confirmed from successful verification during first crediting period. The monitoring arrangements are feasible within the project design. The PP has the ability to implement the monitoring plan as per the PD.

3.4 Non-Permanence Risk Analysis

Not applicable, non-permanence risks were not identified.

4 VALIDATION CONCLUSION

Carbon Check India Pvt. Ltd. has performed validation (renewal of crediting period) of the project activity “Chol Charoen Group Wastewater Treatment With Biogas System I (Khonkaen)” in Thailand, with regard to the relevant requirements for VCS Version 4.0 activities.

The review of the project design document and the subsequent follow-up interviews have provided Carbon Check with sufficient evidence to determine the fulfillment of the stated criteria.

The project correctly applies the approved baseline and monitoring methodology “AMS-III.H”, “Methane recovery in wastewater treatment”, version 19, AMS-I.C, ‘Thermal energy production with or without electricity’, Version 21 and AMS-I.D ‘Grid connected renewable electricity generation’ version 18.

By generating renewable energy from biogas recovery in wastewater treatment, the project results in reduction of CO₂ emissions that are real measurable and giving long-term benefits to the mitigation of climate change. It is demonstrated that the project is not a likely baseline scenario. Emission reductions attributable to the project are hence additional to any that would occur in the absence of the project activity.

The total emission reductions from the “Chol Charoen Group Wastewater Treatment With Biogas System I (Khonkaen)” are estimated to be on average 19,318 tCO₂e per year over the selected 10 years crediting period. The emission reduction forecast has been checked and it is deemed likely that the stated amount is achieved given that the underlying assumptions do not change.

The monitoring plan provides for the monitoring of the project’s emission reductions and of the sustainable development indicators. The monitoring arrangements described in the monitoring plan are feasible within the project design and it is Carbon Check’s opinion that the project participants are able to implement the monitoring plan.

In conclusion, it is Carbon Check’s opinion that the project activity “Chol Charoen Group Wastewater Treatment With Biogas System I (Khonkaen)” in Thailand, as described in the VCS PD version 3 of 14/05/2020, meets all relevant UNFCCC and VCS Version 4.0 requirements for the VCS VER and all relevant host Party criteria and correctly applies the baseline and monitoring methodology “AMS-III.H”, “Methane recovery in wastewater treatment”, version 19, AMS-I.C, ‘Thermal energy production

with or without electricity', Version 21 and AMS-I.D 'Grid connected renewable electricity generation' version 18.

Carbon Check thus requests renewal of the crediting period the VCS project.

APPENDIX A: ABBREVIATIONS

Abbreviations	Full texts
BE	Baseline Emissions
CAR	Corrective Action Request
CC IPL	Carbon Check India Pvt. Ltd.
CDM	Clean Development Mechanism
CDM M&P	Modalities and Procedures CDM
CER(s)	Certified Emission Reduction(s)
CH ₄	Methane
CL	Clarification Request
CO ₂	Carbon dioxide
CO ₂ e	Carbon dioxide equivalent
COD	Chemical Oxygen Demand
DNA	Designated National Authority
DOE	Designated Operational Entity
EB	Executive Board
EF	Emission Factor
ER	Emission Reductions
FAR	Forward Action Request
GHG(s)	Greenhouse gas(es)
GWP	Global Warming Potential
HFO	Heavy Fuel Oil
IPCC	Intergovernmental Panel on Climate Change
LoA	Letter of Approval
MoV	Means of Verification
MR	Monitoring Report
NGO	Non-governmental Organization
ODA	Official Development Assistance

PDD	Project Design Document
PE	Project Emission
PEA	Provincial Electricity Authority
PP(s)	Project Participant(s)
Ref.	Document Reference
SS(s)	Sectoral Scope(s)
TA(s)	Technical Area(s)
TPD	Tons per day
UNFCCC	United Nations Framework Convention on Climate Change
VCS	Verified Carbon Standard
VCU	Verified Carbon Unit
VER	Voluntary Emission Reductions
VVS	Validation and Verification Standard

APPENDIX B: CLARIFICATION REQUESTS, CORRECTIVE ACTION REQUESTS AND FORWARD ACTION REQUEST

Table 1. Remaining FAR from validation and/or previous verification

FAR ID	xx	Section no.	2.5.1	Date: DD/MM/YYYY
Description of FAR				
<i>No remaining FAR to be addressed.</i>				
Project participant response				Date: DD/MM/YYYY
Documentation provided by project participant				
DOE assessment				Date: DD/MM/YYYY

Table 2. CL from this verification

CL ID	01	Section no.	1.4	Date: 31/03/2020
Description of CL				
- VCS-PD in page 9 section 1.11 states (Note that the two boilers together have a total capacity 7,268 kW_{thermal} (3,488 +3,780). However, previous verification report states differently. Please clarify. - Auxiliary connected capacity as per VCS-PD is 277 kW whereas previous verification report states 458 kW. Please clarify.				
Project participant response				Date: 0104/2020

1. The total capacity of boilers of 10.23 MW_{th} has been updated in the revised VCS-PD. At the beginning of the project implementation, the total capacity was 7.268 MW_{th} (3.488 + 3.780) and changed to 7.85 MW_{th} due to replacement of first boiler (from 3.488 to 4.070 MW_{th}) in 2010 during the first verification. In 2020, the second boiler was replaced with 6.61 MW_{th} thermal oil boiler resulting in the total capacity of boilers at 10.23 MW_{th} (4.07 + 6.61). The only reason for this replacement is the performance issue when consuming biogas. In terms of the production capacity, PP has provided the supportive evidence to confirm that there is no change in starch production and wastewater treatment system capacity. Also, the full stop has been used instead of comma. The approved (1st) verification report has been provided as evidence. 2. It is confirmed that the auxiliary capacity is 458 kW. As it was found inconsistency with the actual capacity during the first verification, the value in registered PD was updated from 277 to 458 kW. The mentioned capacity throughout the VCS-PD has been revised in line with the actual auxiliary installed capacity. Also, the approved (1st) verification report has been provided as evidence of the updated value.	
Documentation provided by project participant	
- Revised VCS-PD version 2, date 01/04/2020 - Revised ER sheet version 2, date 01/04/2020 Folder CL 1 Approved verification report (1st) date 04/06/2012	
DOE assessment	Date: 19/05/2020
The editorial corrections are done in the updated VCS-PD and found to be correct with actual project scenario. Previous verification report and monitoring reports used to cross check the details provided and hence CL is closed.	

CL ID	02	Section no.	1.4	Date: 31/03/2020
Description of CL				
Kindly submit copies of followings: 1. Last verification report and monitoring report. 2. Commissioning report of the project activity (Digester & biogas generator) 3. Valid operational license (starch production and biogas generation) issued to project participant (Kean Charoen Co. Ltd.) 4. Agreement between Kean Charoen Co. Ltd. and South Pole Carbon Asset Management Ltd.				

Project participant response		Date: 19/05/2020
The following documents have been provided to VVB for assessment. 1. Last verification report and monitoring report 2. Commissioning report for first biogas usage 3. Valid operation license for starch production 4. Part of signed agreement between Kean Charoen Co. Ltd. and South Pole Carbon Asset Management Ltd. For the operation license for biogas generation, as the biogas implementation is part of starch factory, the same license for starch production can be referred.		
Documentation provided by project participant		
Folder CR 2 CR 2_1 - Verification report, version 01, date 12/06/2019 - Monitoring report, version 01, date 11/06/2019 CR 2_2 - Commissioning of biogas in boiler - First record of biogas used in boiler - Commissioning of biogas in gas engine - First record of biogas used in gas engine CR 2_3 - Operation license issued to Kean Charoen Ltd. CR 2_4 Signed emission reduction purchase agreement between Kean Charoen Co.,Ltd. and South Pole Carbon Asset Management Ltd. date 27/03/2008		
DOE assessment		Date: 19/05/2020
PP has submitted the requested documents and details are consistent with the project design document. Hence CL is closed.		

CL ID	03	Section no.	3.1	Date: 31/03/2020
Description of CL				
PP is requested to clarify how the project activity will continue to operate the second crediting period with its operational technical life.				

Project participant response	Date: 19/05/2020
The confirmation letter for operational lifetime of the wastewater treatment system under the second crediting period has been provided to VVB.	
Documentation provided by project participant	
Folder CR 3 -Confirmation letter	
DOE assessment	Date: 19/05/2020
Third party technical expert assessment has confirmed that the wastewater system with biogas recovery can further last another 20 years with regular maintenance. Hence, the project activity can continue the second crediting period. Hence, CL is closed.	

Table 3. CAR from this verification

CAR ID	01	Section no.	3.3.6	Date: 31/03/2020
Description of CAR				
1. For calculation of project emission pertaining to grid electricity consumption, the ER sheet takes account 20% T&D loss whereas the VCS-PD states T&D loss to be 10%. 2. Project emissions from fossil fuel consumption is not provided in ER worksheet.				
Project participant response				Date: 19/05/2020
1. The calculation of project emission from power consumption has been revised in the ER sheet due to inconsistency of rated power capacity of auxiliary drives. Also, the values of applied TDL and total electrical capacity of auxiliary drives installed in the VCS PD have been revised to be in line throughout the document. 2. The project emissions from fossil fuel consumption are not estimated for ex ante ERs since the methodology deviation as provided under section 3.6 shall be applied for verification. Such deviation does not only estimate baseline emission, it also takes into account CO2 emissions from on-site consumption of fossil fuels due to the project activity.				
Documentation provided by project participant				
- Revised VCS-PD version 2, date 01/04/2020 - Revised ER sheet version 2, date 01/04/2020				

DOE assessment	Date: 19/05/2020
1. Transmission and distribution loss is taken as 20% conservatively and this has been made consistent through out the documents and hence accepted. 2. Project emissions from fossil fuel consumption is not envisaged under the project activity. Even without the project activity, fossil fuel (HFO) would be used in the boiler and hence, PP's justification not to account emissions from HFO consumption is accepted. In summary, CAR is closed.	