

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



By

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Summary:

KBS Certification Services Pvt. Ltd. has been contracted by “South Pole Carbon Asset Management Ltd.” to undertake independent 2nd periodic verification and certification for the greenhouse gas (GHG) emission reductions reported from “Wastewater Treatment with Biogas System in Palm Oil Mill at Sawi, Chumporn, Thailand” for the monitoring period 01/06/2012 to 31/05/2016 in the initial monitoring report Version 1, dated 25/01/2018, with regard to the relevant requirements of VCS Standard Version 3.7 /28/.

The project site is located on the site of the Natural Palm Oil (Chumporn) factory, located at address: 250 M. 12 Petchkasem Rd, Khron, Sawi, Chumporn, about 530 km south of Bangkok, Thailand. Geographical coordinates: Latitude 10°17'34"N and Longitude 99°5'27"E.

The project was validated by TÜV NORD CERT GmbH (VCS validation report with report number 53219308-08/505, dated 18/11/2009) and it was registered with VCS registry project no. 426. The purpose of the project activity is to recover the methane from waste water generated from palm oil mill and utilizing the same in the gas engines for the generation of electricity. The generated electricity is supplied to factory and exported to the national grid. Any surplus biogas is sent to boiler or flare, which is an open flare.

This is the 2nd periodic verification of this project which covers the period from 01/06/2012 to 31/05/2016 (including both the days). The project is verified against the VCS Version 3. The verification is based on the monitoring plan of registered VCS Project Description document (VCS PD) /24/, requirements of VCS (VCS Standard and VCS Program Guide of VCS Version 3) /27/,/28/ and CDM Validation and Verification Standard for project activities /29/.

The methodologies applied for the project to estimate the GHG emission reduction are AMS-III.H., version 13 – Methane recovery in wastewater treatment and AMS-I.D., version 14 – Grid connected renewable electricity generation /31/.

The verification is based on the registered VCS PD, proof of title, proof of right, additional documents related to baseline and monitoring methodology; the subsequent background investigation, follow-up interviews and supporting documents made available to the verification team by project proponent. Monitoring report (MR)/02/, Emission reduction calculation spread sheet (ER sheet) 04/, Project description document (VCS PD)/24/ and other supporting documents have also been made available to the verification team.

A risk based approach has been followed to perform the verification of the project activity. In the course of verification, 03 Corrective Action Requests (CAR) and 02 Clarification Request (CL) have been raised. All the CARs and CLs have been closed out successfully.

It is our responsibility to express an independent GHG verification opinion on the GHG emissions and on the calculation of GHG emission reductions from the project for the period 01/06/2012 to 31/05/2016

based on the reported emission reductions in the final monitoring report Version 03.2 dated 20/06/2018 for the same period.

Based on an understanding of the risks associated with reporting GHG emissions data and the controls in place to mitigate these, KBS planned and performed our work to obtain the information and explanations that we considered necessary to provide sufficient evidence for us to give reasonable assurance that this reported amount of GHG emission reductions for the period is fairly stated.

As a result of the verification, the verifiers confirm that the GHG emission reduction in the verification period from 01/06/2012 to 31/05/2016, including both the days, are **104,426 tCO₂e**.

KBS confirms the following;

Reporting period: 01/06/2012 to 31/05/2016 (Including both the days)

Year	Net GHG emission reductions or removals (tCO ₂ e)	Net GHG emission reductions or removals (tCO ₂ e)
2012	11,830	104,426 tCO₂e
2013	29,441	
2014	27,932	
2015	15,963	
2016	19,260	
Total	104,426	

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1 INTRODUCTION

1.1 Objective

KBS has been commissioned by 'South Pole Carbon Asset Management Ltd.' to perform verification of its registered VCS project 'Wastewater Treatment with Biogas System in Palm Oil Mill at Sawi, Chumporn, Thailand', for the reported GHG emission reductions for the given monitoring period 01/06/2012 to 31/05/2016 (both dates included). The VCS projects must undergo an independent third party verification and certification of emission reductions as the basis for issuance of Voluntary Emission Reductions (VERs/VCUs).

The objectives of this verification exercise are, by review of objective evidence, to establish that:

- The project activity has been implemented and operated as per the registered VCS project description (VCS-PD) and that all physical features (technology, project equipment, and monitoring and metering equipment) of the project are in place;
- Monitoring report and other supporting documents are complete;
- The data is recorded and stored as per the monitoring methodology and approved monitoring plan.
- To confirm that the monitoring system is implemented and fully functional to generate Voluntary Emission Reductions (VERs/VCUs) without any double counting, and
- To establish that the data reported are accurate, complete, consistent, transparent and free of material error or omission by checking the monitoring records and the emissions reduction calculation.

1.2 Scope and Criteria

The verification scope is defined as an independent and objective review of monitoring report, VCS project description (VCS PD), including the monitored data and other relevant documents made available to verifier and information collected through performing interviews during on-site assessment of the project activity.

The project is assessed against the requirements of VCS Standard version 3.7 /24/ and related rules and guidance. KBS has, based on the recommendations in the latest version of Verified Carbon Standard /24/, and employed a rule-based approach (as criteria) in the verification, focusing on the identification of significant reporting rules and the reliability of project monitoring.

The aspects to be covered under the purview of verification are:

- Ensure that the project activity has been implemented and operated as per the registered VCS PD and that all physical features (technology, project equipment, and monitoring and metering equipment) of the project are in place as per the documents provided by the client and on-site visit;
- Ensure that the monitoring report and other supporting documents provided are complete
- Ensure that the practiced monitoring system and procedures comply with the monitoring systems and procedures described in the monitoring plan and the approved CDM methodology;
- Evaluate the data recorded and stored are as per the monitoring methodology.

1.3 Level of Assurance

Reasonable level of assurance

1.4 Summary Description of the Project

The project activity was implemented by The Natural Palm Group Co.,Ltd., the new company of Natural Palm Oil (Chumporn) Co., Ltd. (NPO), which was founded in 2002 and has been operating a palm oil factory since then. It has a capacity of 45-60 tons of fresh fruit bunches (FFB) per hour or 200 tons of palm oil per day. Prior to implementation of the project activity, the wastewater from the plant was treated through a system of 8 cascading lagoons. The average volume of wastewater is about 450 m³/day which gives a retention time of approximately 289 days /11/12/.

The project activity entails the installation of an anaerobic wastewater treatment facility, based on Complete Stirred Tank Reactor (CSTR) 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.

- The mill first installed a 4800 m³ capacity CSTR digester in 2005 together with a 1.064 MW gas engine and started to operate and exported electricity to the national grid in 2006.
- Later in 2007, the second gas engine 1.416 MW was installed in order to support the production of electricity to the grid.
- In 2008, 1800 m³ capacity CSTR was installed together with one covered lagoon receiving treated wastewater from both CSTRs in order to treat more efficiently.
- At the end of 2008, some biogas is sent to replace heavy fuel oil in existing dual fuel fired boiler. The methane produced from CSTRs and the covered lagoon is delivered to both gas engines which generate electricity to be supplied to factory and exported to national grid. Any surplus biogas is sent to boiler or flare, which is an open flare.

Verification team has checked the project activity equipments /11/12/ installed at the project site and found in compliance with the registered VCS PD /24/.

The project site is located on the site of the Natural Palm Oil (Chumporn) factory, located at address: 250 M. 12 Petchkasem Rd, Khron, Sawi, Chumporn, about 530 km south of Bangkok, Thailand. Geographical coordinates: Latitude 10°17'34"N and Longitude 99°5'27"E /18/.

Project initial crediting period is from 01/06/2006 to 31/05/2016, hence the monitoring period selected for 2nd periodic verification i.e. 01/06/2012 to 31/05/2016 is within the crediting period.

The total emission reduction for the 2nd verification period from 01/06/2012 to 31/05/2016 is 104,426 tCO₂e /4/. The emission reduction is calculated conservatively as per the applied methodologies.

Project entity information is presented below:

Item	Data /17/
Project Entities	The Natural Palm Group Co.,Ltd. 250 M.12 Petchkasem Road, Khron, Sawi, Chumporn, Thailand
	South Pole Carbon Asset Management Ltd., Technoparkstrasse 1, Zurich – 8005, Switzerland

2 VERIFICATION PROCESS

2.1 Method and Criteria

The verification process was carried out inline with the requirements of VCS Version 3. In addition, the verification team followed the guidelines of the CDM Validation and Verification Standard for project activities, version 01.0 /25/26/. Standard auditing techniques and KBS's CDM Procedures were also applied during the verification. A risk-based approach was followed to carry out verification and assess all the factors and concerns that relate to the issuance of emission reductions from the project activity.

They include:

- Identification of all the sources contributing to the baseline emissions, project emissions and emission reductions.
- Authenticity of the provided data is checked.
- A risk based analysis is carried out to ensure a clear and transparent assessment. The risks involved in this process are mainly with the informational flows and data recording.

KBS follows a risk based verification approach, wherein a desk review of the project documentation is undertaken, which is followed by an onsite visit by the members of verification team. The verification protocol is filled by the verification team that is based on standard auditing practices and VCS requirements. The verification protocol provides transparent means to record the observations by the verification team members and the non-conformities, if any. The verification protocol is an internal document, and available on request.

Duration of Verification:

Verification Contract	15/01/2018
On site verification	01/02/2018 - 02/02/2018
Findings raised	08/02/2018
Draft Verification Report	04/06/2018
Final Verification Report	20/06/2018

2.2 Document Review

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

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

The list of document reviewed is included in the Appendix 2: 'References'

2.3 Interviews

The site visit for this verification assessment was undertaken by Chetan Swaroop Sharma (Team Leader and Technical Expert (TA 1.1, 13.1)) and Siam Phoolcharoen (Local Expert) /18/. Summary of on-site activities are mentioned below;

Location	<p>During the site visit /18/, 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 /11/12/13/15/.</p> <p>The details on the organization and physical location /18/ where the visit was undertaken is as follows: Natural Palm Oil (Chumporn) factory /18/ 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 /18/</p>
Dates	01/02/2018 to 02/02/2018
Key points discussed	Name of persons interviewed, Designation, Organization
<p>Opening meeting, office inspection, project and technology implementation in the project activity</p> <p>General aspects of the project</p> <p>Project equipment operation and technical details</p> <p>Changes since validation</p> <p>Discussion on the approvals for the plant operation</p> <p>Monitoring and measurement equipment</p> <p>Remaining issues from previous verification</p> <p>Calibration procedures</p> <p>Quality management system</p> <p>Involved personnel and responsibilities</p> <p>Training and practice of the operational personnel</p> <p>Interviews and database inspection</p> <p>Implementation of the monitoring plan</p>	<p>Kraisorn Kaew-on, Factory Manager, Natural Energy Harvesting Co.,Ltd.</p> <p>Thavatchai Bunsuv, Biogas Manager, Natural Energy Harvesting Co.,Ltd.</p> <p>Kridsada Kambamrung, Biogas PM Manager, Natural Energy Harvesting Co.,Ltd.</p> <p>Panthepp Praophn, Biogas Supervisor, Natural Energy Harvesting Co.,Ltd.</p> <p>Orraphan Chookeaw, Lab Deputy Supervisor, Natural Energy Harvesting Co.,Ltd.</p> <p>Krisadakorn Jinahoon, Biogas Plant Manager, Natural Energy Harvesting Co.,Ltd.</p> <p>Jareerat Thongnate, Biogas Officer, Natural Energy Harvesting Co.,Ltd.</p> <p>Natanong Visepakdee, Quality System, Natural Energy Harvesting Co.,Ltd.</p> <p>Nattaya Lonawan, Project Manager, South Pole Carbon Asset Management Ltd.</p> <p>Sirinut Raya, Project Manager, South Pole Carbon Asset Management Ltd.</p>

<p>Monitoring data management, operation and management of project activity</p> <p>Data uncertainty and residual risks</p> <p>GHG calculation</p> <p>Maintenance</p> <p>Local laws and regulations in host country applicable to the project activity.</p> <p>Details on the supporting documents checked during the site visit have been provided under Appendix-2 (References) of the Verification Report.</p>	
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2.4 Site Inspections

A site visit is undertaken by members of verification team, involving but not limited to,

- An assessment of the implementation and operation of the project activity as per the registered VCS PD was carried out on 01/02/2018;
- A review of information flows for generating, aggregating and reporting the monitoring parameters;
- Interviews with relevant personnel to confirm that the operational and data collection procedures are implemented in accordance with the approved monitoring plan was carried out on 01/02/2018;
- A cross-check between information provided in the monitoring report and data from other sources such as plant log books, inventories, purchase records or similar data sources was carried out on 02/02/2018;
- A check of the monitoring equipments including calibration performance and observations of monitoring practices against the requirements of the registered VCS PD and the selected methodologies was carried out on 02/02/2018 /9/10/;
- A review of calculations and assumptions made in determining the GHG data and emission reductions;
- An identification of quality control and quality assurance procedures in place to prevent or identify and correct any errors or omissions in the reported monitoring parameters.

2.5 Resolution of Findings

KBS applies the risk based approach aimed at focusing on high risk issues to the verification results whilst not omitting any part of the mandatory processes. A few discrepancies were found during the verification and the verification report was submitted to the project proponent, indicated under the titles corrective action requests (CARs) and clarification requests (CLs). CARs and CLs require the PP to take relevant actions. Criteria for judging items as CAR or CL are as follows:

Corrective action request (CAR):

- the project participants have made mistakes that will influence the ability of the project activity to achieve real, measurable additional emission reductions
- the Verified Carbon Standard's requirements have not been met, or

- there is a risk that emission reductions cannot be monitored or calculated.

Clarification request (CL):

- Information is insufficient or not sufficiently clear to determine whether the applicable VCS requirements have been met.

FARs is to be raised to highlight issues related to project implementation that require review during the first verification of the project activity. FARs does not relate to VCS requirements for registration.

CARs and CLs are to be resolved or closed out if the PP modifies the monitoring report, rectifies the MR or provides adequate additional explanations or evidence that satisfies the concerns. If this is not completed, the project activity cannot be recommended for registration/issuance under VCS registry.

The monitoring report was revised addressing the CARs & CLs issued by KBS. After reviewing the revised and resubmitted monitoring report/2/; resolving the CARs & CLs raised and outstanding concerns, KBS issues this final verification report and opinion.

03 CAR and 02 CL were found during verification and closed satisfactorily. The list of CARs/CLs raised and the response provided, the means of verification, reasons for their closure and references to correction in the MR are provided in Appendix 4 of this report. The revised MR/2/ with changes incorporated as per the issues raised were rechecked with the documentary evidences and found to be inline.

2.5.1 Forward Action Requests

No FAR was raised during this monitoring period.

2.6 Eligibility for Validation Activities

KBS has carried out verification of the project activity for the monitoring period from 01/06/2012 to 31/05/2016. KBS has a valid UNFCCC accreditation in the sectoral scope from UNFCCC. The validation for project activity was performed by the other VVB and the separate validation report issued and approved by the VCS association.

3 VALIDATION FINDINGS

Refer the above section.

3.1 Participation under Other GHG Programs

The project is already registered under VCS program. It has been confirmed by the project participant that the VERs will be claimed only from the VCS programme. The declaration is submitted from the project participant during the verification that the project will not claim any ERs from any other programme.

3.2 Methodology Deviations

Deviation 1

Description of deviation

The COD_{ww,untreated,y}, COD_{out,CSTR,y} and COD_{y,out,CL /5/} was not measured on daily basis which required by the methodology. Especially from 2015 onwards, the composite samples /13/ of wastewater have been analyzed on weekly basis.

Period of deviation

This deviated approach is applied for the monitoring period.

Deviated approach

The wastewater analysis of the samples from the sump (before entering UASB and HCLU system), and at the effluent from final open lagoon, were carried out, but not on every operational days. Refer to AMS III.H version16, for COD parameters: Average value may be used through sampling with the confidence/precision level 90/10. The example of calculating step from Annex 13 of EB 48 which is followed the standard statistical calculation is applied.

1) Calculate sample mean (μ).

$$\mu_{\text{COD},y} = \sum_{m=1}^{n_m} \text{COD}_y / n_m$$

Where :

- $\mu_{\text{COD},y}$ = Mean of the COD_{ww,untreated,y} and COD_{y,out,PJ,lagoon} in year y ()
- COD_y = Monitored COD_{ww,untreated,y} and COD_{y,out,PJ,lagoon} in measurement m in year y
- n_m = Number of measurements m in year y (minimum is 4)

2) Calculate the sample standard deviation (σ).

$$\sigma_{\text{COD},y} = \sqrt{\sum_{m=1}^{n_m} (\text{COD}_y - \mu_{\text{COD},y})^2 / (n_m - 1)}$$

Where :

$\sigma_{\text{COD},y}$ = Standard deviation of COD_y the in year y ()

3) Calculate the 95% confidence interval.

$$\mu_{\text{COD},y} - t * \sigma_{\text{COD},y} / \sqrt{n_m} \leq \text{COD}_y \leq \mu_{\text{COD},y} + t * \sigma_{\text{COD},y} / \sqrt{n_m}$$

where :

t = Value from standard t distribution for a confidence level of 95% with degrees of freedom $n_m - 1$ ¹

4) Use the lower bound of the 95% confidence interval obtained above for COD_{ww,untreated,y} and the upper bound for COD_{out,CSTR,y} and COD_{y,out,CL} to ensure conservativeness.

The above calculating is performed in the ER calculation spread sheet /4/, monitored parameter adjusting section.

Justification for deviated approach

This approach is inline with the conservative principle, the upper bound value is used for project emission calculation while the lower bound value is used for baseline emission calculation, to achieve the lower emission reductions.

DOE Justification:

As per the paragraph 3.5 of the VCS standard /28/, deviations are permitted where they relate to data and parameters available at validation, data and parameters monitored, or the monitoring plan. The above deviation is related to the monitoring plan of the registered VCS PD and it does not negatively impact the conservativeness of the quantification of GHG emission reductions. Hence, the deviation is found to be valid and accepted by the verification team.

Deviation 2

Description of deviation

The %CH₄, methane content in biogas was not measured by a continuous gas analyzer /5/12/13/ which is required by the methodology. This deviation is also applied for the previous verification.

¹ <http://www.stat.tamu.edu/~lzhou/stat302/T-Table.pdf>

Period of deviation

This deviated approach is applied for the whole monitoring period.

Deviated approach

The data is periodically measured at least on daily basis before sending to biogas utilization components (boiler set, generator set and flare) /12/. The monitored data is adjusted for 95% confidence level according to the guideline described in Annex 13 of EB 48.

- 1) Calculate sample mean (μ).

$$\mu_{WCH4,y} = \sum_{m=1}^{n_m} W_{CH4,m,y} / n_m$$

Where :

$\mu_{WCH4,y}$ = Mean of the fraction of methane in the biogas in year y (%)

$W_{CH4,m,y}$ = Monitored fraction of methane in biogas in measurement m in year y (%)

n_m = Number of measurements m in year y (minimum is 4)

- 2) Calculate the sample standard deviation (σ).

$$\sigma_{WCH4,y} = \sqrt{\sum_{m=1}^{n_m} (W_{CH4,m,y} - \mu_{CH4,y})^2 / (n_m - 1)}$$

Where:

$\sigma_{WCH4,y}$ = Standard deviation of the fraction of methane in biogas in year y (%)

- 3) Calculate the 95% confidence interval.

$$\mu_{WCH4,y} - t * \sigma_{WCH4,y} / \sqrt{n_m} \leq W_{CH4,y} \leq \mu_{WCH4,y} + t * \sigma_{WCH4,y} / \sqrt{n_m}$$

Where :

t = Value from standard t distribution for a confidence level of 95% with degrees of freedom $n_m - 1$ ²

- 4) Use the lower bound of the 95% confidence interval obtained above for BE calculation and the upper bound one for PE calculation to ensure conservativeness.

The above calculating is performed in the ER calculation spread sheet, monitored parameter adjusting section.

Justification for deviated approach

² <http://www.stat.tamu.edu/~lzhou/stat302/T-Table.pdf>

This approach is according to the page-27 of the AMS III.H version 13 which states that “*the fraction of methane in the gas should be measured with a continuous gas analyzer, or, alternatively, with periodically measurement at 95% confidence level*”. To be inline with conservative principle, the upper bound value is used for project emission calculation, while the lower bound value is used for baseline emission calculation.

DOE justification: The above deviation is with respect to the monitoring plan set out in the registered VCS PD. The same complies with the applied methodology/31/ and paragraph 3.5 of the VCS standard /28/. Hence, it is accepted by the verification team.

3.3 Project Description Deviations

Description of deviation:

The monitoring of EG_y and EC_y is changed from the description provided in the registered PD due to the situation for electricity generation and consumption at the project activity has been changed.

- The PPA, Power Purchasing Agreement to sell the electricity from project activity to grid was cancelled on 01/05/2012. The electricity generated from project activity has been delivered to the new biomass power plant which started operation (SCOD) on 31/01/2012.
- The export and import electricity from grid directly to project activity is no more applicable.
- The electricity used by project activity has been served by the installed generator set as primary source, which is same as previous situation. The biomass power plant can deliver electricity to the project activity as secondary source instead of to import electricity from grid.

Period of deviation

This deviated approach is effective for the whole monitoring period.

Deviated approach

The baseline emissions for AMS I.D (EG_y) and the project emissions for AMS III.H (EC_y) are not considered for the emission reduction calculation.

- EG_y :** From registered VCS PD, EG_y is the net electricity generated by gas engines operated on biogas from wastewater treatment plant, can be monitored by electricity transition meter provided at point of power generation sets or power sales invoices based on net electricity sold to PEA grid.
 Since the PPA was cancelled then PEA meter has been removed. Therefore the EG_y is considered as zero for conservativeness.
- EC_y :** From registered VCS PD, EC_y is the electricity consumption by wastewater treatment system and biogas plant, which is calculated from the maximum rated consumption. For the project scenario, the project activity can import electricity from grid which the grid emission factor will be used for calculate the project emissions.

In the existing situation, the installed generator set is the primary source of electricity supply for the project activity which can be monitored via power meter (EM1). In case the generators cannot operate, the electricity will be supplied from the biomass power plant as the secondary source. Then, there is no electricity imported from grid.

In case the electricity is supplied from generators, the consumption will be included in EG_y . If the electricity consumption is supplied from biomass power plant which is not fossil fuel based power plant, then the emissions of biomass firing for electricity generation should be zero.

Impact on methodology applicability and baseline:

All deviations above only relate to monitoring description. The baseline is still the same as described in the registered VCD PD and there is no impact on the applicability of the methodology.

Impact on additionality:

All applied deviations have no impact on additionality as it relates to only the changes in monitoring description.

Justification for deviated approach

In the ER calculation sheet, the actual monitored data of EG_y (from the power monitoring units at generators) and $EC_y/5$ is shown in table below.

Monitored data regarding AMS I.D							
		PD value	2012	2013	2014	2015	2016
EC_y	MWh	1747	368	636	516	350	284
EG_y	MWh	8103	3,001	8,733	5,050	3,403	4,384
$EG_{y,export}$	MWh						6,588

The EC_y which is monitored via EM1 is much more less than the amount of electricity generated from generator no.1 and no.2. Most of electricity generated is delivered to the biomass power plant which is monitored via EM2. If both monitored parameters are included in the emission reduction calculation. The project will achieve 12,423 tCO₂ as BE for AMS I.D while the PE of AMS III.H will be 1,090 tCO₂. The project activity should get 11,333 tCO₂e additional from the

inclusion of electricity monitored data. Therefore, to neglect this amount of emission reductions /4/ should be considered as conservativeness.

DOE justification:

KBS confirms that the deviation are properly described and justified in the monitoring report/02/. Also, the project deviations are deemed to be valid and the project remains in compliance with VCS rules.

3.4 Grouped Project

The project is not a grouped project. Therefore this section is not applicable.

4 VERIFICATION FINDINGS

4.1 Project Implementation Status

This is the second and last monitoring period of the first crediting period of this project activity. The monitoring period is from 01/06/2012 to 31/05/2016, both days are included.

The changes which may impact the project activity in this monitoring period are listed as follows;

- The new CSTR no.3 which started to supply biogas on 10/04/2013 and CSTR no.4 which has been commissioned on 01/06/2016, are not included in the project boundary and in the calculation of emission reductions.
- The third generator was installed on 31/10/2013, to generate electricity from biogas supplied from CSTR no.3 and 4. The electricity delivered from this generator is not counted in EG_y.
- The export of electricity generated from the project activity to the grid was stopped on 01/05/2012. The rest generated electricity from gas engines after consumed by project activity, is delivered to biomass power plant.
- The gas flare station has been temporary disconnected from project activity, and fully closed during 23/02/2010 to 17/01/2013 for safety reason due to the construction of CSTR no.3. The biogas was not sent to flare during this period, as well as the monitoring from flow meter (GM4) was not done.

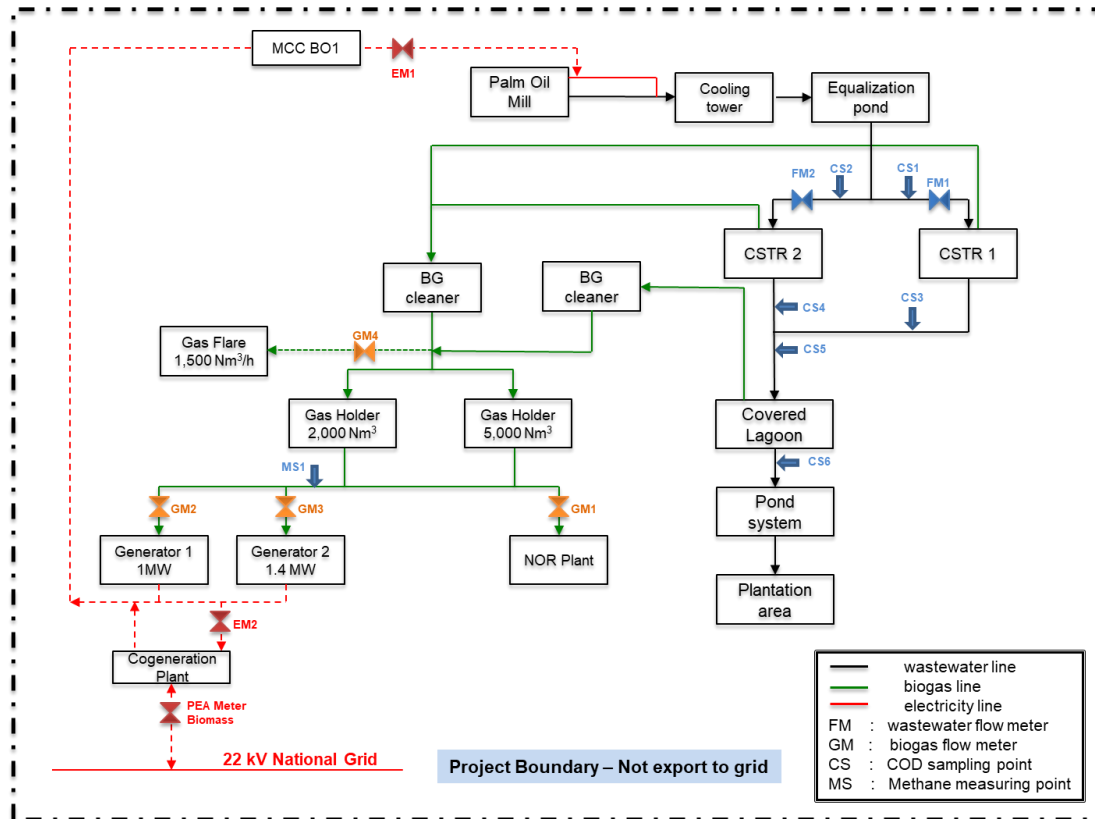


Figure: Monitoring diagram of this monitoring period

The physical components and project boundary as per the description in the registered VCS PD are operational during the monitoring period except for the deviations described under Section 3.2 and Section 3.3 of the Report. Further few additional components have been added at the project site, however they have not been considered in the project boundary and hence no effect on the conservative estimation of emission reductions. The capacity of project equipments have been cross-checked during the on-site visit and found in-compliance with the registered VCS-PD/20/ and the deviations applied. On the basis of on-site visit and reviewed project documentation, the verification team confirms that the project was implemented and operated as described in the registered VCS PD/20/ except for few deviations as described in the Section 3.2 and 3.3 of this Verification report.

Further the verification team was able to confirm that the monitoring plan contained in registered VCS PD/20/ and MR/2/ is in accordance with the applied approved small scale methodologies i.e. AMS III.H: Methane recovery in wastewater treatment, version 13 and AMS I.D: Grid connected renewable electricity generation, version 14 /27/.

Ownership and other programs:

The PP has declared that the project is not registered in any other mechanism/carbon standard apart from VCS standard. Thus emission reductions generated by the project will be solely claimed by PP and PP has right of use and hence accepted. Net GHG emission reductions or removals generated by this project will not be used for compliance with an emissions trading program or to meet binding limits on GHG emissions as the host country i.e. Thailand is not a participant in any emission trading programs or nor does it have any binding limits.

PP will not claim the carbon credits under any other GHG emission reduction scheme for the crediting period under VCS and PP has provided declaration on the same during the validation/verification. Hence there is no possibility of double counting. Apart from VCS, it has neither applied nor been rejected under any other GHG program.

Management and operational system:

Verification team was able to verify that the authorities and responsibilities for monitoring and reporting of all data related to the emission reductions were clearly defined for the monitoring period from 01/06/2012 to 31/05/2016.

The allocation of the responsibilities /16/ is documented in a written form and is followed as described in the registered VCS PD. Routines for the archiving of data are defined and documented. During the site visit all the required plant records /5/19/, name plates of equipments /15/ were verified and found that the data is consistent with the provided in the final MR/2/ and ER sheets/4/.

The monitoring plan described in section 3.3 of the MR is confirmed to be correct. All the parameters of the monitoring plan are monitored using appropriate metering system. The verification team has interviewed the plant personnel who are involved in the monitoring of the parameters that are used to determine the emission reductions of the VER project. It is confirmed based on the interviews that the plant's team is competent enough to monitor the parameters as described in the monitoring plan. As discussed above, the verification team concludes that management and operational system of the project is implemented and operated well. Thus it ensures the quality of data which is required in calculating the emission reductions.

Implementation status of the monitoring plan:

Verification team confirms through on-site verification and from the document review, the actual monitoring system complies with the monitoring plan mentioned in the registered VCS-PD/20/ except for the deviations described under Section 3.2 and Section 3.3 of the Report. Further few additional components have been added at the project site, however they have not been considered in the project boundary and hence no effect on the conservative estimation of emission reductions.

During the verification, all relevant monitoring parameters of the registered monitoring plan have been verified with regard to the appropriateness of the verification method; the correctness of the values applied for ER calculation, the accuracy and applied QA/QC measures. All monitoring parameters have been measured determined without material misstatements and are in line with all applicable standards and relevant requirements. It is confirmed that the monitoring mechanism is effective and reliable. Wherever a parameter was not sufficiently monitored as per the monitoring plan of the VCS PD, a deviation was applied by the PPs and the emission reduction was calculated by a conservative approach.

Therefore, from the document review and onsite verification, it is confirmed that all the parameters were monitored in accordance with the registered monitoring plan during the monitoring period. Following are the details of monitoring in accordance with the monitoring plan of the registered VCS PD:

Data / Parameter	Q _{ww} , y
Data unit	m ³
Description	Volume of wastewater treated in the year y
Source of data to be used	Measured through Volumetric flow meters (FM1, FM2) /11/ which are installed at the inlet of CSTR1 and CSTR2.
Value of data for the monitoring period	The values applied for this monitoring period have been provided in the submitted MR and ER sheet /2//04/ and found correct. The same was also confirmed during the site visit. The details have been provided under Appendix 5 of the Verification

	report.
Measuring frequency	Continuous
Recording and reporting frequency	Daily basis. As per the monitoring report/02/, the operators shall archive the monitored data manually into the log sheets /5/ and then, upload and transfer the same to the electronic storage.
Type of monitoring equipment	The gas flow meter (FM1 and FM2) /11/ is used for monitoring the volume of wastewater treated which was confirmed during the site visit. The details on the monitoring equipment FM1 and FM2 is provided under Appendix 5 of the Verification report.
Is accuracy of the monitoring equipment as stated in the PDD?	The accuracy details have been provided in the under Appendix 5 of the Verification report and found acceptable.
Calibration frequency/interval	Once in three years
Is the calibration interval in line with the monitoring plan of the PDD?	The meter has been calibrated as per the calibration frequency /9/10/ during this monitoring period.
How were the values in the monitoring report verified and cross-checked?	The values are recorded in the log sheets as mentioned in the registered VCS PD/20/. The verification team has checked the log sheets/5/ to check the correctness of the value mentioned in the monitoring report/02/ and found to be matching.
Does the data management (from monitoring equipment to emission reduction calculation) ensure correct transfer of data and reporting of emission reductions?	The data management procedure is transparent; which ensure correct transfer of data and reporting of emission reductions.
If only partial data are available because activity levels or non-activity parameters have not been monitored in accordance with the registered monitoring plan, has the most conservative assumption theoretically possible been applied or has a request for deviation been approved?	NA

Data / Parameter	COD _{ww,untreated,y}
Data unit	mg/l
Description	COD of wastewater entering the wastewater treatment system (CS1 , CS2) /11/
Source of data to be used	Measured using Colorimetric analysis in the on-site laboratory of the treatment plant. The COD sampling point is in the sump just before CSTR1 and CSTR2 /11/, because the CSTR operate in parallel. The estimation of COD is done using the Colorimetric analysis as mentioned in the registered VCS PD /20/ and this applies for all the COD measurement in the project activity. The same is inline with the applied methodology /27/ and hence accepted.
Value of data for the monitoring period	The values applied for this monitoring period have been provided in the submitted MR and ER sheet /2/04/ and found correct. The same was also confirmed during the site visit. The details have been provided under Appendix 5 of the Verification report. The methodology deviation 1 is applied for 95% of confidential level adjusting /13/. Please refer to section 3.2 for deviations in

	the monitoring and measurements.
Measuring frequency	The analysis of composite sample is carried out on weekly basis. The methodology deviation 1 is applied for 95% of confidential level adjusting. Please refer to section 3.2 for deviations in the monitoring and measurements.
Recording and reporting frequency	Weekly basis. As per the monitoring report /02/, the COD content is analyzed using a Colorimetric analysis method /5/ in the on-site laboratory of the treatment plant. The COD sampling point is in the sump just before CSTR1 and CSTR2, because the CSTR operate in parallel as verified during the site visit.
Type of monitoring equipment	Spectrophotometer /11/ for COD test as per information provide in Appendix 5 of the Verification report.
Is accuracy of the monitoring equipment as stated in the PDD?	The details has been provided in the under Appendix 5 of the Verification report and found correct.
Calibration frequency/interval	Once in three years
Is the calibration interval in line with the monitoring plan of the PDD?	The Spectrophotometer has been calibrated as per the calibration frequency /09/10/ during this monitoring period.
How were the values in the monitoring report verified and cross-checked?	<p>The values are recorded in the log sheets as mentioned in the registered PD/24/. The verification team has checked the log sheets/05/ to check the correctness of the value mentioned in the monitoring report/02/ and found to be matching.</p> <p>In addition, to ensure accuracy in laboratory measurements, the wastewater sample is tested by external laboratory /7/ at least once a year. Verification team has cross-checked the value from external laboratory test /07/ and found comparable.</p>
Does the data management (from monitoring equipment to emission reduction calculation) ensure correct transfer of data and reporting of emission reductions?	The data management procedure is transparent; which ensure correct transfer of data and reporting of emission reductions.
If only partial data are available because activity levels or non-activity parameters have not been monitored in accordance with the registered monitoring plan, has the most conservative assumption theoretically possible been applied or has a request for deviation been approved?	The deviation in the monitoring parameter is explained under section 3.2 of this report.

Data / Parameter	$COD_{out,CSTR,y} = COD_{in,CL,y}$
Data unit	mg/l
Description	COD of wastewater exiting the CSTR system or COD entering the covered lagoon process /11/
Source of data to be used	<p>Measured using Colorimetric analysis (CS3, CS4) in the on-site laboratory of the treatment plant. The COD sampling points are at the outlet from CSTR1 and CSTR2 /11/.</p> <p>The estimation of COD is done using the Colorimetric analysis as mentioned in the registered VCS PD /20/ and this applies for all the COD measurement in the project activity. The same is</p>

	inline with the applied methodology/31/ and hence accepted.
Value of data for the monitoring period	<p>The values /13/ applied for this monitoring period have been provided in the submitted MR and ER sheet/2//04/ and found correct. The same was also confirmed during the site visit. The details have been provided under Appendix 5 of the Verification report.</p> <p>The methodology deviation 1 is applied for 95% of confidential level adjusting. Please refer to section 3.2 for deviations in the monitoring and measurements.</p>
Measuring frequency	The analysis of composite sample is carried out on weekly basis. The methodology deviation 1 is applied for 95% of confidential level adjusting. Please refer to section 3.2 for deviations in the monitoring and measurements.
Recording and reporting frequency	Weekly basis. As per the monitoring report/02/, the COD content is analyzed using a Colorimetric analysis method in the on-site laboratory of the treatment plant. The COD sampling points are at the outlet from CSTR1 and CSTR2, as verified during the site visit
Type of monitoring equipment	Spectrophotometer for COD test as per information provide in Appendix 5 of the Verification report.
Is accuracy of the monitoring equipment as stated in the PDD?	The details has been provided in the under Appendix 5 of the Verification report and found correct.
Calibration frequency/interval	Once in three years
Is the calibration interval in line with the monitoring plan of the PDD?	The Spectrophotometer has been calibrated as per the calibration frequency /09/10/ during this monitoring period.
How were the values in the monitoring report verified and cross-checked?	<p>The values are recorded in the log sheets as mentioned in the registered PD/24/. The verification team has checked the log sheets/05/ to check the correctness of the value mentioned in the monitoring report/02/ and found to be matching.</p> <p>In addition, to ensure accuracy in laboratory measurements, the wastewater sample is tested by external laboratory /7/ at least once a year. Verification team has cross-checked the value from external laboratory test /07/ and found comparable.</p>
Does the data management (from monitoring equipment to emission reduction calculation) ensure correct transfer of data and reporting of emission reductions?	The data management procedure is transparent; which will ensure correct transfer of data and reporting of emission reductions.
If only partial data are available because activity levels or non-activity parameters have not been monitored in accordance with the registered monitoring plan, has the most conservative assumption theoretically possible been applied or has a request for deviation been approved?	The deviation in the monitoring parameter is explained under section 3.2 of this report.
Data / Parameter	COD _{y,out,CL}
Data unit	mg/l

Description	COD of wastewater exiting the covered lagoon treatment process
Source of data to be used	<p>Measured using Colorimetric analysis (CS6) /11/ in the on-site laboratory of the treatment plant. The COD sampling point is at the outlet from covered lagoon.</p> <p>The estimation of COD is done using the Colorimetric analysis as mentioned in the registered VCS PD /20/ and this applies for all the COD measurement in the project activity. The same is inline with the applied methodology/27/. Hence, accepted.</p>
Value of data for the monitoring period	<p>The values /12/ applied for this monitoring period have been provided in the submitted MR and ER sheet/02/04/ and found correct. The same was also confirmed during the site visit. The details have been provided under Appendix 5 of the Verification report.</p> <p>The methodology deviation 1 is applied for 95% of confidential level adjusting. Please refer to section 3.2 for deviations in the monitoring and measurements.</p>
Measuring frequency	The analysis of composite sample is carried out on weekly basis. The methodology deviation 1 is applied for 95% of confidential level adjusting. Please refer to section 3.2 for deviations in the monitoring and measurements.
Recording and reporting frequency	Weekly basis. As per the monitoring report/02/, the COD content is analyzed using a Colorimetric analysis method /5/ in the on-site laboratory of the treatment plant. The COD sampling point is at the outlet from covered lagoon, as verified during the site visit
Type of monitoring equipment	Spectrophotometer for COD test as per information provide in Appendix 5 of the Verification report. Please refer to section 3.2 for deviations in the monitoring and measurements.
Is accuracy of the monitoring equipment as stated in the PDD?	The details has been provided in the under Appendix 5 of the Verification report and found correct.
Calibration frequency/interval	Once in three years
Is the calibration interval in line with the monitoring plan of the PDD?	The Spectrophotometer has been calibrated as per the calibration frequency /09/10/ during this monitoring period. The details have been provided the under Appendix 5 of the Verification report and found correct
How were the values in the monitoring report verified and cross-checked?	<p>The values are recorded in the log sheets as mentioned in the registered PD/24/. The verification team has checked the log sheets/05/ to check the correctness of the value mentioned in the monitoring report/02/ and found to be matching.</p> <p>In addition, to ensure accuracy in laboratory measurements, the wastewater sample is tested by external laboratory /7/ at least once a year. Verification team has cross-checked the value from external laboratory test /07/ and found comparable.</p>
Does the data management (from monitoring equipment to emission	The data management procedure is transparent; which will ensure correct transfer of data and reporting of emission

reduction calculation) ensure correct transfer of data and reporting of emission reductions?	reductions.
If only partial data are available because activity levels or non-activity parameters have not been monitored in accordance with the registered monitoring plan, has the most conservative assumption theoretically possible been applied or has a request for deviation been approved?	The deviation in the monitoring parameter is explained under section 3.2 of this report.

Data / Parameter	W_{CH4}
Data unit	%
Description	Methane content in biogas in the year y
Source of data to be used	It is measured (MS1) /11/ with, with application of 95% confidential level as per methodology /27/ deviation 2.
Value of data for the monitoring period	The values applied for this monitoring period have been provided in the submitted MR and ER sheet /2//04/ and found correct. The same was also confirmed during the site visit. The details have been provided under Appendix 5 of the Verification report. It is measured (MS1), with application of 95% confidential level as per methodology deviation 2. Please refer to section 3.2 for deviations in the monitoring and measurements.
Measuring frequency	The methane content in biogas is measured during the operating of generators, at least once a day. It is measured (MS1) /5/, with application of 95% confidential level as per methodology deviation 2. Please refer to section 3.2 for deviations in the monitoring and measurements.
Recording and reporting frequency	The methane content in biogas is measured during the operating of generators /5/, at least once a day. Please refer to section 3.2 for deviations in the monitoring and measurements.
Type of monitoring equipment	Gas analyzer /11/ as per the information provide in Appendix 5 of the Verification report. Please refer to section 3.2 for deviations in the monitoring and measurements.
Is accuracy of the monitoring equipment as stated in the PDD?	The details has been provided in the under Appendix 5 of the Verification report and found correct.
Calibration frequency/interval	Once in three years
Is the calibration interval in line with the monitoring plan of the PDD?	The calibration interval is in-line with the registered PD/24/ and covering the monitoring period. The details have been provided the under Appendix 5 of the Verification report and found correct.
How were the values in the monitoring report verified and cross-checked?	The values are recorded in the log sheets /05/ as mentioned in the registered PD/24/. The verification team has checked the log sheets /05/ to check the correctness of the value mentioned in the monitoring report/02/ and found to be matching.
Does the data management (from monitoring equipment to emission	The data management procedure is transparent; which will ensure correct transfer of data and reporting of emission

reduction calculation) ensure correct transfer of data and reporting of emission reductions?	reductions.
If only partial data are available because activity levels or non-activity parameters have not been monitored in accordance with the registered monitoring plan, has the most conservative assumption theoretically possible been applied or has a request for deviation been approved?	The deviation in the monitoring parameter is explained under section 3.2 of this report.

Data / Parameter	BG _{combusted,y}
Data unit	Nm3
Description	Amount of biogas combusted for gainful use in the year y
Source of data to be used	Measured – continuously using gas flow meter (GM1 , GM2 , GM3) /11/. Gas flow meters are installed at boiler and generation sets.
Value of data for the monitoring period	The values applied for this monitoring period have been provided in the submitted MR and ER sheet /02//04/ and found correct. The same was also confirmed during the site visit. The details have been provided under Appendix 5 of the Verification report. The amount of biogas recorded by GM2, biogas sent to generator no.1, is adjusted for calibration delay in 2013 and 2014 /09/10/.
Measuring frequency	Continuous
Recording and reporting frequency	Daily. As per the monitoring report/02/, the operators archive the monitored data manually into the log sheets /5/ and then, upload and transfer the same to the electronic storage.
Type of monitoring equipment	Gas flow meters (GM1,GM2 and GM3) /11/12/as per the information provide in Appendix 5 of the Verification report
Is accuracy of the monitoring equipment as stated in the PDD?	The details has been provided in the under Appendix 5 of the Verification report and found correct.
Calibration frequency/interval	Once in three years
Is the calibration interval in line with the monitoring plan of the PDD?	The calibration interval is in-line with the registered PD /20/ and covering the monitoring period. The amount of biogas recorded by GM2, biogas sent to generator no.1, is adjusted for calibration delay in 2013 and 2014. The details have been provided the under Appendix 5 of the Verification report and found correct.
How were the values in the monitoring report verified and cross-checked?	The values recorded in the log sheets as mentioned in the registered PD /20/. The amount of biogas recorded by GM2, biogas sent to generator no.1, is adjusted for calibration delay in 2013 and 2014. The verification sheet has checked the log sheets/05/ for the correctness of the value mentioned in the monitoring report /02/ and found to be matching.
Does the data management (from monitoring equipment to emission reduction calculation) ensure correct transfer of data and reporting of	The data management procedure is transparent; which will ensure correct transfer of data and reporting of emission reductions.

emission reductions?	
If only partial data are available because activity levels or non-activity parameters have not been monitored in accordance with the registered monitoring plan, has the most conservative assumption theoretically possible been applied or has a request for deviation been approved?	The amount of biogas recorded by GM2, biogas sent to generator no.1, is adjusted for calibration delay in 2013 and 2014.

Data / Parameter	BG _{TOFlare,y}
Data unit	Nm ³
Description	Amount of biogas flared in the year y.
Source of data to be used	Measured by gas flow meter (GM4) /11/12/. The gas flow meter is installed at the flare system.
Value of data for the monitoring period	The values applied for this monitoring period have been provided in the submitted MR and ER sheet/02/04/ and found correct. The same was also confirmed during the site visit. The details have been provided under Appendix 5 of the Verification report.
Measuring frequency	Continuous
Recording and reporting frequency	Daily. As per the monitoring report/02/, the operators archive the monitored data manually into the log sheets /6/ and then, upload and transfer the same to the electronic storage.
Type of monitoring equipment	Gas flow meters as per the information provide in Appendix 5 of the Verification report.
Is accuracy of the monitoring equipment as stated in the PDD?	The details has been provided in the under Appendix 5 of the Verification report and found correct. .
Calibration frequency/interval	Once in three years
Is the calibration interval in line with the monitoring plan of the PDD?	The calibration interval /09/10/ is in-line with the registered PD/24/ and covering the monitoring period. The details have been provided the under Appendix 5 of the Verification report and found correct.
How were the values in the monitoring report verified and cross-checked?	The values will be recorded in the log sheets as mentioned in the registered PD /20/. The verification sheet has checked the log sheets/06/ to check the correctness of the value mentioned in the monitoring report/02/ and found to be matching.
Does the data management (from monitoring equipment to emission reduction calculation) ensure correct transfer of data and reporting of emission reductions?	The data management procedure is transparent; which will ensure correct transfer of data and reporting of emission reductions.
If only partial data are available because activity levels or non-activity parameters have not been monitored in accordance with the registered monitoring plan, has the most conservative assumption theoretically possible been applied or has a request for deviation been approved?	NA

Data / Parameter	EG _y
Data unit	MWh
Description	Net electricity generated by gas engines operated on biogas from wastewater treatment plant during the year y
Source of data to be used	Power sale invoices based on net electricity sold to PEA grid (EM2)
Value of data for the monitoring period	As per project description deviation 1, this monitoring parameter is not considered in this monitoring period. Hence zero value has been considered in the calculations.
Measuring frequency	As per project description deviation 1, this monitoring parameter is not considered in this monitoring period. Hence zero value has been considered in the calculations.
Recording and reporting frequency	As per project description deviation 1, this monitoring parameter is not considered in this monitoring period.
Type of monitoring equipment	The information provide in Appendix 5 of the Verification report.
Is accuracy of the monitoring equipment as stated in the PDD?	The information provide in Appendix 5 of the Verification report.
Calibration frequency/interval	The information provide in Appendix 5 of the Verification report
Is the calibration interval in line with the monitoring plan of the PDD?	The information provide in Appendix 5 of the Verification report
How were the values in the monitoring report verified and cross-checked?	As per project description deviation 1, this monitoring parameter is not considered in this monitoring period. Hence zero value has been considered in the calculations.
Does the data management (from monitoring equipment to emission reduction calculation) ensure correct transfer of data and reporting of emission reductions?	As per project description deviation 1, this monitoring parameter is not considered in this monitoring period. Hence zero value has been considered in the calculations.
If only partial data are available because activity levels or non-activity parameters have not been monitored in accordance with the registered monitoring plan, has the most conservative assumption theoretically possible been applied or has a request for deviation been approved?	It is not applicable.

Data / Parameter	EC _y
Data unit	MWh

Description	Net electricity generated by gas engines operated on biogas from wastewater treatment plant during the year y
Source of data to be used	Power sale invoices based on net electricity sold to PEA grid (EM2)
Value of data for the monitoring period	As per project description deviation 1, this monitoring parameter is not considered in this monitoring period. Hence zero value has been considered in the calculations.
Measuring frequency	As per project description deviation 1, this monitoring parameter is not considered in this monitoring period. Hence zero value has been considered in the calculations.
Recording and reporting frequency	As per project description deviation 1, this monitoring parameter is not considered in this monitoring period.
Type of monitoring equipment	The information provide in Appendix 5 of the Verification report.
Is accuracy of the monitoring equipment as stated in the PDD?	The information provide in Appendix 5 of the Verification report.
Calibration frequency/interval	The information provide in Appendix 5 of the Verification report
Is the calibration interval in line with the monitoring plan of the PDD?	The information provide in Appendix 5 of the Verification report
How were the values in the monitoring report verified and cross-checked?	As per project description deviation 1, this monitoring parameter is not considered in this monitoring period. Hence zero value has been considered in the calculations.
Does the data management (from monitoring equipment to emission reduction calculation) ensure correct transfer of data and reporting of emission reductions?	As per project description deviation 1, this monitoring parameter is not considered in this monitoring period. Hence zero value has been considered in the calculations.
If only partial data are available because activity levels or non-activity parameters have not been monitored in accordance with the registered monitoring plan, has the most conservative assumption theoretically possible been applied or has a request for deviation been approved?	It is not applicable.

Data / Parameter	Sludge removal and its application
Data unit	Tonnes
Description	The quantity and type of application of organic material / sludge removed from CSTRs and covered lagoon system /11/.

Source of data to be used	Weighing equipment /11/ available at site is used before using the material for any other purpose. Plant record every time sludge is removed from the system.
Value of data for the monitoring period	There is no sludge removed in this monitoring period. Hence zero value has been considered for the monitoring period.
Measuring frequency	Whenever the sludge is removed from reactors.
Recording and reporting frequency	Weighing equipment available at site is used before using the material for any other purpose. Plant record every time sludge is removed from the system
Type of monitoring equipment	Not applicable
Is accuracy of the monitoring equipment as stated in the PDD?	Not applicable
Calibration frequency/interval	Not applicable
Is the calibration interval in line with the monitoring plan of the PDD?	Not applicable
How were the values in the monitoring report verified and cross-checked?	Log records /05/ are maintained at site to record, In-case of any sludge removal as verified during site visit. The zero value has been considered for the monitoring period.
Does the data management (from monitoring equipment to emission reduction calculation) ensure correct transfer of data and reporting of emission reductions?	Proper log records are maintained for sludge removal and end use as soil application at the project site. Soil application for end use of sludge is ensured. The zero value has been considered for the monitoring period.
If only partial data are available because activity levels or non-activity parameters have not been monitored in accordance with the registered monitoring plan, has the most conservative assumption theoretically possible been applied or has a request for deviation been approved?	It is not applicable.

Data / Parameter	$Q_{\text{biogas, flare, h}}$
Data unit	Nm ³ /hr
Description	Biogas sent to flare during a particular hour h
Source of data to be used	Measured - Biogas flow meters (GM4) /11/. The biogas flow meter is installed at flare system for continuous measuring. Log record /05/ shall be maintained on an hourly basis to ascertain net amount of biogas has gone to flare unit during a particular hour.
Value of data for the monitoring period	This is the same value as $BG_{\text{ToFlare, y}}$
Measuring frequency	Continuous
Recording and reporting frequency	Daily. As per the monitoring report/02/, the operators shall archive the monitored data manually into the log sheets and then, upload and transfer the same to the electronic storage.
Type of monitoring equipment	Biogas flow meter (GM4) to monitor the biogas flow
Is accuracy of the monitoring equipment as stated in the PDD?	The details has been provided in the under Appendix 5 of the Verification report and found correct.

Calibration frequency/interval	Once in three years
Is the calibration interval in line with the monitoring plan of the PDD?	The calibration interval /09/10/ is in-line with the registered PD/24/ and covering the monitoring period.
How were the values in the monitoring report verified and cross-checked?	The values will be recorded in the log sheets /5/ as mentioned in the registered PD/24/. The verification team has checked the log sheets/05/ to check the correctness of the value mentioned in the monitoring report/02/ and found to be matching.
Does the data management (from monitoring equipment to emission reduction calculation) ensure correct transfer of data and reporting of emission reductions?	The data management procedure is transparent; which will ensure correct transfer of data and reporting of emission reductions.
If only partial data are available because activity levels or non-activity parameters have not been monitored in accordance with the registered monitoring plan, has the most conservative assumption theoretically possible been applied or has a request for deviation been approved?	The deviation in the monitoring parameter is explained under section 3.2 of this report.

Data / Parameter	η flare-h
Data unit	%
Description	Flare efficiency
Source of data to be used	Tool to determine project emissions from flaring gases containing methane
Value of data for the monitoring period	0% as per the tool /28/. The same is in line with the registered VCS PD/24/.
Measuring frequency	Not applicable.
Recording and reporting frequency	The verification team has verified the procedure with the tool /28/ and registered VCS PD and found to be correct.
Type of monitoring equipment	The information is provided in Appendix 5 of the Verification report.
Is accuracy of the monitoring equipment as stated in the PDD?	The information is provided in Appendix 5 of the Verification report.
Calibration frequency/interval	The information is provided in Appendix 5 of the Verification report.
Is the calibration interval in line with the monitoring plan of the PDD?	The information is provided in Appendix 5 of the Verification report.
How were the values in the monitoring report verified and cross-checked?	Maintenance /16/ of the flare system is conducted periodically as per supplier's specifications to ensure optimal operation.
Does the data management (from monitoring equipment to emission reduction calculation) ensure correct transfer of data and reporting of emission reductions?	The data management procedure is transparent; which will ensure correct transfer of data and reporting of emission reductions. Maintenance of the flare system has been conducted periodically as per supplier's specifications to ensure optimal operation.
If only partial data are available	Not applicable.

because activity levels or non-activity parameters have not been monitored in accordance with the registered monitoring plan, has the most conservative assumption theoretically possible been applied or has a request for deviation been approved?	Since the flare efficiency is not monitored, the 0% is applied for conservativeness.
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Remaining Issues from Validation or Previous Verification:

The verification team has reviewed validation report and the previous (1st) verification report available on VCS registry and found that 3 FARs were raised during the previous verification (1st verification). The FARs has been successfully closed and the details have been provided under Appendix 4 of the Verification report.

4.2 Accuracy of GHG Emission Reduction and Removal Calculations

The verification team has reviewed the emission reduction (ER) spread sheet and checked all the formulae and found they are correct and inline with the description provided in the registered VCS PD /24/ and the applied monitoring methodologies/27/.

The emission reduction due to methane capturing and utilisation for electricity generation was estimated by measuring the required parameters using appropriate monitoring equipment and using the formulae described in the methodologies; AMS III.H., version 13 and AMS I.D., version 14 /27/ and the VCS PD /20/ except the deviations described in the above sections i.e. 3.2 and 3.3. All the monitored parameters are described above in section 4.1 of the verification report. All the ex-ante parameters which are used in the calculation of emission reduction are presented in section 3.1 of the MR transparently. It is confirmed that all the ex-ante parameters have been correctly used in the emission reduction calculations.

The following are the ex-ante parameters used in the ER calculation /4/ which are in compliance with registered VCS PD/20/:

Data/Parameter	Source of data	Value	Unit	Assessment
Global warming potential of methane gas (GWP_{CH_4})	As per the applied methodology AMS-III.H./27/	21 for 2012, 25 for 2013 onwards	-	The verification team has found the value OK.
Methane producing capacity of the COD in wastewater ($B_{o,ww}$)	As per the applied methodology AMS-III.H./27/	0.21	kg CH ₄ / kg COD	The verification team has verified the value with the methodology, IPCC default values & registered PD/20/ and found to be inline.
Model correction factor to account for model uncertainties (UF_{BL})	As per the applied methodology AMS-III.H./27/	0.94	-	The verification team has verified the value with the methodology and registered PD/20/ and found to be inline.
Model correction factor to account for model uncertainties (UF_{PJ})	As per the applied methodology AMS-	1.06	-	The verification team has verified the value with the methodology and registered PD/20/ and found to be inline.

	III.H./27/			
Methane correction factor for the existing anaerobic wastewater treatment systems (MCF _{ww,treatment,BL,lagoon})	As per the applied methodology AMS-III.H./27/	0.8	-	The verification team has verified the value with the methodology and registered VCS PD/20/ and found to be inline.
CO ₂ emission factor for grid power (EF _y)	Emission factor for an electricity system in Thailand 2007, published by Department of Alternative Energy Development and Efficiency, Ministry of Energy, 26 January 2009/30/	0.5057	tCO ₂ /MWh	The verification team has confirmed that the national default value mentioned in the registered VCS PD/20/, is used in this monitoring report. Hence, accepted.
Methane correction factor for the project wastewater treatment system equipped with biogas recovery (MCF _{ww,treatment,PJ,lagoon})	As per the applied methodology AMS-III.H./27/	0.8	-	The verification has verified the value with methodology/27/ and registered VCS PD/20/ and found to be inline.
Methane correction factor for the project wastewater treatment system, UASB, equipped with biogas Recovery (MCF _{ww,treatment,PJ,CSTR})	As per the applied methodology AMS-III.H./31/	0.8	-	The verification has verified the value with methodology/27/ and registered VCS PD/20/ and found to be inline.
Density of methane at normal conditions (DCH ₄)	Tool to determine project emissions from flaring gases containing methane /28/	0.716	kg/m ³	This value is fixed based on the default value mentioned in the tool /28/. The verification team has verified the registered PD /20/ and found to be inline.
Capture efficiency of the biogas recovery equipment in the wastewater treatment	Equation 12 in AMS III.H v.13 /27/	0.9	Fraction	This value is calculated and fixed ex-ante as verified with the registered VCS PD/20/ and the same is applied in this monitoring period also. The

systems (CFE _{ww})					value is a default value as per AMS III.H v.13. Hence, accepted.
Chemical oxygen demand removal efficiency of baseline treatment system	Measured – Historical data based on colorimetric analysis /5/	87.5%	%		This value is calculated and fixed ex-ante as verified with the registered VCS PD/20/ and the same is applied in this monitoring period also. The value is based on the historical data based on colorimetric analysis. Hence, accepted.
Total electrical capacity of the equipment installed in the project activity (Pel)	Plant data/5/	181.3	kW		The verification team has verified the registered PD/20/ and equipment list sheet/11/ and name plate details of the electrical equipment and hence accepted. The same is in line with the details provided in the registered VCS PD and hence accepted.
Flare efficiency (FE)	Tool to determine project emissions from flaring gases containing methane /28/	50%	%		The verification team has verified the value with the tool and registered PD/20/ and found to be inline.
Destruction efficiency of the electricity generator (DE)	SSC WG/34/	100%	%		The verification team has verified the value with the SSC WG /34/ clarification and registered VCS PD and found to be inline.

According to the applied methodologies, the conservativeness of the achieved emission reduction was checked and the calculation has been transparently provided in the ER sheet/4/. The emission reduction is calculated using both COD approach and MD approach as specified by the applied methodology, AMS III.H., version 13. The total emission reduction for the monitoring period calculated by MD approach and COD approach is presented below:

Year	2012	2013	2014	2015	2016
ER by COD approach (tCO ₂ e)	14,061	29,441	27,932	15,963	19,260
ER by MDy approach (tCO ₂ e)	11,830	39,629	36,477	20,367	27,044
Total ER considered in the MR (tCO ₂ e) for applied methodology AMS.III.H	11,830	29,441	27,932	15,963	19,260

The detailed emission reduction calculation is presented in the ER spread sheet/04/. All the formulae and the calculation procedure were checked by the verification team. It was observed that the emission reduction was determined in a conservative manner.

4.3 Quality of Evidence to Determine GHG Emission Reductions and Removals

During the verification site visit, all relevant documents were checked to assess the correctness and quality of data submitted by the project participants, which are used to determine emission reductions.

All records needed for monitoring are archived in line with the requirements of the registered monitoring plan. No significant, lack of evidence and missing data were detected during onsite verification. Hence, the verification team confirms that the monitoring system ensures required quality of the monitoring system to ensure the quality of the monitored data. All internal data are subjected to QA/QC measures.

It was verified through onsite interviews that the plant's team involved in the monitoring of project activity is well experienced. Hence, the verification team concludes that competent staff is employed by the project proponent to carry out the relevant tasks with sufficient accuracy. Furthermore, it was learnt from the onsite interviews with the operating team that internal training programmes /8/12/16/ are conducted on regular basis as per ISO requirements.

The monitored data are recorded into the log sheets by the operators manually. These data are then archived into electronic storage. The verification team has cross checked the log sheets/5/ to verify the data and found to be reliable. The data management is found to be reliable, which will ensure the correct transfer of data and reporting of emission reductions as verified with registered VCS PD, monitoring report/02/ and site visit.

All the default values and calculation used in the monitoring report /02/ are cross checked with the registered VCS PD and found to be inline.

KBS was able to verify all the documented evidence listed above during the verification process and can confirm that data and supporting evidences are complete and accurate. Further, KBS confirms that the data and evidences used to calculate the emission reductions are found to be reliable.

4.4 Non-Permanence Risk Analysis

Not Applicable to the project activity

5 SAFEGUARDS

5.1 No Net Harm

The project activity has no potential negative environment and social-economic impacts /14/31/. Assessment team confirms it based on its on-site visit, document review and local & sectoral expertise.

5.2 Local Stakeholder Consultation

The local stakeholder consultation meeting for the project activity was conducted on project site on 10/09/2008 and the process was validated during the registration of project activity under VCS. VCS validation report has been verified to confirm the same. The PP had invited identified stakeholders well in advance. The stakeholder meeting process is described in the Section 6 of the registered VCS PD /20/ in detail. Further the verification team has interviewed the local stakeholders during the on-site visit for this verification and could not found any negative impact out of the project activity.

6 VERIFICATION CONCLUSION

KBS Certification Services Pvt. Ltd. has been contracted by 'South Pole Carbon Asset Management Ltd.' to undertake independent 2nd periodic verification and certification for the greenhouse gas (GHG) emission reductions reported from "Wastewater Treatment with Biogas System in Palm Oil Mill at Sawi, Chumporn, Thailand", for the monitoring period 01/06/2012 to 31/05/2016 (including both the days).

The verification is based on the registered VCS PD /20/ and the monitoring report/02/ for this project activity. Our verification approach was based on the requirements as defined under the Kyoto Protocol, Marrakech accord, as well as those defined by the CDM Executive Board and the VCS Standard Version 3.7.

The management of the ‘Wastewater Treatment with Biogas System in Palm Oil Mill at Sawi, Chumporn , Thailand’ is responsible for the preparation of GHG emissions data and the reported GHG emissions reductions on the basis set out within the project final Monitoring Report Version 03.2 dated 20/06/2018 /2/. The calculation and determination of GHG emission reductions from the project is the responsibility of the management of ‘The Natural Palm Group Co.,Ltd.’ and ‘South Pole Carbon Asset Management Ltd.’ 17/. The development and maintenance of records and reporting procedures are in accordance with the Monitoring Report Version 03.2 dated 20/06/2018.

It is our responsibility to express an independent GHG verification opinion on the GHG emissions and on the calculation of GHG emission reductions from the project for the period 01/06/2012 to 31/05/2016 based on the reported emission reductions in the final Monitoring Report Version 03.2 dated 20/06/2018 for the same period.

As a result of the verification, the verification team confirms that:

- All operations of the project are implemented and installed as planned and described in the project description.
- The monitoring system is in place and functional.
- The installed equipment essential for generating emission reductions runs reliably.
- The GHG emission reductions are calculated without material misstatements in a conservative and appropriate manner.

Based on an understanding of the risks associated with reporting GHG emissions data and the controls in place to mitigate these, KBS planned and performed our work to obtain the information and explanations that we considered necessary to provide sufficient evidence for us to give reasonable assurance that this reported amount of GHG emission reductions for the period is fairly stated.

Verification period: From 01/06/2012 to 31/05/2016

Verified GHG emission reductions and removals in the above verification period are listed in the below table:

Year	Net GHG emission reductions or removals (tCO ₂ e)	Net GHG emission reductions or removals (tCO ₂ e)
2012 (01/06/2012 to 31/12/2012)	11,830	104,426 tCO₂e
2013	29,441	
2014	27,932	
2015	15,963	
2016 (01/01/2016 to 31/05/2016)	19,260	

Total	104,426	
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Location: Faridabad
Date: 20/06/2018



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

APPENDIX 1: ABBREVIATIONS

Abbreviations	Full texts
CAR	Corrective Action Request
CDM	Clean Development Mechanism
CDM EB	CDM Executive Board
CL	Clarification request
CO ₂	Carbon dioxide
CO ₂ e	Carbon dioxide equivalent
COD	Chemical Oxygen Demand
CSTR	Complete Stirred Tank Reactor
DOE	Designated Operational Entity
EB	Executive Board
ER	Emission Reduction
FAR	Forward Action Request
GHG	Greenhouse Gas(es)
HFO	Heavy Fuel Oil
MP	Monitoring Plan
MR	Monitoring Report
NPO	Natural Palm Oil (Chumporn) Co., Ltd.
PD	Power Density
PP	Project Participant
QA/QC	Quality Assurance / Quality Control
SCADA	Supervisory Control And Data Acquisition

UNFCCC	United Nations Framework Convention on Climate Change
VCS	Verified Carbon Standard
VCSA	VCS Association
VCS PD	VCS Project Design document
VCU	Verified Carbon Unit
VVS	Validation And Verification Standard for project activities

APPENDIX 2: REFERENCES

S. No.	Name of document	Version, Date
/1/	Draft Monitoring report	Version 01, dated 25/01/2018
/2/	Final Monitoring report	Version 03.2, dated 20/06/2018
/3/	Draft ER sheet	Version 01, dated 25/01/2018
/4/	Final ER sheet	Version 03.1, dated 20/04/2018
/5/	Log sheets and Daily reports for all the monitoring parameters (waste water flow, COD loading, COD removal, biogas generation, biogas flaring, biogas used in boiler, Effluent, COD removal efficiency etc.) corresponding to the monitoring period.	-
/6/	Document supporting for the flaring done in this monitoring period-Daily Log book for this monitoring period	-
/7/	COD Measurement from External Laboratory for all the three COD Monitoring parameters corresponding to this monitoring period	-
/8/	Attendance sheets for the training conducted in the plant during this monitoring period	-
/9/	Calibration certificates for the instruments used in the project activity covering this monitoring period	-
/10/	Competency proof of the calibrating agency.	-
/11/	<p>Technical Specifications of the Equipments installed under the project activity:</p> <ol style="list-style-type: none"> 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. List of auxiliary drives 10. Diagram representation of the Cover Lagoon, Open Pond 11. Organizational chart 12. Single Line Diagram corresponding to the project activity describing the monitoring points. 13. 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. <p>E+H Promag 50 https://portal.endress.com/wa001/dla/5000000/0373/000/06/BA046DEN_1209.pdf E+H T-mass 65l</p>	-

	<p>https://www.th.endress.com/en/Field-instruments-overview/Flow-measurement-product-overview/Product-Thermal-flowmeter-t-mass-65l</p> <p>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</p>	
/12/	<p><u>Reports, Manuals & Procedures</u></p> <ol style="list-style-type: none"> 1. Operation Manual of Biogas Plant 2. Biogas production report:QF-BGS-100-01 3. Approved daily reports of Natural Palm Group Co., Ltd. 4. Biogas weekly report 5. Waste water analysis report: QF-QCC-117-01 6. Job description of Biogas plant Supervisor and Operating Staff/ Quality Control Laboratory Staff 7. Procedure for Control of Biogas Process. 8. Operational manual of Wastewater treatment Plant 9. Procedure for Quality control of Biogas and Methane content measurement 10. Procedure for Operation and Control of Generator 11. Procedure for Quality Control and COD analysis 12. Biogas Flare Maintenance Report 13. Competency certificates of operators 	-
/13/	<ol style="list-style-type: none"> 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 	-
/14/	<p><u>Approvals & Agreements</u></p> <ol style="list-style-type: none"> 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 	-
/15/	<p>Snap shots of the following</p> <ol style="list-style-type: none"> 1. Equipments: Covering the equipment and corresponding nameplates under project boundary (all major equipments). 2. All the meters and measuring & testing equipment (including their specifications/nameplates). 	-
/16/	<p>Operation and Maintenance</p> <ol style="list-style-type: none"> 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 	-

/17/	<p>Company related documents</p> <ol style="list-style-type: none"> 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. 	-
/18/	<p>Site visit related documents</p> <ol style="list-style-type: none"> 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 	-
/19/	Palm Oil production data for the monitoring period	-
/20/	Registered VCS PD for “Wastewater Treatment with Biogas System in Palm Oil Mill at Sawi, Chumporn, Thailand”	Version 3.1, Dated 15/11/2009
/21/	TÜV NORD CERT GmbH: Validation Report for “Wastewater Treatment with Biogas System in Palm Oil Mill at Sawi, Chumporn, Thailand”	Dated 18/11/2009
/22/	Verification report for “Wastewater Treatment with Biogas System in Palm Oil Mill at Sawi, Chumporn, Thailand” corresponding to 1 st monitoring period i.e. 01/01/2009 to 31/05/2012	Dated: 19/10/2012
/23/	<p>VCS Website: http://verra.org/ http://verra.org/project/vcs-program/rules-and-requirements/</p> <p>VCS Program Guide Version 3.7 http://verra.org/wp-content/uploads/2018/03/VCS_Program_Guide_v3.7.pdf</p>	v3.7
/24/	<p>VCS Project Standard http://verra.org/wp-content/uploads/2018/03/VCS_Standard_v3.7.pdf</p>	v3.7
/25/	CDM validation and verification standard for project activities	Version 01.0
/26/	CDM project standard for project activities	Version 01.0
/27/	<p>CDM Executive Board: Baseline and monitoring methodology “AMS-III.H.”, “Methane recovery in wastewater treatment”, version 13 of 17/07/2009.</p> <p>“AMS-I.D.”, Grid connected renewable electricity generation, version 14</p>	<p>version 13 of 17/07/2009.</p> <p>version 14</p>
/28/	<p><u>Tools</u></p> <p>Tool to determine project emissions from flaring gases containing methane”, Annex 13, EB 28</p> <p>Tool to calculate the emission factor for an electricity system” version 1.1.</p>	-
/29/	<p>Reference link for IPCC guidelines for National Greenhouse Gas Inventories, http://www.ipcc-nggip.iges.or.jp/public/2006gl/</p>	-
/30/	<p>Reference Link for emission factor estimation, http://www2.dede.go.th/cdm/520126_GridEmission2007.pdf</p>	=
/31/	<p><u>Environmental Rules and Regulations</u></p> <p>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</p> <p>Regulations on the specifications on the treated wastewater to be discharged:</p>	-

	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	
/32/	Reference link for the density of methane , http://cdm.unfccc.int/EB/028/eb28_repan13.pdf	-
/33/	Reference link for flare efficiency , http://cdm.unfccc.int/methodologies/PAMethodologies/tools/am-tool-06-v1.pdf	-
/34/	Reference link for destruction efficiency of biogas combustion for gainful use http://cdm.unfccc.int/filestorage/V/N/W/VNWAGY8MS92ZXDKUHEF5LB07QICT1P/Response%20WG%20provided.pdf?t=bmR8bjcxZ2owfDCUBcesxyevgNUz4IEzQNYE	-

APPENDIX 3: COMPETENCE OF TEAM MEMBERS AND TECHNICAL REVIEWERS

Personnel Name:		Chetan Swaroop Sharma	
Qualified to work as:			
Team Leader	<input checked="" type="checkbox"/>	Technical Expert	<input checked="" type="checkbox"/>
Validator/Verifier	<input checked="" type="checkbox"/>	Financial Expert	<input checked="" type="checkbox"/>
Technical Reviewer	<input checked="" type="checkbox"/>	Local Expert (India)	<input checked="" type="checkbox"/>
Area(s) of Technical Expertise			
Sectoral Scope		Technical Area	
Energy industries (renewable/non-renewable sources)	TA 1.1: Thermal energy generation from fossil fuels and biomass including thermal electricity from solar		
	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	<input type="checkbox"/>	Technical Expert	<input type="checkbox"/>
Validator/Verifier	<input type="checkbox"/>	Financial Expert	<input type="checkbox"/>
Technical Reviewer	<input type="checkbox"/>	Local Expert (Thailand)	<input checked="" type="checkbox"/>

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	<input checked="" type="checkbox"/>	Technical Expert	<input checked="" type="checkbox"/>
Validator/Verifier	<input checked="" type="checkbox"/>	Financial Expert	<input checked="" type="checkbox"/>
Technical Reviewer	<input checked="" type="checkbox"/>	Local Expert (India)	<input checked="" type="checkbox"/>
Area(s) of Technical Expertise			
Sectoral Scope	Technical Area		
Energy industries (renewable/non-renewable sources)	TA 1.1: Thermal energy generation from fossil fuels and biomass including thermal electricity from solar		
	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:		M P Kanal	
Qualified to work as:			
Team Leader	<input checked="" type="checkbox"/>	Technical Expert	<input checked="" type="checkbox"/>
Validator/Verifier	<input checked="" type="checkbox"/>	Financial Expert	<input checked="" type="checkbox"/>
Technical Reviewer	<input checked="" type="checkbox"/>	Local Expert (India)	<input checked="" type="checkbox"/>
Area(s) of Technical Expertise			
Sectoral Scope	Technical Area		
Energy industries (renewable/non-renewable sources)	TA 1.2: Energy generation from renewable energy sources		
Energy Demand	TA 3.1: Energy Demand		
Waste handling and disposal	TA 13.1. Solid waste and wastewater		
Agriculture	TA 15.1. Agriculture		
Approved by (Manager C & T)	Gagandeep Kakkar		
Approval date:	03/11/2015		

APPENDIX 4: CLARIFICATION REQUESTS, CORRECTIVE ACTION REQUESTS AND FORWARD ACTION REQUESTS

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

FAR ID	01	Section no.	NA	Date: 08/02/2018
Description of FAR				
FAR raised during 1st verification: As mentioned in section 2.1 of the MR, new CSTR (no.3) is under construction in place of equalization pond. The reason for the change as understood from the factory manager is that the project proponent plans to increase the production (to double during peak season). Therefore, in order to take care of additional wastewater generation, CSTR-3 is being installed. It was further understood from the onsite interviews that the capacity expansion and additional wastewater generation will not be included in the project activity. Therefore, it shall be ensured the excess wastewater generated, the new CSTR and the additional biogas generation will not be included in the project activity and the same shall be verified during the next verification.				
Project participant response				Date: 08/03/2018
The new CSTR no.3 and 4 have been installed , with the separate biogas flow meters. The biogas generated from both new reactors are sent to new generator only. Therefore the wastewater and biogas of both units are not considered for emission reduction calculation.				
Documentation provided by project participant				
Monitoring Report				
DOE assessment				Date: 22.03.2018
During the site visit, it was confirmed that the new CSTR no.3 and 4 have been installed and they have separate biogas flow meters. Further it was confirmed that the biogas generated from both new reactors are sent to new generator only. Therefore the wastewater and biogas of both units are not considered for emission reduction calculation. The same has been found appropriate by the assessment team and hence acceptable. The issue is closed.				

FAR ID	02	Section no.	NA	Date: 08/02/2018
Description of FAR				
FAR raised during 1st verification: An inline gas analyser will be installed by the PPs to monitor the methane content in biogas on a continuous basis. This shall be verified during the next verification.				
Project participant response				Date: 08/03/2018
The inline gas analyser was installed at the project which frequently damage. The PP has decided that the inline type is not the appropriate for the project condition. The portable gas analyser is used with 95% of confidential level applied as per the explanation of methodology deviation 2 of the MR.				
Documentation provided by project participant				
Monitoring Report				
DOE assessment				Date: 22.03.2018
The PP has used the portable gas analyser with 95% of confidential level applied as per the explanation of methodology deviation 2 of the MR. The same was confirmed during the site visit and found acceptable. The issue is closed.				

FAR ID	03	Section no.	NA	Date: 08/02/2018
Description of FAR				
FAR raised during 1st verification: The biogas flow meter for flare will be reinstalled by the PPs during the 2 nd monitoring period and daily monitoring of biogas flow to flare is ensured. This shall be verified during the 2 nd verification.				
Project participant response				Date: 08/03/2018
The biogas flow meter for flare has been installed on 17/01/2013 and the meter recording was started.				

Documentation provided by project participant	
Monitoring Report	
DOE assessment	Date: 22.03.2018
The biogas flow meter for flare has been installed on 17/01/2013 and the same was confirmed during the site visit. The issue is closed.	

Table 2. CL from this verification

CL ID	01	Section no.	-	Date: 08/02/2018
Description of CL				
For the monitoring parameters W_{CH_4} (under section 3.2 of the MR), the frequency of monitoring/recording is not clear.				
Project participant response				Date: 08/03/2018
The monitoring/recording frequency in section 3.2 is referred to deviation 2 , where the explanation of W_{CH_4} monitoring frequency is at least once a day with 95% of confidential level applied.				
Documentation provided by project participant				
DOE assessment				Date: 22.03.2018
The monitoring/recording frequency as referred to deviation 2 under section 3.2 of the MR has been applied. The monitoring frequency of W_{CH_4} is at least once a day with 95% of confidential level applied during the monitoring period which is acceptable to the assessment team. The issue is closed.				
CL ID	02	Section no.	-	Date: 08/02/2018
Description of CL				
During the site visit, verification team has found that the COD measurement from the internal and external lab test is not consistent. PP need to provide a comparison for the same along with justification.				
Project participant response				Date: 08/03/2018

The wastewater test by internal lab is carried out by the *composite sample with the colorimetric method*. The operator will take the wastewater samples on daily basis, and the samples for the whole week are mixed into one composite sample for COD test. The result of COD test will be represented for the whole week.

The wastewater test by the third party's lab is carried out by the *grab sample with the closed-reflux method*, which is inline with the regulations. The test result is depended on the time of sampling, which related to the process steps of the palm oil mill.

The test procedures from two laboratories are different for sampling method and test methods , which are both in line with the different standard methods. The accuracy of internal test result can be also ensured by the calibration of photometer as well as the Certificate Of Analysis (COA) of the COD test tube³. The cross-checking with the third party lab may not be required.

Additionally, as per the internal test results for the whole year, the results are varied between 20% to 30%. Therefore, it is possible that the results from two sources are not matched and can be varied.

Year	COD of raw wastewater		Difference
	Internal Lab	External lab	
2012	73,597	68,000	7.6%
2013	63,974	51,498	10%
2014	62,181	73,260	17%
2015	51,446	48,013	7%
2016	59,704	37,257	37%

Documentation provided by project participant

-

DOE assessment **Date:** 22.03.2018

Why all the CODs used under the project activity are not compared. For the COD of raw wastewater, year 2016 is high. Is high COD conservative for ER calculation? Open.

Project participant response **Date:** 05/04/2018

With reference from the registered PD for the QA/AC of COD parameters ; *The colorimetric method is well documented and well accepted either by national or international standards. In addition, to ensure accuracy in our measurements, the plant shall periodically send wastewater samples to be tested by external laboratory and compare these results with internal measurements. At least once a year.*

The accuracy of COD test by internal lab is ensured by compliance with the international standard method , the COA of the COD standard solution for test tube by the supplier , as well as the calibration of the photometer which are the most appropriate and maximum level of quality assurance for the in house COD testing method.

The COD test by certified external lab is difference by the test method (closed reflux vs. colorimetric method) and sampling method (grab vs. composite) , as well as the sampling time. It is possible that the test results may be different. Furthermore , the COD test by external lab will be analysed only once a year. Only one result cannot represent the COD results over a year. Therefore , the conservative approach is not applicable for this case.

Documentation provided by project participant

³ The COA is online available for each lot number : http://www.merckmillipore.com/TH/en/product/COD-Cell-Test,MDA_CHEM-101796?ReferrerURL=https%3A%2F%2Fwww.google.co.th%2F#anchor_COA

-			
DOE assessment		Date: 18/04/2018	
The justification provided is Ok. However, please also provide comparison for other CODs.			
Project participant response		Date: 20/04/2018	
Year	COD of wastewater out from CSTR	Difference	
	External Lab	Internal lab	
2012	14,667 / 17,333 Avg. 16,000	3,804 / 4,408 Avg. 4,106	-
2013	3,836	3,352 / 4,888 Avg. 4,120	6.9%
2014	3,965	4,097 / 4,612 Avg. 4,354.5	8.9%
2015	3,687	3,206 / 4,696 Avg. 3,951	6.7%
2016	4,911	4,736 / 5,067 Avg. 4,901.5	-0.2%
The variation of test results from the internal lab for the whole monitoring period are 23% and 28% for the COD outlet from CSTR 1 and 2. The differences of test results from two laboratories are within the variation range of 23% and 28%, except the results in 2012.			
Year	COD of wastewater out from CL	Difference	
	External Lab	Internal lab	
2012	5,333	3,203	-65.7%
2013	3,521	3,275	-7.5%
2014	3,028	2,813	-7.6%
2015	2,842	2,741	-3.7%
2016	3,758	3,405	-10.4%
The variation of test results from the internal lab for the whole monitoring period is 31% for the COD outlet from covered lagoon. The differences of test results from two laboratories are within the variation range of 31%, except the results in 2012.			
Documentation provided by project participant			
-			
DOE assessment		Date: 22.03.2018	
The justification provided by the PP is acceptable to the assessment team. The issue is closed.			

Table 3. CAR from this verification

CAR ID	01	Section no.	-	Date: 08/02/2018
Description of CAR				
During the site visit, verification team has found that the calibration of the monitoring equipments is not covering the monitoring period. PP need to submit the calibration certificate of the monitoring equipments covering the monitoring period along with the supportive document for the meter change.				
Project participant response				Date: 08/03/2018
The pending calibration reports and the record of meter relocation are submitted.				
Documentation provided by project participant				
Calibration reports and meter relocation records				
DOE assessment				Date: 23.03.2018
Please check comments in Emission Reductions sheet.				
Project participant response				Date: 05/04/2018

The calibration information in the ER sheet is revised as per the comment.	
Documentation provided by project participant	
Monitoring Report and ER calculation sheet	
DOE assessment	Date: 18/04/2018
The Calibration details in the Emission Reductions excelsheet are now revised. The issue is closed.	

CAR ID	02	Section no.	-	Date: 08/02/2018
Description of CAR				
PP need to mention the monitoring points for all the monitoring parameters (under section 3.2 of MR /xx/) as per figure 2 of the monitoring report.				
Project participant response				Date: 08/03/2018
The monitoring diagram in figure 2 is updated , to add the methane measuring point.				
Documentation provided by project participant				
Monitoring Report				
DOE assessment				Date: 23.03.2018
Also please mention the monitoring points under the monitoring parameters. Open.				
Project participant response				Date: 05/04/2018
The monitoring points are mentioned in the monitoring description.				
Documentation provided by project participant				
Monitoring Report				
DOE assessment				Date: 18.04.2018
The monitoring points are now indicated in the description provided in the revised monitoring report. The issue is closed.				

CAR ID	03	Section no.	-	Date: 08/02/2018
Description of CAR				
For the monitoring parameter $Q_{\text{biogas,flare,h}}$ (under section 3.2 of the MR), the parameter is reported twice.				
Project participant response				Date: DD/MM/YYYY
The duplicate monitoring table of the same parameter is removed.				
Documentation provided by project participant				
Monitoring Report				
DOE assessment				Date: 23.03.2018
The repetition in the monitoring table of the parameter is now removed. The issue is now closed.				

Table 4. FAR from this verification

No FAR raised during this monitoring period.

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

APPENDIX 5: MONITORING DETAILS
Equipment details

Meter	Location	Tag	Brand	Model	Accuracy	S/N
FM1	CSTR1	FT/007	E+H	PROMAG 50	0.5% OR	79006020000
FM2	CSTR2	FT/008	E+H	PROMAG 50	0.5% OR	A2019020000
			E+H	PROMAG 50	0.5% OR	K904AA20000
GM4	Flare		E+H	t-mass 65 l	1%OR	E1059F02000
			Actaris	TZ 100	1%OR	8759701001
GM1	Boiler		E+H	t-mass 65 l	1%OR	9908A202000
			Binder	Combimass	1%OR	C130280
GM2	Gen 1 - 1.0 MW	FT/004	Actaris	TZ 100	1%OR	8759701001
			E+H	Proline t-mass 65 l	1%OR	A30CEA02000
			E+H	Proline t-mass 65 l	1%OR	A20B2B02000
GM3	Gen 2 - 1.4 MW	FT/012	E+H	t-mass 65 l	1%OR	A20B2B02000
MS	Gas analyzer	BC/011	Geotech	Biogas Check	0.03	BM 12438
			Binder	Combimass	5.0%	11634
			Geotech	Biogas5000	5.0%	G504389
CODmeter	Lab - COD		Hanna	C99	10 mg/l	H105199
			Merck	Pharo		MTHA 0717-06

Calibration details

Meter	Calibration Date						
	Before 2011	2012	2013	2014	2015	2016	2017
FM1	4-Mar-11	15-Jun-12		30-Aug-14		4-Aug-16	
FM2	24-Sep-11	15-Jun-12		30-Aug-14			
						4-Aug-16	
GM4	17-Feb-11	There was no flare operation (flare closed) from 23/02/10 to					

		17/01/13					
	25-Aug-11						
GM1	28-Sep-10	25-Aug-12					
					31-Mar-15		25-Feb-17
GM2	25-Aug-11	25-Aug-12					
	24-Sep-10			3-Sep-14		4-Aug-16	
						4-Aug-16	19-Aug-17
GM3	24-Sep-10	25-Aug-12		3-Sep-14		4-Aug-16	19-Aug-17
MS	7-Apr-11	6-Mar-12					
			7-Jan-13		15-Jan-15	16-Dec-16	
							6-Jan-17
CODmeter	2-Dec-10						
		6-Jul-12			8-Jul-15		5-Jul-17

Details on calibration delay and error applied

Meter	Using period		Calibration Delay
	Installed	Moved	Error Applied Period
FM1			
FM2		4-Aug-15	
	4-Aug-15		
GM4		11-Jun-11	
	17-Jan-13		
GM1		22-Oct-13	
	22-Oct-13		2013 to 2015
GM2		22-Jun-12	
	22-Jun-12		2013 to 2014
	23-Jun-17		
GM3		23-Jun-17	
MS		10-Jun-14	
	as spare		
	15-Jan-17		
CODmeter	as spare		
	21-Jun-12		

Monitoring and calculated parameters

Parameter	Unit	2012	2013	2014	2015	2016
Q _{ww,CSTR1,y}	m ³	48,069	100,804	101,406	90,133	85,673
Q _{ww,CSTR2,y}	m ³	31,625	62,219	56,259	17,289	30,096
Q _{ww,y}	m ³	79,694	163,023	157,665	107,421	115,769
COD _{ww, untreated, y}	mg/l	73,597	63,974	62,181	52,782	59,704
COD _{out, CSTR,y} = COD _{in,CL,y}	mg/l	3,609	3,939	4,281	3,446	4,822
COD _{y,out, CL}	mg/l	3,306	3,453	2,884	2,963	3,854
COD _{load, untreated, y}	tonnes	5,865	10,429	9,804	5,670	6,912
COD _{load, out, CL, y}	tonnes	263	563	455	318	446
COD _{load, out, lagoon, y}	tonnes	32.94	70.37	56.83	39.79	55.77
COD _{load, removed,i, y}	tonnes	5,132	9,126	8,578	4,961	6,048
COD _{removed, PJ, CL, y}	tonne/m ³	0.07029	0.06052	0.05930	0.04982	0.05585
COD _{load,removed, PJ, lagoon, y}	tonne/m ³	0.00289	0.00302	0.00252	0.00259	0.00337
MEP _{ww, treatment, y}		998	1,757	1,665	953	1,151
BG _{combusted, y}	Nm ³	1,552,082	4,013,345	3,431,547	2,165,598	2,743,242
BG _{TOFlare, y}	Nm ³	0	0	0	0	0
W _{CH4}	%	50.69%	55.16%	59.39%	52.54%	55.08%
EG _y	MWh	0	0	0	0	0
EC _y	MWh	0	0	0	0	0
Sludge removed	Tonnes	0	0	0	0	0
Q _{biogas,flare,h}	Nm ³ /hr	0	0	0	0	0
η _{flare-h}	%	0%	0%	0%	0%	0%

Monitoring Parameter Adjusting

		2012	2013	2014	2015	2016
COD _{ww,in,CSTR1}	Mean	76,317	63,828	61,299	56,284	64,844
	Count	191	342	331	44	39
	STDEV	17,187	13,999	10,842	17,308	20,021
	t	1.984	1.984	1.984	2.021	2.042
	Lower	73,850	62,326	60,116	51,011	58,297
	COD _{ww,in,CSTR2}	Mean				

		75,101	68,535	67,311	69,742	68,929
	Count	200	200	333	41	37
	STDEV	13,475	13,475	12,960	24,483	15,546
	t	1.984	1.984	1.984	2.021	2.042
	Lower	73,211	66,644	65,902	62,014	63,711
COD _{out,CSTR1,y}	Mean	3084	3352	4097	3206	4736
	Count	193	343	331	44	39
	STDEV	501.45	597	1424.92	788.45	862.80
	t	1.984	1.984	1.984	2.021	2.042
	Upper	3,156	3,416	4,253	3,446	5,018
COD _{out,CSTR2,y}	Mean	4408	4888	4612	4696	5067
	Count	200	339	332	41	36
	STDEV	730.71	1360.51	1676.60	1476.08	1314.40
	t	1.984	1.984	1.984	2.021	2.042
	Upper	4,510	5,035	4,795	5,162	5,514
COD _{y,out,CL}	Mean	3203	3275	2813	2741	3405
	Count	201	346	335	43	23
	STDEV	736.02	1667.16	648.49	720.92	1039.83
	t	1.984	1.984	1.984	2.021	2.069
	Upper	3,306	3,453	2,884	2,963	3,854
%CH ₄	Mean	51.0	55.5	60.2	52.9	56.6
	Count	161	339	322	266	158
	STDEV	2.04	2.79	7.20	3.29	9.62
	t	1.984	1.984	1.984	1.984	1.984
	Upper	51.33	55.77	60.98	53.34	58.11
	Lower	50.69	55.16	59.39	52.54	55.08
Adjusting by the delay of calibration						
Q _{ww,y}	Max error	314,154	795,915	889,895		
	0.2%					