"WASTEWATER TREATMENT WITH BIOGAS SYSTEM IN PALM OIL MILL AT SAWI, CHUMPORN, THAILAND"

Document Prepared By: KBS Certification Services Pvt. Ltd.

Project Title	Wastewater Treatment with Biogas System in Palm Oil Mill at Sawi, Chumporn, Thailand
Version	02.0
Report ID	VCS.18.VER.001_Crediting period renewal

Report Title	Wastewater Treatment with Biogas System in Palm Oil Mill at Sawi, Chumporn, Thailand
Client	South Pole Carbon Asset Management Ltd.
Pages	58
Date of Issue	11-May-2018
Prepared By	KBS Certification Services Pvt. Ltd.
Contact	Registered Office: 414-424, Om Shubham Tower, Neelam-Bata Road, N.I.T., Faridabad-121001, Haryana India. Contact us at: Tel.: +91-129-4034513, 4054513, 403513, Fax: +91-129-4035139. Webpage: www.kbsindia.in.
Approved By	Kaushal Goyal, Managing Director
Work Carried Out By	Team Leader: Chetan Swaroop Sharma (TA 1.1, 13.1)

	Team Member: Rohit Badaya (TA 1.1, 13.1) Local Expert: Siam Phoolcharoen Technical Reviewer: Sanjay Kandari (TA 1.1, 13.1) Manager - Technical and Certification: Sanjay Kandari

Summary:

KBS Certification Services Pvt. Ltd. has been contracted by, "South Pole Carbon Asset Management Ltd." to undertake independent validation of the renewable crediting period of the project activity with the title "Wastewater Treatment with Biogas System in Palm Oil Mill at Sawi, Chumporn, Thailand" and VCS registry no. 426, with regard to the relevant requirements of VCS Standard Version 3.7.

KBS Certification Services Pvt. Ltd. has performed the validation of the renewable of the crediting period of the project activity with the title "Wastewater Treatment with Biogas System in Palm Oil Mill at Sawi, Chumporn, Thailand" and VCS registry no. 426. An independent and objective review of the project document (revised) and the project baseline along with the other relevant documents is reviewed against the requirement of the VCS Standard v3.7 and "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.

The report is based on the assessment of the revised project document, revised ex-ante emission reduction calculation sheet, application of standard auditing techniques including but not limited to desk review, follow up actions (e.g., on site visit, electronic (telephonic or e-mail) interviews) and also the review of the applicable approved methodological and relevant tools, guidances and CDM decisions.

In the course of validation, 01 Corrective Action Requests (CAR) and 02 Clarification Request (CL) have been raised. All the CARs and CLs have been closed out successfully.

Hence, KBS requests the renewable of the crediting period of the project activity (VCS ID. 426) "Wastewater Treatment with Biogas System in Palm Oil Mill at Sawi, Chumporn, Thailand".

Abbreviations

AMS	Approved Methodology for Small-scale project activities
BE	Baseline Emissions
CAR	Corrective Action Request
CDM	Clean Development Mechanism
CL	Clarification Request
CO_2	Carbon dioxide
COP	Conference of Parties
DOE	Designated Operational Entity
DR	Document Review
EB	Executive Board
EF	Emission Factor
ER	Emission Reduction
FAR	Forward Action Request
GHG	Greenhouse gas(es)
IPCC	Intergovernmental Panel on Climate Change
ISO	International Organization for Standardization
KP	Kyoto Protocol
LE	Leakage Emission
LSC	Local Stakeholder Consultation
MP	Monitoring Plan
PA	Project Activity
PCP	Project Cycle Procedure for project activities
PD	Project Description
PE	Project Emissions
PP	Project Participant
PPA	Power Purchase Agreement
QA/QC	Quality Assurance/Quality Control
UNFCCC	United Nations Framework Convention on Climate Change
VCS	Verified Carbon Standard
VER	Verified Emission Reduction
VVS	Validation and Verification Standard for project activities

Table of Contents

1 INTRODUCTION

1.1 Objective

South Pole Carbon Asset Management Ltd. has commissioned KBS to perform the validation of request to renew crediting period of the VCS project “Wastewater Treatment with Biogas System in Palm Oil Mill at Sawi, Chumporn, Thailand” (Project Id. 426) /1/2/. The assessment was done with regard to the relevant requirements of VCS Version 3.7 /2/.

The purpose of validation is to ensure a thorough, independent assessment of registered VCS project activity submitted for renewal of crediting period against the applicable VCS requirements.

In particular, the validity of project's baseline and regularity surplus are validated in order to confirm the clause no. 3.8.5 of VCS Standard Version 3.7 for the “Renewal of Project Crediting Period”. The validation is seen as necessary to provide assurance to stakeholders of the quality of the project and its intended generation of verified emission reduction (VER).

1.2 Scope and Criteria

The assessment was performed in accordance with the requirements of Verified Carbon Standard V3.7 and included an assessment, but not limited to, of following:

1. Demonstration of the regulatory surplus, in reference to the additionality of the project, in accordance with section 4.6.3 of the VCS Version 3.7.
2. Validity of the original baseline scenario reviewing the following:
    a. Evaluation of impact of new relevant national and/or sectoral policies and circumstances on the validity of the baseline scenario.
    b. Assessment of GHG emissions associated with the original baseline scenario 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 /2/.
    c. If original baseline scenario is no longer valid, whether the current baseline scenario is established in accordance with the VCS rules.
    d. 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.
3. The updated project description is validated in accordance with the current VCS rules (V3.7).

1.3 Level of Assurance

☒ Reasonable level of assurance

☐ Limited level of assurance

1.4 Summary Description of the Project

The project activity is the wastewater treatment plant implemented at the Natural Palm Group in Chumporn province, operated by the Natural Energy Harvesting Co., Ltd., which was founded in 2013 and has been operating a biogas plant in palm oil factory.

The initial company name "*Natural Palm Oil (Chumporn) Co.,Ltd."* was changed to "*The Natural Palm Group Co.Ltd."* as confirmed from the 1st Monitoring report. This new company is a combination of "*Natural Refinery Co.,Ltd.*", "*Natural Palm Oil (Chumporn) Co., Ltd.*" and "*Natural Electric (Chumporn) Co.,Ltd*", which was registered on 30th December 2009 with the cancellation of the old company on the same day. Subsequently, the "*Natural Energy Harvesting Co.,Ltd"* was registered on 25th April 2013 /10/. This company has the operating license for the biogas production and selling, issued on 8th March 2016 /8/. And another operating license issued on 30th November 2016 /8/ for the electricity generation from biogas. The operating license for the biogas production, selling and electricity generation has been checked by the assessment team and further confirmed through the interviews with the PP during the site visit /11/. The PPA which is also expected in year 2018 was discussed during the site visit. Further based on our local expertise, we confirm that the "*Natural Energy Harvesting Co.,Ltd"* is the project proponent for the project activity, as was also confirmed during the site visit. Further the other entity "South Pole Carbon Asset Management Ltd." is the Emission Reduction project developer/consultant for the project activity, which was also confirmed during the site visit.

The proposed project activity entails the installation of an anaerobic wastewater treatment facility, based on Complete Stirred Tank Reactors (CSTRs) biogas reactor technology and anaerobic covered lagoon which is a newly built lagoon, at the existing crude palm mill that used to discharge to the open anaerobic lagoons before discharge to existing system /3/5/. The methane produced from CSTRs and the covered lagoon is delivered to gas engines which generate electricity to serve the internal consumption and will be delivered to grid under the power purchase agreement.

In the absence of the project activity, the baseline wastewater treatment facility – a series of cascading open lagoon ponds is able to treat the wastewater and meet the current environmental standards. The treated wastewater is not discharged into any body of water resource, but sent to the nearby plantation and serves as fertilizer. After implementing the project, the quality of the treated water, which is subject to effluent standards regulated by the environmental authorities, will improve substantially due to higher efficiency and improved process control of the biogas reactor as compared to open lagoons. The project will also avoid odour emissions, contributing significantly to an improved quality of life around the project site, as compared to an anaerobic lagoon. Moreover, the treated water will still be utilized as fertilizer for the plantation.

The system comprises five major components: equalization pond, CSTR reactor tank, covered lagoon, gas storage and gas engine set.

Continuous Stirred Tank Reactor, CSTR technology is used in the project for methane biogas generation from wastewater with a high concentration of organic content by anaerobic digestion. The CSTR reactor consists of a well-stirred tank, incorporating a mechanical stirrer. The

wastewater is continuously pumped into the reactor at the same time as the treated water is removed. The CSTR is a versatile reactor, which allows simple catalyst charging and replacement. Its well-mixed nature (due to stirring) permits straightforward control over the temperature and pH of the reaction and the supply or removal of gas. The two CSTRs were implemented at a gap of two years and have a volumetric capacity of 4800 m^3 and 1800 m^3 respectively.

Anaerobic covered lagoon is a simple, effective and reliable technology to capture anaerobic lagoon-produced biogas. Material, used to cover the anaerobic pond, is synthetic high density polyethylene (HDPE) which is sealed by means of strip-to-strip welding and a peripheral anchor trenched around the perimeter of the existing lagoon.

The effluent from the wastewater treatment system will flow into the existing system of 8 cascading lagoons. It must be mentioned that there is no wastewater discharge outside the factory at all. The method of final discharge remains the same before and after the project activity. A relatively small amount of sludge will be removed infrequently and will be treated aerobically by land application. The methane capture will be used as fuel for gas engines which will also reduce the emission from methane avoidance which causes global warming.

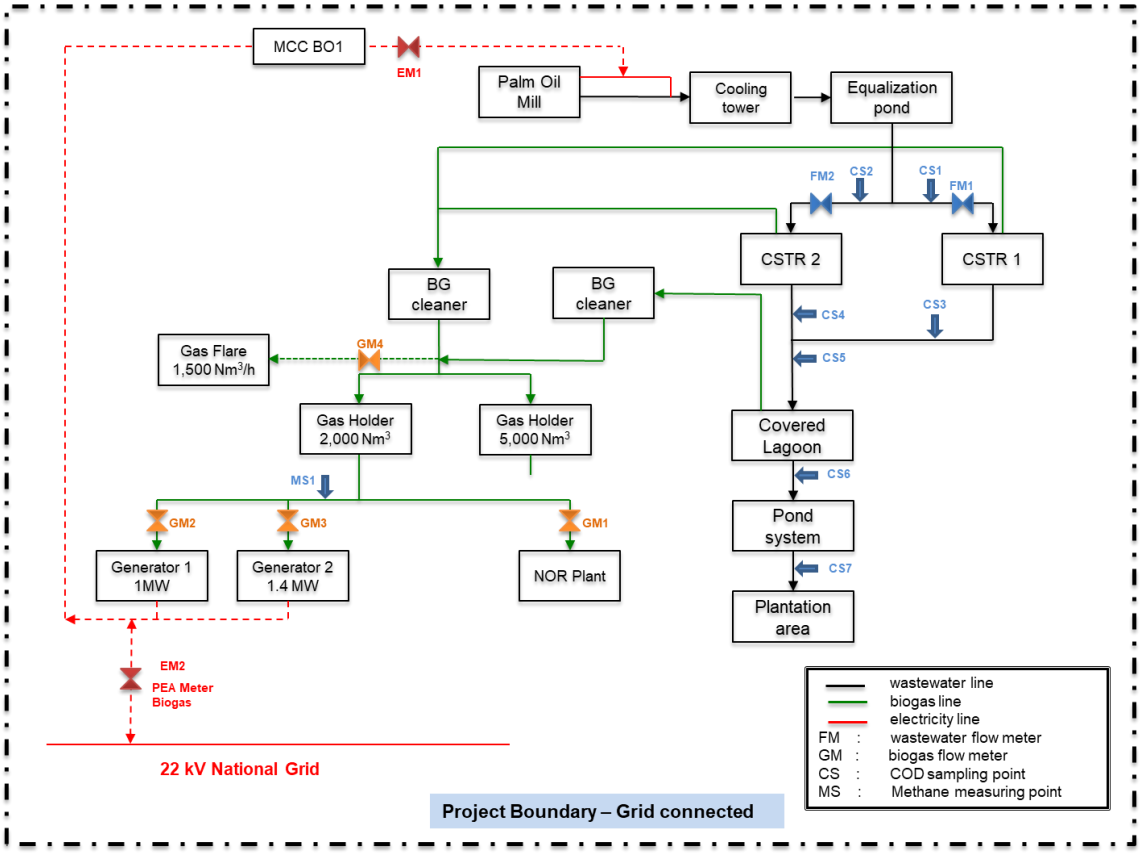
The project has a gas scrubbing system installed to cleanse the gas to finally use in the gas engines and two gas storages of capacity 5000 Nm^3 and 2000Nm^3 are available at project site. The gas storage sends the gas to gas cleansing system i.e. scrubber and then the blower delivers the gas to gas engines for electricity generation. There are 2 gas engines (GE Jenbacher) included in project boundary, with a capacity of 1.064 MW and 1.415 MW respectively. The generated electricity serves the internal consumption and will be delivered to grid under the power purchasing agreement for very small power plant. Any surplus biogas is sent to boiler or flare, which is an open flare.

The following are the details of the main equipment /3/5/6/ installed under the project activity.

Project/Baseline Component	**Brief Description**
Lagoon System	There are 8 open anaerobic lagoons at the baseline. The starting date of open anaerobic lagoon is July 2003 /5/.
CSTR (2 units)	The primary digesters, which are used in the project, have the capacity of 4800 m^3 for the CSTR1 and 1800 m^3 for CSTR2. The commissioning dates for those are on February 2006 and February 2007 /5/.
Covered lagoon	The covered lagoon is the anaerobic digester which is having the capacity of 25,168 m^3. It was commissioned together with CSTR2 /5/
Gas storage	There are two gas storages in the project site. The capacities are 5,000 and 2,000 m^3 /5/.

Gas engine	There are 2 gas engines (GE Jenbacher) have a capacity of 1.064 MW and 1.415 MW respectively. The first one was installed in 2005 and the second one later in 2007 /5/.
Flare (open flare type)	Flare has a maximum operation capacity of 500 Nm^3/hr as per the technology description in the proposal. This is higher than maximum gas generation capacity of anaerobic wastewater treatment plant. Commissioning date of flare is March 2006 /5/.
Capacity of Auxiliary drive	Total capacity of the auxiliary drives amount to 181.3 kW; the same can be referred in the GHG calculation sheet as well as in the document submitted during validation /5/.

The system is diagrammatically represented in the figure below /5/.



The proposed project activity helps reduce the emission of methane, which is otherwise released uncontrolled to the atmosphere from open lagoons. The proposed project activity is expected to reduce 35,028 tCO2e annually or total of 350,280 tCO2e during 10-years of the second crediting period /4/.

Comparing to the registered project design /02/, there are no major changes in project design during this renewable of crediting period. The new units (reactor no. 3, 4 and generator no.3) are not included in the project boundary, as well as in the emission reduction calculations. Hence it does not affect the project design during this renewable of crediting period for this project activity. Further this also does not impact the baseline scenario and additionality

CAR 01 was raised in this regard and successfully closed. (refer 2.5 of this report for the closure of this CAR 01). None of the changes impact the baseline scenario, applicability of the applied methodologies and additionality of the project activity.

The technical details and project description was cross checked through the documents review /5/ and confirmed during the site visit /11/, which was found correct.

2 VALIDATION PROCESS

2.1 Method and Criteria

The validation process was carried out in line with the requirements of VCS Version 3.7. Standard auditing techniques and KBS's CDM Procedures were also applied during the validation. The validation process included the following processes as described in the subsequent sub-sections.

Duration of Validation:

Validation Contract	15/01/2018
On-site Verification	01/02/2018 to 02/02/2018 /11/
Findings raised	08/02/2018
Draft Validation Report	29/03/2018
Final Validation Report	11/05/2018

2.2 Document Review

Desk review was performed of the revised PD /03/ against the registered and validated VCS PD /01/. The validation report /01/ and the previous verification reports /01/ were also reviewed to validate the renewal of crediting period in accordance with the VCS Standard Version 3.7 /02/. In addition, certain supportive documents, relating the project performance (like technical specifications /5//6/, COD measurements /07/, operating license /08/, operator log sheets /09/, company related documents /10/) were also reviewed.

The list of document reviewed is included in the Appendix 1: 'Reference Documents'

2.3 Interviews

The site visit for this validation assessment was undertaken by the members of the assessment team. Summary of on-site activities /11/ are mentioned below;

Location visited during site visit	During the site visit /11/, the palm oil factory was visited including the biogas plant, various installations & equipments, biogas handling & storage, wastewater treatment facility, secondary treatment system. The equipments visited include lagoon system, CSTR units, covered lagoon, gas storage, gas engine, flares and auxiliary drives /5/. The details on the organization and physical location /10/ where the visit was undertaken is as follows: Natural Palm Group (Chumporn) factory /10/ Address: 250 M. 12 Petchkasem Rd, Khron, Sawi, Chumporn, about 530 km south of Bangkok, Country: Thailand The project site is located at Latitude “10°17"34'N” and Longitude “99°5"27'E” /1//11/
Dates of site visit	01/02/2018 to 02/02/2018
Key points discussed, activities performed on-site and matter subject, documents	**Name of persons interviewed, Designation, Organization /11/**
Opening meeting, office inspection, project and technology implementation in the project activity, methodology justification, validity of baseline, additionality demonstration, discussion on the approvals for the plant operation, validation of supporting documents records, interviews and database inspection, emission reductions calculations, monitoring plan, project performance, operation and management of project activity, training of personnel, local laws and regulations in host country applicable to the project activity. Details on the supporting documents checked during the site visit has been provided under Appendix-1 (Reference documents) of the Report.	Kraisorn Kaew-on, Factory Manager, Natural Energy Harvesting Co.,Ltd. Thavatchai Bunsuv, Biogas Manager, Natural Energy Harvesting Co.,Ltd. Kridsada Kambamrung, Biogas PM Manager, Natural Energy Harvesting Co.,Ltd. Panthep Praophn, Biogas Supervisor, Natural Energy Harvesting Co.,Ltd. Orraphan Chookeaw, Lab Deputy Supervisor, Natural Energy Harvesting Co.,Ltd. Krisadakorn Jinahoon, Biogas Plant Manager, Natural Energy Harvesting Co.,Ltd. Jareerat Thongnate, Biogas Officer, Natural Energy Harvesting Co.,Ltd. Natanong Visespakdee, Quality System, Natural Energy Harvesting Co.,Ltd. Nattaya Lonawan, Project Manager, South Pole Carbon Asset Management Ltd. Sirinut Raya, Project Manager, South Pole Carbon

	Asset Management Ltd.

2.4 Site Inspections

A site visit was undertaken by members of validation team, involving but not limited to,

- An assessment of the implementation and operation of the VCS project activity as per the revised VCS PD was carried out on 01/02/2018 /11/.
- Interviews with relevant personnel to confirm that the operational and data collection procedures are implemented in accordance with the mentioned monitoring plan was carried out on 01/02/2018 /11/.
- A cross-check between information provided in the revised PD and data from other sources such as plant log books, inventories, purchase records or similar data sources was carried out on 02/02/2018 /11/.
- A check of the monitoring equipments including performance and observations of monitoring practices against the requirements of the registered VCS PD and the selected methodology was carried out on 02/02/2018 /11/.

2.5 Resolution of Findings

During the validation of the renewable of the crediting period, the following corrective actions request (1 CAR) and clarifications request (2 CLs) have been raised and resolved after satisfactory response from the project participants.

Table-1. CL from this validation

CL ID	01	**Section no.**	Section 1.12	**Date:** 08/02/2018
Description of CL				
PP need to submit the supportive document corresponding to the section "**1.12.1 Project Ownership**" under the VCS PD.				
Project participant response				**Date:** 09/03/2018
The PP: Natural Energy Harvesting is the owner of this project activity according to the operating license and Emission Reduction Purchasing Agreement.				
Documentation provided by project participant				
• The operating license of Natural Energy Harvesting (NEH) was submitted before the site visit. • The amendment to original ERPA for NEH is submitted.				
DOE assessment				**Date:** 22/03/2018
The Operating license, Company registration certificate, ISO documents and ERPA has been checked and confirmed that the Project ownership lies with the entity Natural Energy Harvesting. The same was also discussed and confirmed during the site visit. The issue is closed.				

CL ID	02	**Section no.**	Section 1.6	**Date:** 08/02/2018
Description of CL				
As per the section 1.6 of the registered VCS PD, the duration of the project activity was estimated to last 15 years and the project activity starts operation from May 2006. However the second crediting period is considered from 01/06/2016 to 31/05/2026. PP need to clarify.				
Project participant response				**Date:** 09/03/2018
The letter to extend the lifetime of CSTR is submitted.				
Documentation provided by project participant				

Lifetime Letter	
DOE assessment	**Date:** 22/03/2018
The PP has now submitted the letter which clearly specifies the lifetime of 20 years for the CSTR system. Hence the crediting period from 01/06/2016 to 31/05/2026 is appropriate considering the latest lifetime of the project activity. The issue is closed.	

Table-2. CAR from this validation

CAR ID	01	**Section no.**	Section 1.8	**Date:** 08/02/2018
Description of CAR				
PP need to highlight the major changes done in this renewable of crediting period.				
Project participant response				**Date:** 09/03/2018
There is no major change occurred within project boundary. The new units (reactor No.3 , 4 and generator No.3) are not included in the project boundary , as well as the emission reduction calculation.				
Documentation provided by project participant				
-				
DOE assessment				**Date:** 22/03/2018
The PP has now clarified that no major changes happened to the project activity during this renewable of crediting period. Although the new units (reactor no. 3, 4 and generator no.3) have been installed but they are not included in the project boundary and also not considered in the emission reduction calculations. The issue is closed.				

Table 3. FAR from this validation

No FAR from this validation.

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

2.5.1 Forward Action Requests

No Forward Action Request (FAR) is raised during this validation of the renewal crediting period.

3 VALIDATION FINDINGS

3.1 Project Details

The proposed project activity entails the installation of an anaerobic wastewater treatment facility, based on Complete Stirred Tank Reactors (CSTRs) biogas reactor technology and anaerobic covered lagoon which is a newly built lagoon, at the existing crude palm mill that used to discharge to the open anaerobic lagoons before discharge to existing system /1//3/5/. The methane produced from CSTRs and the covered lagoon is delivered to gas engines which generate electricity to serve the internal consumption and will be delivered to grid under the power purchase agreement /11/.

The total capacity of the electricity generation in the project activity is 2.479 MW /5//8/ which is below than 15 MW for a small-scale CDM project activity. The scale of the project has also been confirmed through the desk review of previous verifications available on the VCS website, technical specifications /5/ and through interviews conducted during the site visit. Therefore the project also falls under the Type-1 category.

The estimated emission reductions achieved by the project activity is 35,028 tCO_2e per year /4/. Therefore the project also falls under the Type-III small scale category. The scale of the project has also been confirmed through the desk review of previous verifications available on the VCS website, technical specifications /5/ and through interview conducted during the site visit. Validation team has also cross-checked the same from ex-ante ER calculation sheet /4/.

The project details are same as in the registered VCS PD /01/. Comparing to the registered project design /01/, there are no major changes in project design during this renewable of crediting period. The new units (reactor no.3, 4 and generator no.3) are not included in the project boundary, as well as the emission reduction calculation /5/. Hence it does not affect the project design during this renewable of crediting period for this project activity. Further this does not impact the baseline scenario and additionality of the project activity.

In the pre-project scenario of the project activity, the wastewater treatment facility consisted of a series of cascading open lagoon ponds, able to treat the wastewater and meet the current environmental standards. The treated wastewater was not discharged into any body of water resource, but sent to the nearby plantation and serves as fertilizer. The pre-project scenario was confirmed through the review of documents, including the previous verifications and also confirmed during the site visit /11/.

The project activity is not a grouped project activity, hence the Eligibility criteria as per the Section 3.4.9 of the VCS standard, version 3.7 is not applicable. The project site is located at the site of the Natural Palm Group (Chumporn) factory, which is at the address: 250 M. 12 Petchkasem Rd, Khron, Sawi, Chumporn, about 530 km south of Bangkok. The same location was found during the site visit /11/.

CAR 01 has been raised in this regard and successfully closed. (refer 2.5 of this report for the closure of this CAR). None of the change impacts the baseline scenario, applicability of the applied methodologies and additionality of the project activity.

- **Project crediting period**: 2nd Crediting period, 10 years from 01/06/2016 to 31/05/2026. The previous crediting period has been confirmed through the previous approved monitoring and verification reports /1/ which are available on the VCS registry. The same was also confirmed during the site visit.
- **Project estimated GHG emission reductions or removals**: 350,280 emission reductions credits for the 10 year second crediting period and 35,028 tCO_2e emission reduction credits per year. The same has been confirmed through the Emission Reductions excelsheet submitted by the PP /4/.
- **Project start date**: The start date is 15/05/2006, the date of first usage of biogas in gas engine to generate power i.e. destruction of captured biogas starts. The start date was confirmed during the site visit /11/. The project start date has already been validated during the registration of project during the 1st crediting period and confirmed through the previous validation report /1/ of the project activity and found Ok.
- **Participation under other GHG programs**: The project has not been registered, participated nor rejected under any other GHG program. Further the project has not sought or eligible to be sought any other forms of environmental credit. The same was confirmed during the site visit and confirmed through the other registries of GHG programs.

Validation team confirms that the project description is accurate, complete, and provides an understanding of the nature of the project. CL 01 and CL 02 were raised during the validation process, which was subsequently successfully closed.

The project details and project description was cross checked through the documents review /1//5/ and confirmed during the site visit /11/, which was found correct.

3.2 Application of Methodology

3.2.1 Title and Reference

The project uses the VCS board-approved consolidated baseline and monitoring methodologies:

- AMS III.H: Methane Recovery in Wastewater Treatment, version 18.0[1] /12/;
- AMS I.D: Grid Connected Renewal Electricity Generation, version 18.0[2] /12/.

The above selected methodologies also refer to the latest approved versions of the following approved methodologies and methodological tools:

a) Project emissions from flaring, version 02.0.0[3] /13/;

[1] https://cdm.unfccc.int/methodologies/DB/H9DVSB24O7GEZQYLYNWUX23YS6G4RC
[2] https://cdm.unfccc.int/methodologies/DB/W3TINZ7KKWCK7L8WTXFQQOFQQH4SBK

b) Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation, version 03.0[4] /13/;
c) Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion, version 03[5] /13/;
d) Tool to calculate the emission factor for an electricity system, version 06.0[6] /13/.

3.2.2 Applicability

In accordance with the paragraph 3.8.5 of the VCS standard V3.7 /02/ and Assessment of the validity of the original/current baseline and to update the baseline at the renewal of a crediting period, version 3.0.1 /02/, the VCS PD has been updated using the latest version of the applied methodologies i.e. AMS III.H: Methane Recovery in Wastewater Treatment, version 18.0 and AMS-I.D.: Grid Connected Renewal Electricity Generation, version 18.0 and applicable methodological tools. The project meets the applicable criteria of the latest version of the applied methodologies. Validation team has checked the PP's justification (in the revised VCS PD /03/) for the applicability criteria of the latest version of the applied methodologies and found Ok.

The assessment of the project's compliance with each applicability condition of the applied methodologies is given below.

Applicability for AMS III.H /12/

Applicability Criteria	**Project Status**	**Validation team assessment**
2. This methodology comprises measures that recover biogas from biogenic organic matter in wastewater by means of one, or a combination, of the following options: (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	In the absence of the project activity the wastewater would have been treated in existing open lagoons (all with depth greater than 2 meters) under anaerobic condition without biogas recovery. The project activity involves the installation of CSTR and covered lagoon system to treat high COD concentration of wastewater generated and to capture biogas. Therefore, the project activity can fulfil the applicability condition (f).	The project activity involves the installation of CSTRs and covered lagoon system to treat high COD concentration of wastewater generated and to capture biogas. The recovered biogas is delivered to gas engines which generate electricity to serve the internal consumption and will be delivered to grid under power purchase agreement. Any surplus biogas is sent to boiler or flare, which is an open flare.

[3] https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-06-v2.0.pdf
[4] https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-05-v3.0.pdf
[5] https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-03-v3.pdf
[6] https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-07-v6.pdf

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 that is presently being treated in an anaerobic lagoon without methane recovery).		Validation team has checked the same from the on-site visit, previous registered VCS PD /01/ and document review /5//6/7/8/. The same was also validated during previous crediting period. The response given by the PP is acceptable to the validation team. The condition under criteria (f) satisfies for the project activity.

3. 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.	The wastewater would have been treated in an open anaerobic lagoon in the absence of the project. a) The baseline system is anaerobic lagoons with the minimum depth of 2 m.; b) The average atmospheric temperature in the region is 27 degree Celsius[7]; c) There was no any sludge removal before the implementation of project activity. The minimum interval is definitely more than 30 days. Therefore, the project activity is applicable for this criterion.	The validation team has checked the PP response and found acceptable. a) The baseline system is 8 open anaerobic lagoons with minimum depth of 2 meter /5/8/. Validation team has cross-verified the same during the on-site visit. b) The yearly average atmospheric temperature in the region is more than 27°C as cross-checked from Thai Meteorological Department[8] . c) The retention time is more than 30 days as checked from the on-site interview /11/ and from documents review. This information was also validated during previous crediting period and hence acceptable to the validation team.
4. 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	The captured biogas from the project activity will be utilized for thermal and electricity energy generation directly which falls under condition a).	The justification by the PP is accepted to the validation team. The recovered biogas is delivered to gas engines which generate electricity to serve the internal consumption

[7] Source: METEOROLOGICAL DEPARTMENT, website http://www.tmd.go.th/agromet_report.php
[8] https://www.tmd.go.th/en/climate.php?FileID=5

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 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.		and will be delivered to grid and any surplus biogas is sent to boiler or flare, which is an open flare. Hence condition "a" is applicable. Validation team has checked the same from the on-site visit /11/, previous registered VCS PD /01/ and document review. The same was also validated during previous crediting period.
5. If the recovered biogas is used for project activities covered under paragraph 4(a), that component of the project activity can use a corresponding methodology under Type I.	The project activity also applies AMS I.D for electricity generation component.	The project uses the recovered biogas for electricity generation which was confirmed based on the document review /1/5/, hence the justification provided by

		the PP is acceptable to the Validation team. The same was confirmed during the site visit.
6. 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 CO_2 emissions avoided by the displacement of fossil fuel can be claimed under the corresponding Type I methodology, e.g. "AMS-I.C.: Thermal energy production with or without electricity".	This condition is not relevant to the project activity.	The condition is not relevant to the project activity as checked from the on-site visit /11/.
7. 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.	This condition is not relevant to the project activity.	The condition is not relevant to the project activity as checked from the on-site visit /11/.
8. For project activities covered under paragraph 4(c)(ii), emission reductions for the displacement of the use of fuels can be claimed	This condition is not relevant to the project activity.	The condition is not relevant to the project activity as checked from the on-site visit /11/.

	following the provision in the corresponding Type I methodology, e.g. AMS-I.C.		
9.	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.	This condition is not relevant to the project activity.	The condition is not relevant to the project activity as checked from the on-site visit /11/.
10.	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).	This condition is not relevant to the project activity.	The condition is not relevant to the project activity as checked from the on-site visit /11/.
11.	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 using methane extracted from biogas".	This condition is not relevant to the project activity.	The condition is not relevant to the project activity as checked from the on-site visit /11/.
12.	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".	This condition is not relevant to the project activity.	The condition is not relevant to the project activity as checked from the on-site visit /11/.

13. 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.	The project activity is not a greenfield project. Hence this condition is not relevant to the project activity.	Project is not a green field project activity. The condition is not relevant to the project activity as checked from the on-site visit /11/. The same was also validated during the previous crediting period.
14. 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 project activity is clearly identified in section 1.9 above.	The justification provided by the PP is acceptable. The project location and source of generating wastewater is clearly defined in the Section 1.8 & 1.9 of the VCS PD. The same was also confirmed during the site visit and hence this criterion is met.
15. 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 achieved by this project activity is 35,028 tCO_2e per year which is much less than the limit.	The emission reductions achieved by the project activity is 35,028 tCO_2e per year, hence the criteria have been met. Therefore the project also falls under the Type-III small scale category. The scale of the project has also been confirmed through the desk review of previous verifications /1/5/ available on the VCS website /2/,

		technical specifications /5/ and through interview during the site visit /11/.Validation team has cross-checked the same from Ex-ante ER calculation sheet /4/.

Applicability for AMS-I.D.

Applicability Criteria	Project Status	Validation team assessment
2. This methodology comprises renewable energy generation units, such as photovoltaics, 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 involves the installation of generators that will use biogas as fuel to produce electricity. The total capacity of the generators is 2.479 MW. Hence, the project activity is satisfied with this applicability criterion.	This condition is applicable to the project activity as checked from the on-site visit. The recovered methane is used as fuel to produce electricity. The total capacity of the generators is 2.479 MW as confirmed through the desk review /5//6/8/. The same was also validated during previous crediting period.
3. Illustration of respective situations under which each of the methodology (i.e. "AMS-I.D.: Grid connected renewable electricity generation", "AMS-I.F.: Renewable electricity generation for captive use and mini-grid" and "AMS-I.A.: Electricity generation by the user) applies is included in the appendix.	The project activity will use a part of biogas (a renewable fuel) which is captured from the methane avoidance component of the project activity to generate electricity by the gas engines. The electricity generated will be firstly served the internal consumption and then exported to the national grid. Hence, it can be concluded that AMS I.D is applicable for this project activity.	The justification by the PP is acceptable to the validation team. The recovered biogas is delivered to gas engines which generate electricity to serve the internal consumption and will be delivered to grid. The same was checked during the on-site visit /11/. Hence this applicability criterion is applicable to the project activity.
4. This methodology is applicable to project activities that (a) Install a Greenfield plan; (b) Involve a capacity addition in (an) existing plant(s); (c) Involve a retrofit of (an) existing plant(s); (d) Involve a rehabilitation	The project activity will install a gas engine set at the project site where there was no renewable energy power plant operating prior to the implementation of the project.	The justification by the PP is acceptable to the validation team. The recovered biogas is delivered to gas engines which generate electricity to serve the internal consumption and will be delivered to grid. The same was verified from the on-site visit /11/ and from the document review /5/6/8/.

of (an) existing plant(s)/unit(s); or (e) Involve a replacement of (an) existing plant(s).		The same was also validated during the last crediting period. Hence this criterion have been met.
5. Hydro power plants with reservoirs that satisfy at least one of the following conditions are eligible to 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/m_2; (c) The 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.	This condition is not relevant to the project activity.	Project activity is neither a hydro power plant nor a green field project activity. Hence, this condition is not relevant to the project activity.
6. If the new unit has both renewable and non-renewable components (e.g. a wind/diesel unit), the eligibility limit of 15MW for a small-scale CDM project activity applies only to the renewable component. If the unit added co-fires fossil fuel, the capacity of the entire unit shall not exceed the limit of 15 MW.	The total capacity of the generators for producing electricity is 2.479 MW which does not use the co-fired fossil fuel. Therefore, the project activity is applicable for this criterion.	The total capacity of the electricity generation in the project activity is 2.479 MW /5//8/ which is below than 15 MW for a small-scale CDM project activity. The scale of the project has also been confirmed through the desk review of previous verifications /1/ available on the VCS website, technical specifications /5/ and through the interview during the site visit /11/. Hence the criterion

		has been met by the project activity.
7. Combined heat and power (co-generation) systems are not eligible under this category.	This condition is not relevant to the project activity	The project does not involve cogeneration systems and hence the criterion is not applicable to the project activity. The same was confirmed during the site visit.
8. 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.	This condition is not relevant to the project activity	This condition is not relevant to the project activity as checked during the on-site visit.
9. 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.	This condition is not relevant to the project activity	The total capacity of the electricity generation in the project activity is 2.479 MW /5/8/ which is below than 15 MW for a small-scale CDM project activity. The scale of the project has also been confirmed through the desk review of previous verifications /1/ available on the VCS website, technical specifications /5/ and through the interview during the site visit. Hence this criterion has been met by the project activity.
10. In the case of landfill gas, waste gas, wastewater treatment and agro-industries projects, recovered methane	The approved baseline and monitoring methodologies. AMS-I.D. is used for the electricity generation components of the project	The project has electricity generation component and the baseline for the electricity component is applied in accordance with the

emissions are eligible under a relevant Type III category. If the recovered methane is used for electricity 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.	activity.	procedures prescribed under the applied methodology AMS I.D. Therefore the project also falls under the Type-1 category. The same has been verified through the review of the VCS-PD and confirmed during the site visit interview.
11. In case biomass is sourced from dedicated plantations, the applicability criteria in the tool "Project emissions from cultivation of biomass" shall apply.	This condition is not relevant to the project activity	This condition is not relevant to the project activity as the biogas is generated at the project site by the PP. The biomass is not sourced from any dedicated plantations.

3.2.3 Project Boundary

As per paragraph 20 of the applied methodology "**AMS-III.H.: Methane recovery in wastewater treatment --- Version 18.0**", definition of the project boundary is "*the project boundary is the physical, geographical site where the wastewater and sludge treatment takes place, in the baseline and project situations. It covers all facilities affected by the project activity including sites where processing, transportation and application or disposal of waste products as well as biogas takes place*".

As per paragraph 18 of the applied methodology "**AMS-I.D.: Grid connected renewal electricity generation --- Version 18.0**", definition of the project boundary is "*the spatial extent of the project boundary includes the project power plant and all power plants connected physically to the electricity system that the CDM project power plant is connected to*".

The project boundary is the physical, geographical site where the wastewater and sludge treatment takes place, in the baseline and project situations. It covers all facilities affected by the project activity including sites where processing, transportation and application or disposal of waste products as well as biogas takes place.

The components of the project boundary mentioned in the VCS PD /01/ were found to be in compliance with applicable paragraph of the applied methodologies. The validation team conducted the on-site inspection to confirm the appropriateness of the project boundary identified. The validation team confirmed during the site visit that all GHG sources required by the methodology have been included within the project boundary. It was assessed by physical inspection that no emission sources related to project activity will cause any deviation from the applicability of the methodology or accuracy of the emission reductions.

The project boundary for the calculations of project and baseline emissions is given in the below figures.

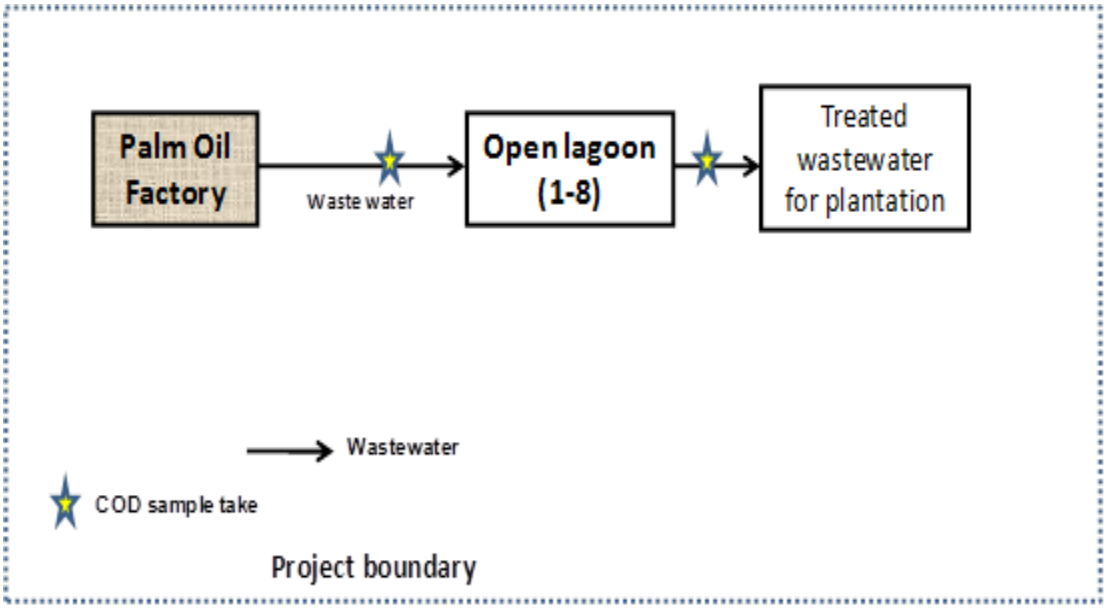


Figure: Baseline System Boundary

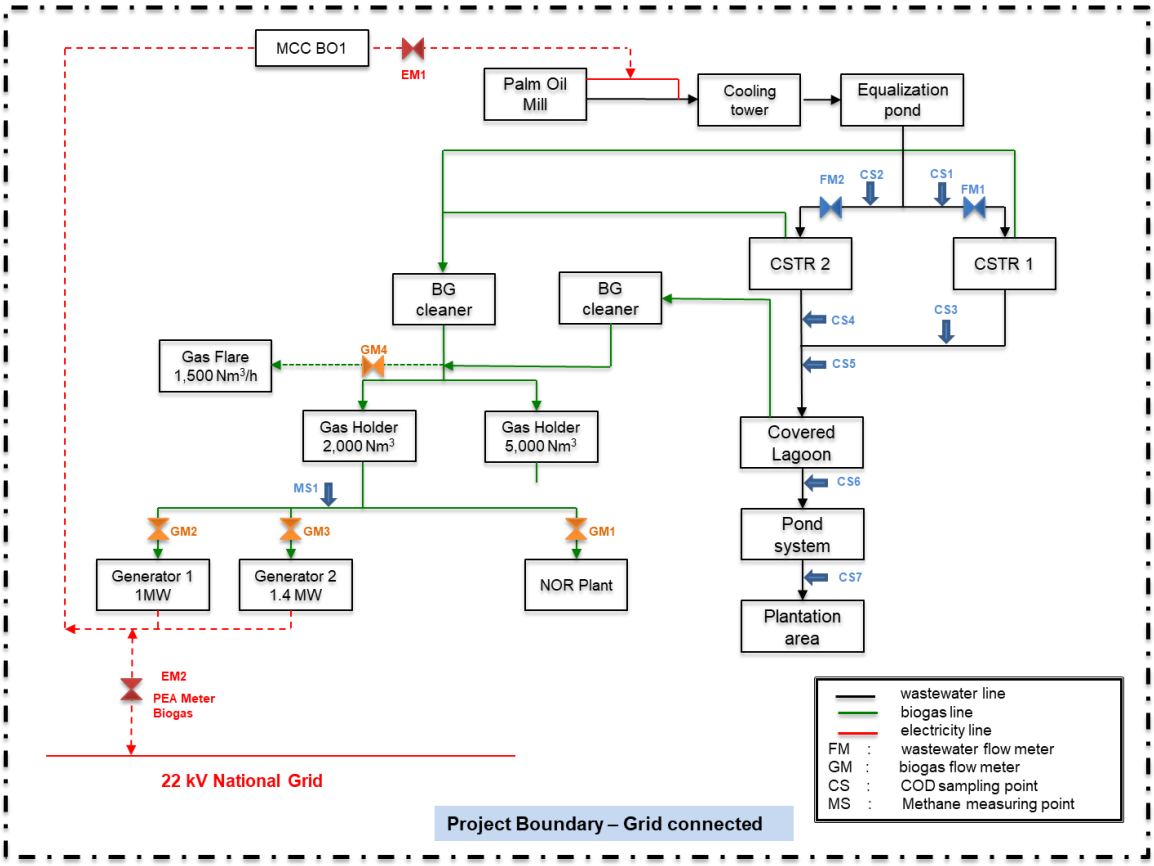


Figure: Project System Boundary

The validation team was able to assess that complete information regarding the project boundary has been provided in VCS PD /01/ and could be validated from the above diagram and confirmed during the site visit.

The validation team confirms that all identified boundary, selected emissions sources are justified for the project activity. It could be confirmed that there are no emissions expected due to implementation of the project activity, contributing more than 1% of the overall expected average annual emission reductions, which are not addressed by the applied methodologies.

3.2.4 Baseline Scenario

The revised VCS PD (version 02, dated 09/03/2018) /01/ applying the latest version of the applied methodologies **AMS III.H: Methane Recovery in Wastewater Treatment, version 18.0 and AMS I.D: Grid connected renewal electricity generation, version 18.0 and applicable methodological tools**, found in line with paragraph 3.8.5 (2) of VCS standard V3.7 /02/.

The baseline scenario for the project activity has been demonstrated in accordance with the paragraph 3.8.5 (2) "Renewal of Project Crediting Period" of VCS Standard: VCS Version 3.7 /02/ and following steps have been taken.

Assessment as per VCS standard v3.7 **(Paragraph 3.8.5 (2) "Renewal of Project Crediting Period")**	**PP Justification**	**Validation team confirmation**
(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.	Refer to section 1.11 of this PD, *The proposed project activity is in compliance with all local laws and regulations*. Therefore, there is no impact to the original baseline of project activity.	Validation team has reviewed the local waste water related policies /14/ and electricity generation related policies /14/ and as per which, there is no impact on the current baseline and hence the same is accepted to the validation team.
(b) Where it is determined that the original baseline 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 upd*ate the baseline at the renewable of a crediting period.	The assessment is provided in Table 3 and Table 4 of the VCS PD	The original baseline is still valid. The assessment as per "*Assessment of the validity of the original/current baseline and to update the baseline at the renewal of a crediting period, version 3.0.1*" /2/ is provided in Table 3 and Table 4 under section 2.4 of the revised VCS PD /03/. Validation team has checked the assessment on original baseline in Table 3 and Table 4 under section 2.4 of the revised VCS PD /03/ and

Assessment as per VCS standard v3.7 **(Paragraph 3.8.5 (2) "Renewal of Project Crediting Period")**	**PP Justification**	**Validation team confirmation**
		found Ok. Validation opinion for the same is given in the below tables in this report.
(c) Where it is determined that the original baseline scenario is no longer valid, the current baseline scenario shall be established in accordance with the VCS rues.	According to assessment result presented in Table 3 and Table 4 of VCS PD, the original baseline scenario is still valid. This section is not applicable.	According to assessment result presented in Table 3 and Table 4 under section 2.4 of the revised VCS PD /03/, the original baseline scenario is still valid. This section is not applicable.
(d) The project description, containing updated information with respect to the baseline, the estimated GHG emission reductions or removals and the monitoring plan, shall be submitted for validation.	The project description is updated and revised according to the latest approved version of AMS III.H and AMS I.D including the relevant tools to the applied methodologies.	Validation team has checked the updated project description, GHG emission reductions or removals and the monitoring plan and found OK. Hence this is acceptable to the validation team.

Methane avoidance component:

At the project location, open anaerobic lagoons without methane recovery represent the existing wastewater treatment system and the biogas reactor system is being introduced as a sequential stage with methane recovery to the existing lagoon system.

Therefore, the baseline scenario to the project activity is as follows:

"The existing anaerobic wastewater treatment system without methane recovery for the case of introduction of a sequential anaerobic wastewater treatment system with methane recovery"

The baseline scenario consists of 8 anaerobic lagoons, which were used to treat wastewater prior to project implementation. The lagoons have a minimum depth of 2 m. According to the principle design of the anaerobic pond, the average volume of waste water is about 450 m^3/day which gives a retention time of approximately 289 days. The ponds are minimum 2 meters in depth measured from the water surface. Therefore, the open lagoons of starch factory are under anaerobic process because the retention time and depth of ponds are higher than principle design value.

Validation team has assessed the validity of the original baseline scenario, including information about any new relevant national and/or sectoral policies and their effect on the baseline scenario and the reassessment of GHG emissions associated with the original baseline scenario as per the requirement of CDM Tool **"***Assessment of the validity of the original/current baseline and to update the baseline at the renewal of a crediting period, version 3.0.1***"** /2/ as given below. It is confirmed that the original baseline scenario is still valid for the next crediting period.

Validity of original baseline for methane avoidance component:

Assessment as per CDM Tool "*Assessment of the validity of the original/current baseline and to update the baseline at the renewal of a crediting period, version 3.0.1***"**	**PP Justification**	**Validation team confirmation**
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 polices	The project complies with the national policies as the justification is provided in the previous section of the VCS-PD.	As per the local waste water related policies, there is a limit on the BOD and COD levels /7/ of the waste water that can be discharged out of palm oil factory. The project, however, do not discharge wastewater outside the factory, instead the wastewater is used in plantation area. The same was confirmed during the site visit and hence there is no impact on the existing baseline scenario. Validation team has further checked the major Act (National Environmental Quality Act B.E.2535 (NEQA 1992)) /14/ relates to Pollution Control Department (PCD) /14/ roles to establishment of pollution control standards from sources, categorization of Pollution control source as controlled emissions,

		effluence or waste disposal. Also the Factories Act B.E 2535 (1992) and the Ministerial regulation B.E. 2546 /14/ have been checked by the validation team. Validation team has reviewed the local and national waste water related policies from the document review /14/ and found that the project complies with the national policies. Validation team confirms that there are no new relevant national and/or sectoral policies and circumstances ever since the project was registered that have an impact on the current baseline. Hence there is no need to update the current baseline.
Step 1.2: Assess the impact of circumstances	There is no change in the circumstance that would impact the continuation of existing open lagoon system as a baseline scenario of the project.	There is no change in the circumstances including the local, national or sectoral policies /14/ which may impact the current baseline of project activity. Validation team has checked the same from document review /22/. Hence the justification provided by the PP is Ok.
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 identified baseline scenario at the first validation of this project was the continuous using of the existing anaerobic open lagoons without any investment. This system requires extremely limited operation and maintenance due to the self-regulatory nature of the systems. Hence, lagoons are a very cost-effective	The continuation of the identified baseline scenario during 1st validation does not require any investment and also the new technical lifetime for the CSTR system has been checked as per which 20 years of new lifetime /14/ is expected, which exceeds next crediting period for

	solution, do not require advanced technology and are easy to operate and maintain[9]. The technical lifetime of baseline system exceeds the crediting period for which renewal is requested.	which renewal is requested. Moreover, the PP conducts the internal inspection plus the overhaul of piping and stirrer every 5 years. The performance of the system is still as per the design specification after 10 years operation (COD removal and biogas generation rate) /6/. The PP has the operating license /8/, specifically for biogas production from anaerobic system. The operating license must be renewed every 5 years /8/. Hence the continuation of current baseline scenario is the likely scenario for the next crediting period as well. The justification provided by the PP is OK.
Step 1.4: Assessment of the validity of the data and parameters	All data and parameters that were determined at the start of the crediting period are updated accordingly.	Validation team has checked the revised VCS PD /01/ and found that the all the data and parameters are updated accordingly and found OK.

The justification provided above shows that the current baseline scenario for methane avoidance component is still valid for subsequent crediting period for which renewal is requested. Also, all data and parameters have been updated accordingly for the next crediting period.

Electricity generation component:

[9] Cinara, 2004 "Waste stabilization ponds for wastewater treatment, International Water and Sanitation Centre"
http://www.irc.nl/page/8237
https://bioenergyinternational.com/feedstock/asia-biogas-turning-pome-to-power

According to paragraph 19 of the AMS.I.D (version 18.0), the baseline scenario for Greenfield power plant is "*the baseline scenario is that the electricity delivered to the grid by the project activity would have otherwise been generated by the operation of grid-connected power plants and by the addition of new generation sources into the grid".*

In absence of the project activity, the project would use electricity supplied from grid.

Validity of original baseline for electrical energy generation component

Assessment as per CDM tool "*Assessment of the validity of the original/current baseline and to update the baseline at the renewal of a crediting period, version 3.0.1***"**	**PP Justification**	**Validation team confirmation**
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 polices	The project complies the national policies as the justification is provided in the previous section.	Validation team has reviewed the local and national policies on electrical energy generation. The "Thailand Power Development Plan [10] " (2015-2036) dated June 30, 2015 by "Ministry of Energy" /14/ has been cross checked and found that the current national/sectoral policies do not impact the current baseline identified during the 1st crediting period. Hence the same is accepted to the validation team.
Step 1.2: Assess the impact of circumstances	There is no change in the circumstance that would impact the continuation of using electricity from grid system as a baseline scenario of the project.	There is no change in the circumstances which could impact the current baseline (continuation of using electricity from grid system). The justification

[10] http://www2.eppo.go.th/power/PDP2015/PDP2015_Eng.pdf

		by the PP is OK.
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 continuation to use the electricity imported from grid as a most likely scenario for source of electricity supplied to project activity is still applicable for this crediting period.	The palm oil mill can continue to use the electricity from grid without investment instead of using the biogas for electricity generation. The gas engines are inspected on regular basis as per the relevant regulations. Since the electricity generation and export can only take place once it has the permission from relevant government authorities under the regulations of Thailand /14/, hence it implies that the there are no circumstances (national policies/regulations) /14/ which could impact the continuation of the original baseline for the use of the electricity imported from grid. The justification by the PP is OK. The same is also discussed under CL 02 which was successfully closed. Validation team has checked the documents /20/ for the confirmation. Hence the continuation of current baseline scenario is the likely scenario for the next crediting period as well. The justification provided by the PP is OK.
Step 1.4: Assessment of the validity of the data and parameters	All data and parameters that were determined at the start of the crediting period are updated	Validation team has checked the revised VCS PD /01/ and found that all the data and parameters

	accordingly.	are updated accordingly and found Ok.

The justification provided above shows that the current baseline scenario for electricity generation component is still valid for subsequent crediting period for which the renewal is requested. Also, all data and parameters have been updated to use for the renewed crediting period.

3.2.5 *Additionality*

Referring to the VCS Standard version V3.7 paragraph 3.8.5, a full reassessment of additionality is not required when renewing the project crediting period, the additionality of the project was assessed for the regulatory surplus.

There is no legal requirement for the industry to treat the wastewater in closed anaerobic system and subsequent methane collection. There is no other regulatory requirement for the implementation of a specific wastewater treatment technology such as anaerobic digester or aerobic treatment system to palm oil mill for wastewater treatment[11]. The current law in Thailand, which allows the use of open lagoon systems and other waste treatment technologies that meet effluent standards for the discharge of treated wastewater into the environment (COD ≤ 400 mg/l)[12].

To further clarify on this point, Validation team has checked the major act (National Environmental Quality Act B.E.2535 (NEQA 1992)) relates to Pollution Control Department (PCD) /14/ roles to establishment of pollution control standards from sources, categorization of Pollution control source as controlled emissions, effluence or waste disposal. Also the Factories Act B.E 2535 (1992) and the Ministerial regulation B.E. 2546 have been checked by the validation team. The "Thailand Power Development Plan[13]" (2015-2036) dated June 30, 2015 by "Ministry of Energy" /14/ on the electrical energy generation has also been cross checked by the assessment team. Validation team has also checked the national and sectoral policies applicable to project activity from the review of documents and the assessment team is in the opinion that the project continues to be voluntary and further the project is in compliance with the applicable laws, statutes and other regulatory frameworks /14/.

Therefore, the proposed project activity is a regulatory surplus as it is not being implemented to respond to laws or regulations.

[11] https://www.jetro.go.jp/thailand/e_survey/factoryact.html
https://www.jetro.go.jp/ext_images/thailand/pdf/MOIEffluentStandards2560.pdf
[12] Notification by the Ministry of Industry, No. 2, B.E. 2539 (1996) issued under the Factory Act B.E. 2535 (1992); Re: Standard of Discharging Effluent from Factories. As well, the maximum permissible COD content of wastewater discharge is 400 mg/l for all types of industry.
[13] http://www2.eppo.go.th/power/PDP2015/PDP2015_Eng.pdf

3.2.6 *Quantification of GHG Emission Reductions and Removals*

The emission reductions in the project activity have been generated due to avoidance of methane emissions and generation of electricity through gas engines. The project activity involves the installation of a CSTRs and covered lagoon system to treat high COD concentration of wastewater generated and to capture biogas and the methodology AMS III. H., version 18 /12/ has been applied for the estimation of emission reductions for this component. The project has applied the methodology AMS I.D., version 18 /12/ for the estimation of emissions reductions for the component related to the combustion of biogas in the gas engines for the electrical energy generation.

Baseline Emissions for Methane Recovery Component /1/

The project proponent refers to paragraph 27 of the AMS III.H. version 18 for the calculation of baseline emissions for methane recovery component.

BEy = BEpower,y + BEww,treatment,y + BEs,treatment,y + BEww,discharge,y + BEs,final,y

where:

BEy = Baseline emissions in year y (tCO_2e)

BEpower,y = Baseline emissions from electricity or fuel consumption in year *y* (tCO_2e)

BEww,treatment,y = Baseline emissions of the wastewater treatment systems affected by the project activity in year *y* (tCO_2e)

BEs,treatment,y = Baseline emissions of the sludge treatment systems affected by the project activity in year *y* (tCO_2e)

BEww,discharge,y = Baseline methane emissions from degradable organic carbon in treated wastewater discharged into sea/river/lake in year y (tCO_2e). The value of this term is zero for the case 1(b)

BEs,final,y = Baseline methane emissions from anaerobic decay of the final sludge produced in year *y* (tCO_2e). 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

A. Baseline emissions from electricity or fuel consumption (BEpower,y)

The only electricity consumption devices used in the baseline wastewater treatment systems are pumps for pumping the wastewater from the palm oil factory into the open anaerobic lagoons. For the sake of simplification and conservativeness, baseline emissions from electricity and fuel consumptions ($BE_{power,\ y}$) are assumed to be zero which has been found conservative by the assessment team.

$$BE_{power,\ y} = 0$$

B. Methane emissions from baseline wastewater treatment systems ($BE_{ww,treatment,y}$);

The PP has correctly applied the following equation of AMS-III.H. version 18 for the calculations of baseline emissions of wastewater treatment systems. The parameters are validated and tabulated as follows:

$$BE_{ww,treatment,y} = \sum_{i}\left(Q_{ww,i,y} \times COD_{inflow,i,y} \times \eta_{COD,BL,i} \times MCF_{ww,treatment,BL,i}\right) \times B_{0,ww} \times UF_{BL} \times GWP_{CH4}$$

$Q_{ww,i,y}$	=	Volume of wastewater treated in baseline wastewater treatment system i in year y (m^3). However, the ex post emissions reduction calculation shall be based on the actual monitored volume of treated wastewater. For ex ante estimation, forecasted wastewater generation volume (135,000 m^3/year) based on the historical records have been estimated. The same was verified by the assessment team during the site visit and found correct.
$COD_{inflow,i,y}$	=	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. For the ex-ante estimation, the value of 80,000 mg/l has been used which cross checked with the log books during the site visit and found correct.
$\eta_{COD,BL,i}$	=	COD removal efficiency of the baseline treatment system *i*. The value of 87.49% has been considered based on the measurement campaign which has been found to be correct.
$MCF_{ww,treatment,BL,i}$	=	Methane correction factor for baseline wastewater treatment systems *i*. PP has considered the MCF value of 0.8[14] based on the IPCC default values which have been found correct.
$B_{0,ww}$	=	Methane producing capacity of the wastewater. The IPCC value of 0.25 kg CH_4/kg COD[15] has been considered which is found correct by the assessment team.
UF_{BL}	=	The Model correction factor of 0.89[16] to account for model uncertainties is found correct based on the source of data (FCCC/SBSTA/2003/10/Add.2, page 25) provided to the assessment team.
GWP_{CH4}	=	Global Warming Potential for methane of 25 has been used which has been found correct based on the 2006 IPCC default values.

[14] Default values from chapter 6 of volume 5. Waste in 2006 IPCC Guidelines for National Greenhouse Gas Inventories.
[15] Project activities may use the default value of 0.6 kg CH_4/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.
[16] Reference: FCCC/SBSTA/2003/10/Add.2, page 25

C. Methane emissions from baseline sludge treatment systems ($BE_{s,treatment,y}$)

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 which has been found conservative by the assessment team.

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

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 which has been found appropriate.

$BE_{ww, discharge, y} = 0$

E. Baseline methane emissions from anaerobic decay of the final sludge produced ($BE_{s,final,y}$)

The baseline methane emissions from anaerobic decay of the final sludge ($BE_{s, final, y}$) produced has been neglected which is found conservative by the assessment team.

$BE_{s, final, y} = 0$

Baseline Emissions for Electricity Generation Component /1/

The project proponent refers to paragraph 22 of the AMS I.D. version 18 for the calculation of baseline emissions for electricity generation component.

Baseline emissions include only CO_2 emissions from electricity generation in power plants that are displaced due to the project activity. The methodology assumes that all project electricity generation above baseline levels would have been generated by existing grid-connected power plants and the addition of new grid-connected power plants. The baseline emissions are to be calculated as follows:

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

Where:

BE_y	=	Baseline emissions in year *y* (t CO_2)
$EG_{PJ,y}$	=	Quantity of net electricity generation that is produced and fed into the grid as a result of the implementation of the project activity in year *y* (MWh)

$EF_{grid,y}$ = Combined margin CO_2 emission factor for grid connected power generation in year *y* calculated using the latest version of the "Tool to calculate the emission factor for an electricity system" (t CO_2/MWh)

Greenfield power plants

If the project activity is the installation of a greenfield power plant, then:

Equation (1)

$$EG_{PJ,y} = EG_{PJ,facility,y}$$

Where:

$EG_{PJ,facility,y}$ = Quantity of net electricity generation supplied by the project plant/unit to the grid in year *y* (MWh)

The emission factor shall be calculated in a transparent and conservative manner as follows:

a) A combined margin (CM), consisting of the combination of operating margin (OM) and build margin (BM) according to the procedures prescribed in the "Tool to calculate the emission factor for an electricity system"; or
b) The weighted average emissions (in t CO_2/MWh) of the current generation mix. The data of the year in which project generation occurs must be used.

Determination of $EF_{grid,y}$

The option a) : a combined margin (CM) which consisting of the combination of operating margin (OM) and build margin (BM) , is chosen in this case.

The combined margin emission factor for Grid system in Thailand is calculated and reported by Thailand Greenhouse Gas Management Organization or TGO[17]. The data used for national grid emission calculation is provided by Energy Regulatory Commission or ERC. The $EF_{grid,CM,y}$ from latest available version of the grid emissions study will be used. This approach is in line with the condition identified in clause 19: option A1 of the reference tool, ($EF_{EL,j,y} = EF_{grid,CM,y}$).

The result of grid emission factor for general project reported by the "*Thailand Grid Emission Factor for GHG Reduction Project/Activity"* , published by TGO on 28/09/2017 is shown in table below ;

Tool	Weight	Emission Factor	Unit
Operating Margin: OM	0.5	0.5719	tCO_2/MWh
Build Margin: BM	0.5	0.5609	
Combined Margin: CM – General Project		**0.5664**	

[17] http://ghgreduction.tgo.or.th/t-ver/images/Grid_Emission_Factor_2559_-_Finalised.pdf

Refer to clause 84 (b) of *'Tool to calculate the emission factor for an electricity system'* , version 05.0 , *All other projects:* w_{OM} *= 0.5 and* w_{BM} *= 0.5 for the first crediting period, and* w_{OM} *= 0.25 and* w_{BM} *= 0.75 for the second and third crediting period.*

Equation (16)

$$EF_{grid,CM,y} = EF_{grid,OM,y} * w_{OM} + EF_{grid,BM,y} * w_{BM}$$

Where :

$EF_{grid,BM,y}$	Build margin CO2 emission factor in year y (t CO_2/MWh)
$EF_{grid,OM,y}$	Operating margin CO2 emission factor in year y (t CO_2/MWh)
W_{OM}	Weighting of operating margin emissions factor (per cent)
W_{BM}	Weighting of operating margin emissions factor (per cent)

The $EF_{grid,CM,y}$ is re-calculated by using equation (16) , the value to be used is 0.5637.

Summary of Baseline Emissions (BE) calculation /1/4/

Baseline Emissions as per AMS.III.H		
Design capacity of palm oil mill	60	t/h
Operating hours	15	h/d
Wastewater generation - design value	0.50	m^3/t
Operating days	300	d/y
Wastewater flow - $Q_{ww,y}$	135,000	m^3/year
COD in	80,000	mg/l
Efficiency of lagoon system - COD removal	87.49%	-
COD out - based on baseline system efficiency	10,010	mg/l
Model correction factor - UF_{BL}	0.89	-
COD removal - baseline	0.069990	t/m^3
$B_{o, ww}$	0.25	tCH4/tCOD
$MCF_{ww, treatment, BL, i}$	0.8	-

GWP_{CH4}	25	-
$BE_{ww,treatment,y}$	**42,046**	**t CO2e/year**
MD_y	**39,901**	**t CO2e/year**

COD removal efficiency of CSTR system	80%	-
COD removal efficiency of CL	60%	-
COD out - project activity	6,400	mg/l
COD removed - project activity (anaerobic)	0.0736	t/m^3

Baseline Emissions as per AMS.I.D		
Electricity generation - $EG_{PJ,y}$	7,901.68	MWh
Efficiency of generator	100%	-
Grid emisison factor	0.5637	tCO_2/MWh
BE_y	**4,454**	**tCO2e/year**

Project Emissions for Methane Recovery Component /1/

The project emissions are calculated from

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

Where:

PE_y	Project activity emissions in the year y (tCO_2e)
$PE_{power,y}$	Emissions from electricity or fuel consumption in the year *y* (tCO_2e).
$PE_{ww,treatment,y}$	Methane emissions from wastewater treatment systems affected by the project activity, and not equipped with biogas recovery, in year *y* (tCO_2e).
$PE_{s,treatment,y}$	Methane emissions from sludge treatment systems affected by the project activity, and not equipped with biogas recovery, in year y (tCO_2e).
$PE_{ww,discharge,y}$	Methane emissions from degradable organic carbon in treated wastewater in year y (tCO_2e).
$PE_{s,final,y}$	Methane emissions from anaerobic decay of the final sludge produced in year y (tCO_2e).
$PE_{fugitive,y}$	Methane emissions from biogas release in capture systems in year y

	(tCO_2e)
$PE_{flaring,y}$	Methane emissions due to incomplete flaring in year y (tCO_2e).
$PE_{biomass,y}$	Methane emissions from biomass stored under anaerobic conditions. (tCO_2e)

A. CO_2 emissions from electricity and fuel used by the project facilities ($PE_{power,y}$)

These emissions shall be calculated as per paragraph 28 of the methodology, "*If recovered biogas in the baseline is used to power auxiliary equipment it should be taken into account accordingly, using zero as its emission factor".* The electricity used by project activity will be firstly supplied by the gas engines which use biogas as fuel, to import electricity from the grid is the second option when the gas engines do not operate. However, after the COD of the biomass power plant in 2013 as VSPP, this power plant also deliver the electricity to the project activity before delivery to the grid. Then the chance that the project activity will use electricity from grid is very low. Therefore, $PE_{power,y}$ can be considered as zero.

However, in case only when the biogas plant need to import the electricity from grid the $PE_{power,y}$ will be taken into account , which can be calculated from the same equation (1) of the baseline calculation formula for AMS I.D.

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

The combined margin emission factor for Grid system in Thailand is calculated and reported by "Thailand Greenhouse Gas Management Organization" or TGO. The data used for national grid emission calculation is provided by "Energy Regulatory Commission" or ERC. The $EF_{grid,CM,y}$ from latest available version of the grid emissions study will be used. Thailand Grid Emission Factor as published by the TGO has been considered as appropriate for the project activity. The value used in the calculation is 0.5664.

B. Methane emissions from wastewater treatment systems affected by the project activity, and not equipped with biogas recovery in the project scenario ($PE_{ww,treatment,y}$)

These emissions shall be calculated as per equation (2) in the baseline emission calculation, using an uncertainty factor of 1.12 and data applicable to the project situation ($MCF_{ww,treatment,PJ,k}$) and with the following changed definition of parameters:

$MCF_{ww,treatment,PJ,k}$	Methane correction factor for project wastewater treatment system *k*

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

The approach used for the estimation of the above methane emissions in the VCS PD have been considered as appropriate and found ok.

C. Methane emissions from sludge treatment systems affected by the project activity, and not equipped with biogas recovery in the project situation ($PE_{s,treatment,y}$)

The project activity does not include sludge treatment system, therefore the emission from sludge treatment system are not taken into consideration and hence found correct.

D. Methane emissions on account of inefficiency of the project activity wastewater treatment systems and presence of degradable organic carbon in treated wastewater ($PE_{ww,discharge,y}$)

The treated wastewater will be discharged in existing open lagoons and there will be no discharge to river, sea or lake in the project activity. Hence, emissions from this component have not been included for estimation of emissions which is found Ok.

E. Methane emissions from the decay of the final sludge generated by the project activity treatment systems ($PE_{s,final,y}$)

A relatively small amount of final sludge will be removed from the digester. The project proponent will apply final sludge for field application as fertilizer and the final disposal of the sludge shall be monitored during the crediting period. Hence the anaerobic decay from the final sludge produced has been omitted in line with the AMS III.H version 18 which is found Ok.

F. Methane fugitive emissions due to inefficiencies in capture systems ***(*** $PE_{fugitive,y}$ ***)***

Project activity emissions from methane release in capture systems are determined as follows:

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

where,

$PE_{fugitive,ww,y}$ = Fugitive emissions through capture inefficiencies in the anaerobic wastewater treatment systems in the year y (t CO2e)

$PE_{fugitive,s,y}$ = Fugitive emissions through capture inefficiencies in the anaerobic sludge treatment systems in the year *y* (t CO_2e)

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

where,

CFE_{ww} = Capture efficiency of the biogas recovery equipment in the wastewater treatment systems (a default value of 0.9 shall be used)

$MEP_{ww,treatment,y}$ = Methane emission potential of wastewater treatment systems equipped with biogas recovery system in year *y* (t)

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

where,

$COD_{removed,PJ,k,y}$ = The chemical oxygen demand removed[18] by the treatment system *k* of the project activity equipped with biogas recovery in the year *y* (t/m^3)

[18] Difference between the inflow COD and the outflow COD.

$MCF_{ww,treatment,PJ,k}$ = Methane correction factor for the project wastewater treatment system *k* equipped with biogas recovery equipment (*MCF* values as per Table 2 above)

UF_{PJ} = Model correction factor to account for model uncertainties (1.12)

Thus, the fugitive emissions through capture inefficiencies in the anaerobic wastewater treatment systems are given as:

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

Since there is no anaerobic sludge treatment in the project activity. Therefore the PEfugitive,y is considered as zero and excluded from the project emission calculation and found Ok.

G. Methane emissions due to incomplete flaring ***(*** $PE_{flaring,y}$ ***)***

The project emissions due to the flaring of biogas has been estimated using the "*Tool to determine project emissions from flaring gases containing methane"* version 02.0.0" which has been found appropriate by the assessment team.

H. Methane emissions from biomass stored under anaerobic conditions which would not have occurred in the baseline situation ($PE_{biomass,y}$)

The project does not involve the biomass storage. Therefore methane emissions from biomass stored under anaerobic conditions which does not take place in the baseline situation are not taken into consideration and found Ok.

Project Emissions for the Electricity Generation Component (AMS I.D., version 18) /1/

The project emissions have been considered as zero in line with the paragraph 39 of the applied methodology (AMS I.D., version 18), which is found correct by the assessment team.

Summary of Project Emissions (PE) calculation /1//4/

Project Emissions as per AMS.III.H		
Rated power capacity	181	kWh
Annual Power Consumption	1,685	MWh/year
Emission Factor of electricity (EF_y)	0.5637	tCO2/MWh
TDL	6.073%	-
$PE_{power,y}$	**1,007**	**tCO2e/year**
Wastewater flow - Q ww,y	135,000	m^3/year
CODout from project activity	0.0064	t/m^3
COD - reduction in open lagoon	87.5%	-

$B_{o, ww}$	0.25	tCH4/tCOD
UF_{PJ} - Model correction factor	1.12	-
$MCF_{ww, treatment, PJ, k}$	0.8	-
$PE_{ww, treatment,y}$	**4,233**	**tCO2e/year**
CFE - ww	0.9	-
$MEP_{ww,treatment,y}$	2,226	t CH4/year
$PE_{fugitive,y}$	**6,232**	**tCO2e/year**
Biogas to be flared ($BG_{ToFlare,y}$)	0	Nm^3/year
	0	kg/year
Flare efficiency	0%	-
$PE_{flare, y}$	**0**	**tCO2e/year**

Leakage Emissions /1//4/

The leakage emissions in the project activity have not been considered since no equipment is transferred from another activity. This is also in line with the methodologies AMS.III.H and AMS.I.D applied by the project activity.

Emission Reductions due to Methane Recovery Component (as per AMS III.H) /1//4/

For the ex-ante calculations, the emission reductions have been calculated based on the baseline emissions, project emissions and leakage emissions as follows:

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

Where:

$ER_{y,ex\ ante}$ = Ex ante emission reduction in year *y* (t CO_2e)

$LE_{y,ex\ ante}$ = Ex ante leakage emissions in year *y* (t CO_2e)

$PE_{y,ex\ ante}$ = Ex ante project emissions in year *y* calculated as paragraph 41 (t CO_2e)

$BE_{y,ex\ ante}$ = Ex ante baseline emissions in year *y* calculated as per paragraph 27 (t CO_2e)

For cases 2(f), the ex-post estimation of emission reductions, the lowest value of the following shall be used in line with the paragraph 46 of the applied methodology (AMS III.H version 18).

a) The amount of biogas recovered and fuelled or flared (MD_y) during the crediting period, that is monitored ex post;

b) Ex post calculated baseline, project and leakage emissions based on actual monitored data for the project activity.

or

For cases 2(f): it is possible that the project activity involves wastewater and sludge treatment systems with higher methane conversion factors (*MCF*) or with higher efficiency than the treatment systems used in the baseline situation. Therefore the emission reductions achieved by the project activity is limited to the ex post calculated baseline emissions minus project emissions using the actual monitored data for the project activity. The emission reductions achieved in any year are the lowest value of the following:

$$ER_{y,ex\ post} = min\left(\left(BE_{y,ex\ post} - PE_{y,ex\ post} - LE_{y,ex\ post}\right), \left(MD_y - PE_{power,y} - PE_{biomass,y} - LE_{y,ex\ post}\right)\right)$$

Where:

$ER_{y,ex\ post}$ = Emission reductions achieved by the project activity based on monitored values for year *y* (t CO_2e)

$BE_{y,ex\ post}$ = Baseline emissions calculated as per paragraph 27 using ex post monitored values

$PE_{y,ex\ post}$ = Project emissions calculated as per paragraph 41 using ex post monitored values

MD_y = Methane captured and destroyed/gainfully used by the project activity in the year *y* (t CO_2e)

In the case of flaring/combustion MD_y will be measured using the conditions of the flaring process:

$$MD_y = BG_{burnt,y} \times w_{CH4,y} \times D_{CH4} \times FE \times GWP_{CH4}$$

where:

$BG_{burnt,y}$ = Biogas flared/combusted in year *y* (m^3)

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

D_{CH4} = Density of methane at the temperature and pressure of the biogas in the year *y* (t/m^3)

FE = Flare efficiency in year *y* (fraction). If the biogas is combusted for gainful purposes, e.g. fed to an engine, an efficiency of 100 per cent may be applied

Emission Reductions due to Electricity Generation Component (as per AMS I. D)

The emission reductions shall be calculated as follows:

ERy = BEy – PEy - LEy

Where:
ERy = Emission reductions in year y (tCO_2e)
BEy = Baseline emissions in year y (tCO_2e)
PEy = Project emissions in year y (tCO_2e)
LEy = Leakage emissions in year y (tCO_2e)

The emission reductions based on the above equations have been estimated as follows /4/:

Year	Estimated baseline emissions or removals (tCO_2e)	Estimated project emissions or removals (tCO_2e)	Estimated leakage emissions (tCO_2e)	Estimated net GHG emission reductions or removals (tCO_2e)
Year 0	27,125	6,693	0	20,433
Year 1	46,500	11,473	0	35,028
Year 2	46,500	11,473	0	35,028
Year 3	46,500	11,473	0	35,028
Year 4	46,500	11,473	0	35,028
Year 5	46,500	11,473	0	35,028
Year 6	46,500	11,473	0	35,028
Year 7	46,500	11,473	0	35,028
Year 8	46,500	11,473	0	35,028
Year 9	46,500	11,473	0	35,028
Year 10	19,375	4,780	0	14,595
Total	465,000	114,730	0	350,280

The calculation of emission reduction has been updated as per the requirement of the latest version of the applied methodologies and the applicable methodological tools. The validation team has assessed the calculations of the project emissions, baseline emissions and leakage emissions and emission reductions provided in the Emission Reductions excelsheet /4/. It has been confirmed that the calculation for emission reductions are in accordance with the applied methodologies (AMS III. H, version 18 and AMS I.D, version 18). The formulae used in the calculations of the emission reductions are correct and have been transparently documented in the VCS PD and Excel spreadsheet.

3.2.7 Methodology Deviations

There are no deviations found from the applied methodologies.

3.2.8 Monitoring Plan

The project applies the monitoring methodology as per the AMS III.H: Methane Recovery in Wastewater Treatment, version 18.0 /12/ and AMS I.D: Grid connected renewable electricity generation, version 18.0 /12/ and applicable methodological tools. Both the methodologies are approved CDM methodologies. The baseline and project emission parameters that are monitored are available in the Section 4 of the VCS-PD. The Validation team has verified the list of parameters and confirms that these are in line with the requirements of the applied methodologies.

Monitoring Parameters /1/12/:

1. Flow of wastewater ($Q_{ww,i,y}$): The flow is continuously measured through the Volumetric flow meter (magnetic flow type) installed before CSTR system which was confirmed during the site visit. The flow meter is also subjected to maintenance/calibration at least once every 3 years which is in line with the industry standards. The measurement procedures are in line with the requirements as defined under Section 6.1 of the applied methodology. The flow of wastewater shall be used for the calculation of baseline and project emissions.

2. Chemical oxygen demand of untreated waste water ($COD_{ww,untreated,y}$): The COD content will be analyzed using a colorimetric method in the on-site laboratory of the treatment plant which was confirmed during the site visit. The equipment which shall be used for the colorimetric analysis is Spectrophotometer which is USEPA approved for wastewater analysis (standard method 5220 D). The sampling and analysis will be carried out adhering to internationally recognized procedures and ensure a 90/10 confidence level. The spectrophotometer is calibrated at least once every 3 years. The measurement of the COD is thus in line with the national and international standards as per the requirements of the monitoring parameter in Section 6.1 of the applied methodology. The results will be logged in the plant operation report on daily basis and used in the estimation of baseline and project emissions.

3. Chemical oxygen demand of treated waste water ($COD_{ww,treated,y}$): The COD content will be analyzed using a colorimetric method in the on-site laboratory of the treatment plant which was confirmed during the site visit. The equipment which shall be used for the colorimetric analysis is Spectrophotometer which is USEPA approved for wastewater analysis (standard method 5220 D). The sampling and analysis will be carried out adhering to internationally recognized procedures and ensure a 90/10 confidence level. The spectrophotometer is calibrated at least once every 3 years. The measurement of the COD is thus in line with the national and international standards as per the requirements of the monitoring parameter in Section 6.1 of the applied methodology. The results will be logged in the plant operation report on daily basis and used in the estimation of baseline and project emissions.

4. Amount of dry matter in the sludge ($S_{final,PJ,y}$): The amount of dry matter in sludge will be measured through the weighbridge at palm oil plant which was verified during the site visit. The total quantity of sludge is measured on a wet basis and the volume & density or direct weighing will be used for determining the sludge amount on wet basis. The 100 per cent of the sludge amount will be monitored through continuous or batch measurements and moisture content through representative sampling to ensure the 90/10 confidence/precision level. The measurement is in line with the requirements of the monitoring parameter in Section 6.1 of the applied methodology. The results shall be recorded and used for the estimation of project emissions.

5. Amount of biogas combusted for gainful use in year y ($BG_{burnt,combusted,y}$): The amount of biogas will be measured through the Gas flow meter (thermal mass type) which was checked during the site visit. The gas flow meter shall automatically measure temperature and pressure, expressing biogas volumes in normalized cubic meters (Nm^3) sent to the gas engines. The gas is monitored continuously (at least hourly measurements are undertaken, if less, confidence/precision level of 90/10 shall be attained). The Gas flow meters will undergo maintenance/calibration subject to appropriate industry standards, at least once every 3 years. The measurement is in line with the requirements of the monitoring parameter in Section 6.1 of the applied methodology. The results shall be recorded and used for the estimation of baseline emissions.

6. Amount of biogas sent to flare system ($BG_{burnt,TOFlare,y}$ / $v_{RG,m}$): The amount of biogas will be measured through the Gas flow meter (thermal mass type) which was checked during the site visit. The gas flow meters with an accepted level of accuracy have been installed at the plant, providing continuous measurements of the total biogas volume sent to the flare system. Thermal-mass type flow meters shall automatically measure temperature and pressure, expressing biogas volumes in normalized cubic meters (Nm^3). The gas is monitored continuously (at least hourly measurements are undertaken, if less, confidence/precision level of 90/10 shall be attained). The Gas flow meters will undergo maintenance/calibration subject to appropriate industry standards, at least once every 3 years. The measurement is in line with the requirements of the monitoring parameter in Section 6.1 of the applied methodology. The results shall be recorded and used for the estimation of project emissions.

7. Methane content in biogas ($w_{CH4,y}$): The amount of methane content in biogas will be measured using Methane Gas Analyzer which was checked during the site visit. The methane content measurement shall be carried out close to a location in the system where a biogas flow measurement takes place. The fraction of methane in the gas to be measured with a continuously or, alternatively, with periodical measurements at a 90/10 confidence/precision level. The Gas analyser will undergo maintenance/calibration subject to appropriate industry standards, at least once every 3 years. The measurement is in line with the requirements of the monitoring parameter in Section 6.1 of the applied methodology. The results shall be recorded and used for the estimation of baseline and project emissions.

8. Flare Efficiency ($\eta_{flare-m}$): The default value of 0.0% has been considered as flare efficiency which is on a conservative side and hence acceptable. The same is in line with the requirements of the monitoring parameter in Section 6.1 of the applied methodology. The results shall be recorded and used for the estimation of project emissions.

9. Quantity of electricity consumed by the project activity ($EC_{PJ,j,y}$): The electricity consumed by the project activity is measured through the Electricity meter owned and maintained by Provincial Electricity Authority (PEA). The electricity meter is owned and maintained by PEA and the meter maintenance is not under the jurisdiction of project proponent. The readings are measured continuously and recorded and reported on a monthly basis by PEA. The monthly report issued by PEA shall be used to get the amount of electricity consumed from grid. The same was confirmed through the discussions during the site visit. The measurement is in line with the requirements of the monitoring parameter in Section 6.1 of the applied methodology. The results shall be recorded and used for the estimation of project emissions.

10. Quantity of net electricity generation supplied by the project plant/unit to the grid in year y ($EC_{PJ,facility,y}$): The quantity of net electricity generation supplied by the project plant/unit to the grid is measured through the Electricity meter owned and maintained by Provincial Electricity Authority (PEA). This parameter should be either monitored using bi-directional energy meter or calculated as difference between (a) the quantity of electricity supplied by the project plant/unit to the grid; and (b) the quantity of electricity the project plant/unit from the grid.

    The electricity meter is owned and maintained by PEA and the meter maintenance is not under the jurisdiction of project proponent. The readings are measured continuously and recorded and reported on a monthly basis by PEA. The monthly report issued by PEA shall be used to get the amount of electricity delivered to grid. The same was confirmed through the discussions during the site visit. The measurement is in line with the requirements of the monitoring parameter in Section 6.1 of the applied methodology. The results shall be recorded and used for the estimation of project emissions.

The above monitoring parameters will give an opportunity for real measurements of achieved emission reductions. The details of the data to be collected, the frequency of data recording, format and storage type have been clearly described in the VCS-PD. The algorithms and formulae used are clearly presented and the calculations are without errors. The monitoring plan provided detailed information related to the collection and archiving of all relevant data needed to estimate or measure emissions occurring from GHG sources, sinks and reservoirs. The responsibility and authority for measurement, measurement and monitoring frequency, data collection and management system, quality assurance and quality control, data storage and back-up, reporting and registration activities have been discussed during the site visit and found to be in line with the description as provided in the VCS-PD

The monitoring plan was validated against the requirements of the latest version applied methodologies AMS III.H: Methane Recovery in Wastewater Treatment, version 18.0 and AMS I.D: Grid Connected Renewal Electricity Generation, version 18.0 and applicable methodological tools and found in compliance.

3.3 Non-Permanence Risk Analysis

Not Applicable to the project activity.

4 SAFEGUARDS

4.1 No Net Harm

The project activity has no potential negative environment and social-economic impacts. The assessment team has confirmed based on the on-site visit, document review and local & sectoral expertise.

4.2 Environmental Impact

Same as in the registered VCS PD /02/.

4.3 Local Stakeholder Consultation

Same as in the registered VCS PD /02/.

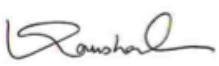
4.4 Public Comments

This is not a new project activity hence this section is not applicable.

5 VALIDATION CONCLUSION

The project activity "Wastewater Treatment with Biogas System in Palm Oil Mill at Sawi, Chumporn, Thailand", VCS Registry no. 426 as described in project document version 03.1 dated 03/05/2018 /3/ meets the requirements of the renewal of the crediting period as stated in the paragraph 3.8.5 of the VCS Standard V3.7 /02/ and Assessment of the validity of the original/current baseline and update of the baseline at the renewal of the crediting period, version 3.0.1 /02/. The applied methodologies are also the latest (AMS III.H: Methane Recovery in Wastewater Treatment, version 18.0 /12/ and AMS I.D.: Grid connected renewal electricity generation 18.0 /12/) in accordance with the procedure for renewal. The project activity meets all the criteria and the conditions to generate verified emission reductions (VERs) for the requested crediting period i.e. 01/06/2016 to 31/05/2026.

Validation team confirms that project complies with the validation criteria for projects set out in VCS Version 3.7, and includes any qualifications or limitations. Further the project is likely to achieve estimated GHG emission reduction or removals.



Location: Faridabad
Date: 15/05/2018

Authorized Signatory: Kaushal Goyal
Designation: Managing Director
KBS Certification Services Pvt. Ltd.

APPENDIX 1: REFERENCE DOCUMENTS

S. No	Document Name
/1/	VCS Registered documents (Project Id. 426) 1. VCS registered PD for project: "Wastewater Treatment with Biogas System in Palm Oil Mill at Sawi, Chumporn, Thailand", Version 3.1 dated 15/11/2009. 2. TÜV NORD CERT GmbH: Validation report for the project "Wastewater Treatment with Biogas System in Palm Oil Mill at Sawi, Chumporn, Thailand", Dated 18/11/2009. 3. Previous verification reports
/2/	VCS/CDM Rules and Regulations 1. VCS Website: http://verra.org/ http://verra.org/project/vcs-program/rules-and-requirements/ 2. VCS Program Guide Version 3.7 http://verra.org/wp-content/uploads/2018/03/VCS_Program_Guide_v3.7.pdf 3. VCS Project Standard http://verra.org/wp-content/uploads/2018/03/VCS_Standard_v3.7.pdf 4. Assessment of the validity of the original/current baseline and to update the baseline at the renewal of a crediting period, version 3.0.1 https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-11-v3.0.1.pdf
/3/	1. VCS-PD dated 23/01/2018, version 01 2. VCS-PD dated 03/05/2018, version 03.1
/4/	1. Emission Reductions Excelsheet dated 23/01/2018, version 01 2. Emission Reductions Excelsheet dated 09/04/2018, version 03
/5/	Technical Specifications of the Equipments installed under the project activity: 1. Technical specifications of the Generator, Engine, 2. Operating instructions 2006 – Natural circulation steam boiler type Nuk-HP 3. CSTR Specifications 4. Technological Lifetime Certificate dated 01/02/2018 of the CSTR system for 20 years. 5. Flow diagram of biogas digester system 6. Content with specifications of main equipment (bleaching and soft column deodorizing plant) 7. Flare specifications 8. Technical data of the modules 9. Diagram representation of the Cover Lagoon, Open Pond 10. Organizational chart 11. Single Line Diagram corresponding to the project activity describing the monitoring points. 12. Extract of manual of all the major equipments and all meters/measuring instruments/devices clearly indicating their specifications/ technical details corresponding to the project activity. E+H Promag 50 https://portal.endress.com/wa001/dla/5000000/0373/000/06/BA046DEN_1209.pdf E+H T-mass 65I https://www.th.endress.com/en/Field-instruments-overview/Flow-measurement-product-overview/Product-Thermal-flowmeter-t-mass-65I Actaris-TZ

	http://www.stream-measurement.com/5473/products/2543/tz-turbine-gas-meter---for-fiscal-applications.aspx http://www.bindergroup.info/binder/downloads/EN/BIDE-M-PROS-COMBIMASS-FLOW-EN-R03.pdf http://www.keison.co.uk/geotechnical_biogas.shtml https://www.geotechuk.com/products/biogas-5000/ http://www.bindergroup.info/binder/downloads/EN/BIDE-M-D-COMBIMASS-GA-m-EN-R09-Datenblatt-COMBIMASS-GA-m.pdf http://www.hannacan.com/PDF/manC99.pdf http://download.sechang.com/pds/2000/2000_21302a.pdf
/6/	Operation and Maintenance 1. Endress+Hauser: Standard Operating Procedure for Calibration and Maintenance https://portal.endress.com/wa001/dla/5000000/0373/000/06/BA046DEN_1209.pdf 2. Training and Performance Evaluation of Biogas Operators/Quality Control Laboratory Staff 3. Extracts of Operation and Maintenance Report 4. Records of outage
/7/	1. COD Sampling method 2. COD and BOD Analysis Reports dated 05/04/2012, 13/03/2013, 18/07/2014, 24/12/2015 and 29/01/2016 from External Laboratory
/8/	Approvals & Agreements 1. Operating License dated 08/03/2016 and 30/11/2016 2. Governmental Approvals from Local Section and Ministry of Industry, Thailand 3. COD Approval. 4. Emission Reduction Purchase Agreement dated 21/11/2017
/9/	Operator Log sheets 1. Operator log sheets of Natural Palm Group Co. Ltd. for waste water flow, electricity and gas meter 2. Operator log sheets of Natural Palm Group Co., Ltd.- for waste water analysis i.e. COD. 3. The Natural Palm Group Co., Ltd.: Log sheets of COD, March 2006 (For commissioning of CSTR1)
/10/	Company related documents 1. Company Registration Certificate 2. Company documents including Company Affidavit dated 25/04/2013, Deed dated 30/12/2009 according to the Civil and Commercial code and Organizational chart. 3. ISO documents including the ISO Certificate dated 22/05/2015 to “The Natural Palm Group Co., Ltd.” and documents - Job description forms, Control of biogas process, Operation of wastewater treatment plant, Quality control of biogas process, Procedure for COD, temperature & COD analysis for biogas system, Operation instruction of electricity system, On the job training forms.
/11/	Site visit related documents 1. Audit plan sent to the PP for the On-site inspection. 2. Attendance sheet for the site visit carried out on 01/02/2018 to 02/02/2018
/12/	Small-Scale approved CDM methodologies 1. AMS III.H: Methane Recovery in Wastewater Treatment, version 18.0; https://cdm.unfccc.int/methodologies/DB/H9DVSB24O7GEZQYLYNWUX23YS6G4RC 2. AMS-I.D: Grid connected renewal electricity generation, version 18.0. https://cdm.unfccc.int/methodologies/DB/W3TINZ7KKWCK7L8WTXFQQOFQQH4SBK
/13/	Tools 1. Tool to calculate the emission factor for an electricity system, Version 06 2. Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion, version 03.0

	3. Project emissions from flaring, version 02.0.0 4. Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation", version 03.0.
/14/	Environmental Rules and Regulations http://www.aecen.org/sites/default/files/country_report_thailand.pdf http://webeng.mnre.go.th/ewt_news.php?nid=5 http://www.aecen.org/ http://www.environnet.in.th/en/archives/1832 http://www2.eppo.go.th/power/PDP2015/PDP2015_Eng.pdf Regulations on the specifications on the treated wastewater to be discharged: https://www.jetro.go.jp/thailand/e_survey/factoryact.html https://www.jetro.go.jp/ext_images/thailand/pdf/MOIEffluentStandards2560.pdf Notification by the Ministry of Industry, No. 2, B.E. 2539 (1996) issued under the Factory Act B.E. 2535 (1992); Re: Standard of Discharging Effluent from Factories. As well, the maximum permissible COD content of wastewater discharge is 400 mg/l for all types of industry. EIA Book on Environmental Impact Assessment in Thailand
/15/	Grid emission factor for general project reported by the "*Thailand Grid Emission Factor for GHG Reduction Project/Activity"* , published by TGO (Thailand Greenhouse Gas Management Organization) on 28/09/2017 http://ghgreduction.tgo.or.th/t-ver/images/Grid_Emission_Factor_2559_-_Finalised.pdf
/16/	Reports, Manuals & Procedures 1. Biogas production report:QF-BGS-100-01 2. Approved daily reports of Natural Palm Group Co., Ltd. 3. Biogas weekly report 4. Waste water analysis report: QF-QCC-117-01 5. Job description of Biogas plant Supervisor and Operating Staff/ Quality Control Laboratory Staff 6. Procedure for Control of Biogas Process. 7. Operational manual of Wastewater treatment Plant 8. Procedure for Quality control of Biogas and Methane content measurement 9. Procedure for Operation and Control of Generator 10. Procedure for Quality Control and COD analysis 11. Biogas Flare Maintenance Report 12. Competency certificates of operators
/17/	Calibration Certificates for the monitoring equipments 1. The Natural Palm Group Co., Ltd.: Calibration Plan 2. Competency proof of the calibrating agency http://www.mit.in.th/htmlthai/about.php 3. Calibration Certificates dated 04/09/2014, 15/08/2016 for the installed Magnetic Flowmeters. 4. Calibration Certificates dated 15/10/2010, 30/08/2012, 05/09/2014, 27/05/2015, 16/08/2016, 28/02/2017 for Thermal Mass Flowmeter 5. Calibration Certificates dated 16/07/2015, 05/07/2017, 06/07/2017 for the Spectrophotometer 6. Calibration Certificate dated 22/08/2017 for the Flow Transmitter Gas Engine 7. The Natural Palm Group Co., Ltd.: Calibration Plan

APPENDIX 2: COMPETENCE OF TEAM MEMBERS AND TECHNICAL REVIEWERS

Personnel Name:		**Chetan Swaroop Sharma**	
Qualified to work as:			
Team Leader	☒	Technical Expert	☒
Validator/Verifier	☒	Financial Expert	☒
Technical Reviewer	☒	Local Expert (India)	☒
Area(s) of Technical Expertise			
Sectoral Scope	**Technical Area**		
Energy industries (renewable/non-renewable sources)	TA 1.1: Thermal energy generation from fossil fuels and biomass including thermal electricity from solar		
	TA 1.2: Energy generation from renewable energy sources		
Energy Demand	TA 3.1. Energy demand		
Waste handling and disposal	TA 13.1. Solid waste and wastewater TA 13.2. Manure		
Approved by (Manager C & T)	Sanjay Kandari		
Approval date:	01/05/2017		

Personnel Name:		**SIAM PHOOLCHAROEN**	
Qualified to work as:			
Team Leader	☐	Technical Expert	☐
Validator/Verifier	☐	Financial Expert	☐
Technical Reviewer	☐	Local Expert (Thailand)	☒
Area(s) of Technical Expertise			
Sectoral Scope	**Technical Area**		
NA	**NA**		
Approved by (Manager C & T)	Sanjay Kandari		
Approval date:	11/11/2016		

Personnel Name:		**Rohit Badaya**	
Qualified to work as:			
Team Leader	☒	Technical Expert	☒
Validator/Verifier	☒	Financial Expert	☒
Technical Reviewer	☒	Local Expert (India)	☒
Area(s) of Technical Expertise			
Sectoral Scope	**Technical Area**		

Energy industries (renewable/non-renewable sources)	TA 1.1: Thermal energy generation from fossil fuels and biomass including thermal electricity from solar
	TA 1.2: Energy generation from renewable energy sources
Energy demand	TA 3.1. Energy Demand
Waste Handling and Disposal	TA 13.1 Solid waste and wastewater TA 13.2 Manure
Approved By	Manager Competency & Training
Approval date:	16/10/2017

Personnel Name:		**Sanjay Kandari**	
Qualified to work as:			
Team Leader	☒	Technical Expert	☒
Validator/Verifier	☒	Financial Expert	☒
Technical Reviewer	☒	Local Expert (India)	☒

Area(s) of Technical Expertise	
Sectoral Scope	**Technical Area**
Energy Industries (renewable/non-renewable sources)	TA 1.1: Thermal energy generation from fossil fuels and biomass including thermal electricity from solar
Energy industries (renewable/non-renewable sources)	TA 1.2: Energy generation from renewable energy sources
Energy demand	TA 3.1. Energy Demand
Waste Handling and Disposal	TA 13.1 Solid waste and wastewater TA 13.2 Manure
Approved by (Manager C & T)	Akhilesh Joshi
Approval date:	11/12/2015