

VERIFICATION REPORT

“P.S.C STARCH WASTEWATER TREATMENT AND BIOGAS UTILIZATION PROJECT”



Document Prepared By RINA Services S.p.A. (RINA)

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Summary:

RINA Services S.p.A. (RINA), commissioned by Swiss Carbon Value Ltd., has verified the greenhouse gas emission reductions reported for the project activity “P.S.C Starch Wastewater Treatment and Biogas Utilization Project” in Thailand, VCS Registration Reference N° 417, for the period 01/01/2018 to 31/12/2018 with regard to the relevant requirements for VCS activities.

The objective of the verification is to have an independent review ex-post determination of the monitored reductions in GHG emission reductions. Verification was conducted using RINA procedures in line with the requirements specified in the VCS Version 3.7 Requirements, VCS validation and verification manual version 3.2, CDM M&P, the latest version of the CDM Validation and Verification Standard, and relevant decisions of the COP/MOP and the CDM EB and applying standard auditing techniques. The verification consisted of desk review, on-site assessment and the resolution of outstanding issues and the issuance of the final verification report and certification.

The verification shall ensure that reported emission reductions are complete and accurate in accordance with applicable VCS / CDM requirements in order to be certified.

The project was validated by TUV Nord Cert (validation report N° 53219108-08/509 dated 18/11/2009) and it was registered under the VCS registration reference N° 417.

The GHG emission reductions were calculated on the basis of the approved methodology AMS-III.H ‘Methane Recovery in Wastewater Treatment’ version 13 and the monitoring plan included in the registered Project Design Document, version 03.1 of 18/11/2009.

During this verification, 02 Corrective Action Request (CAR) and 1 Clarification Requests (CRs) were identified related to operation, GHG emission reduction estimation, monitoring and baseline scenario of the VCS project activity in relation to all relevant VCS requirements for the project activity and the applied baseline and monitoring methodology, and these CARs and CRs are successfully closed after necessary corrections/clarifications by the client. The same has been discussed in Appendix B of this verification report.

In conclusion, it is RINA's opinion that the project activity “P.S.C Starch Wastewater Treatment and Biogas Utilization Project” in Thailand, VCS project ID 417, meets all relevant requirements for VCS standard and guidelines and correctly applies the baseline and monitoring methodology AMS-III.H ‘Methane Recovery in Wastewater Treatment’ version 13. The monitoring system is in place and the emission reductions are calculated without material misstatement. Hence, RINA is able to certify that the emission reductions from the project during the monitoring period 01/01/2018 to 31/12/2018 amount to 58,924 tCO₂e.

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1 INTRODUCTION

1.1 Objective

RINA has been commissioned by “Swiss Carbon Value Ltd.” to perform an independent verification of its VCS project, “P.S.C Starch Wastewater Treatment and Biogas Utilization Project”, already registered under VCS with Project ID. 417 for the reported GHG emission reductions for the given monitoring period 01/01/2018 up to 31/12/2018. The VCS projects must undergo 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 project description (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:

- to verify that actual monitoring systems and procedures are in compliance with the monitoring systems and procedures described in the monitoring plan;
- to evaluate the GHG emission reduction data and express a conclusion with a reasonable level of assurance about whether the reported GHG emission reduction data is free from material misstatement;
- to verify that reported GHG emission data is sufficiently supported by evidence.

The project is assessed against the requirements of VCS standard version 3.7, VCS program guide version 3.7, validation and verification manual version 3.2 and related rules and guidance. RINA has, based on the recommendations in the latest version of CDM Validation and Verification Standard, VCS validation and verification manual 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.

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

1.3 Level of Assurance

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

The technical review was performed by a technical reviewer(s) qualified in accordance with RINA's qualification scheme for VCS and CDM validation and verification.

The verification team and the technical reviewers consist of the following personnel.

Role	Last Name	First Name	Country
Team Leader, verifier & Technical Expert (TA 13.1)	Buragohain	Champok	India
Technical reviewer	Liu	Huifeng	China

1.4 Summary Description of the Project

The project activity involves biogas recovery and its utilization as a fuel in hot oil boiler and steam boilers. The project involves wastewater generation from two different manufacturing units turning out three products (i.e. starch, sweetener and ethanol). The project is implemented at P.S.C Starch Products Public Company Limited in 28/04/2005 (project start date). In the baseline, wastewater generated was treated in cascading open anaerobic lagoons. The project activity involves an intertwined network of anaerobic treatment system which consist of UASB system and covered lagoons. The newly constructed covered lagoon 1 (CL1) pre-treats the wastewater before feeding to UASB. Later, in June 2006, a covered sheet at the existing first open anaerobic lagoon was installed to collect biogas generated. The covered lagoon (CL 2) was designed to receive wastewater from sweetener plant together with the effluent from the UASB reactors. In October 2009, a new ethanol plant started operation in line with these existing facilities. Wastewater from ethanol plant is taken into a covered lagoon (CL 3) and then diverted to covered lagoon 1. Thus the biogas generated by the overall system (UASB+CL1+CL2+CL3) is used at sweetener plant (steam boilers), starch plant (hot oil boiler) and sweetener plant (electricity generation). The components of electricity production and fuel replacement are not claimed for emission reductions. Verification team has checked the project activity equipments installed at the project site and found in compliance with the registered VCS PD version 3.1 /02/.

The project site is located in the compound of the P.S.C. Starch factory located at 999 Nongya Bothong road, Nongyai District, Chonburi Province , Thailand , about 150km away from Bangkok. Geographical coordinates: Latitude 13°18'6.50"N and Longitude 101°21'49.47'E.

As per the registered VCS PD (VCS Ref. No: 417) of the VCS project, baseline emissions are calculated as the sum of fugitive methane emissions from lagoons in the baseline case in the absence of the project activity. Project emissions are calculated as the fugitive methane emissions from the project activity, the electricity consumption to run the project activity in present scenario. The emission reduction is calculated as the difference of baseline emissions and the project emissions as the leakage emissions are considered to be negligible for the project activity as per the applied methodologies.

The project is going for the 4th verification (from 01/01/2018 to 31/12/2018) under the first crediting period (01/12/2009 to 30/11/2019) with emission reductions 58,924 tCO_{2e}. The emission reductions are calculated conservatively as per the applied methodology.

Main components of the project activity include Acidification ponds, UASB, Gas storage pond, Thermal oil boilers, Cascading open lagoons system (Evaporation ponds) and Open flaring system.

The main information of the project activity is summarized in the table below:

Project Participant(s)	P.S.C Starch Products Public Company Limited Swiss Carbon Value Ltd.		
Project Title	P.S.C Starch Wastewater Treatment and Biogas Utilization Project		
Location of the project	The project site is located in the compound of the P.S.C. Starch factory located at 999 Nongya Bothong road, Nongyai District, Chonburi Province , Thailand , about 150km away from Bangkok. Geographical coordinates: Latitude 13°18'6.50"N and Longitude 101°21'49.47"E		
Methodology(ies)	AMS-III.H 'Methane Recovery in Wastewater Treatment' version 13		
Sectoral Scope(s)	13	RINA's Technical Area(s)	13.1
Registered PDD	Version 3.1 of 18/11/2009		
Starting date of the crediting period	01/12/2009		
Project's crediting period	01/12/2009 – 30/11/2019		
Project documentation link	https://www.vcsprojectdatabase.org/#/project_details/417		

2 VERIFICATION PROCESS

2.1 Method and Criteria

Verification was conducted using RINA procedures in line with the requirements specified in the VCS Requirements, i.e. VCS Program Guide, VCS Version 3 (v3.7) and VCS Standard, VCS Version 3 (v3.7). The GHG emission reductions are on the basis of the approved Baseline and monitoring methodology AMS-III.H 'Methane Recovery in Wastewater Treatment' version 13.

The verification consisted of the following three phases

- Document review;
- On-site assessment including Interviews and Site Inspections;
- Resolution of Any Material Discrepancy and the issuance of the final verification report and certification.

The following sections outline each step in more detail.

2.2 Document Review

The monitoring report (MR) version 01 of 12/04/2019 and version 02 of 03/05/2019 /01/, the emission reduction calculations spreadsheet (300493PSC_ER cal_4thMR(PAF)_12042019.xlsx) version 01 of 12/04/2019, version 02 'VCS417PSC_ER cal_4thMR(PAF)_ver2.0_03052019.xlsx' of 03/05/2019 /03/, were assessed as part of the verification. In addition the registered Project Design Document (VCS-PD) /02/ in particular the baseline estimations and the monitoring plan for the project were reviewed.

The following table lists the documentation that was reviewed during the verification

/01/	Swiss Carbon Value Ltd.: VCS monitoring report for the project activity "P.S.C Starch Wastewater Treatment and Biogas Utilization Project", version 1.0 of 12/04/2019 and version 02 fo 03/05/2019
/02/	Swiss Carbon Value Ltd.: VCS project description for project activity "P.S.C Starch Wastewater Treatment and Biogas Utilization Project" in Thailand, version 3.1 of 18/11/2009
/03/	Swiss Carbon Value Ltd.: Emission Reduction spread sheet titled "300493PSC_ER cal_4thMR(PAF)_12042019.xlsx" version 01 of 12/04/2019. Version 02 of 03/05/2019
/04/	VCS: VCS Program Guide, VCS Version 3 (v3.7), Requirements Document of 21/06/2017
/05/	VCS: VCS Standard, VCS Version 3 (v3.7), Requirements Document of 21/06/2017
/06/	CDM Executive Board: AMS-III.H 'Methane Recovery in Wastewater Treatment' version 13
/07/	VCS: P.S.C Starch Wastewater Treatment and Biogas Utilization Project (ID: 417) https://www.vcsprojectdatabase.org/#/project_details/417
/08/	VCS: Monitoring report form (MONITORING REPORT: VCS Version 3) , version 03.4 dated 19/10/2016
/09/	TUV Nord: Validation report (validation report N° 53219108-08/509 of 18/11/2009) for the project activity "P.S.C Starch Wastewater Treatment and Biogas Utilization Project"
/10/	KBS Certification Services Pvt. Ltd.: Verification report for the project activity 'P.S.C Starch Wastewater Treatment and Biogas Utilization Project' covering the monitoring period 12/05/2016 to 31/12/2017
/11/	Daily log sheets of P.S.C. Starch Company: - Wastewater flow meter readings for the period 01/01/2018 to 31/12/2018 - Methane content (% CH₄) in biogas for the period 01/01/2018 to 31/12/2018 - COD measurement of wastewater for the period 01/01/2018 to 31/12/2018 - Biogas consumption for boilers and turbine (GM 1 & GM 2) for the period 01/01/2018 to 31/12/2018 - Biogas consumption for flare for the period 01/01/2017 to 31/12/2018
/12/	Calibration Reports: Wastewater Flow meter (FM1): Serial Number: 3K672016320307 Calibrated by ABB on 16/08/2016 and on 05/03/2018 by Miracle International Technology Co. Ltd.

	b) Wastewater Flow meter (FM2): Serial Number: 6201472 Calibrated by Miracle International Technology Co. Ltd. on 26/12/2017 c) Wastewater Flow meter (FM3): Serial Number: S5G802553736 Calibrated by Miracle International Technology Co. Ltd. on 26/12/2017 and serial number 3K672018091156 by ABB on 08/03/2018 d) Continuous gas analyser: Serial Number: 96159; By AWJ Innovation Co. Ltd.: Test Certificate with Calibration date 14/03/2017 e) Biogas flow meter to boiler (GM1): Serial Number: 503208; By Miracle International Technology Co. Ltd, calibrated on 21/12/2017 f) Biogas flow meter to boiler (GM2): Serial Number: 630166; By Miracle International Technology Co. Ltd, calibrated on 20/12/2017 g) Biogas flow meter to boiler (GM2): Serial Number: 630165; By Miracle International Technology Co. Ltd, calibrated on 12/11/2018
/13/	List of Accredited Laboratories; webpage https://www.tisi.go.th/home/en in English language retrieved on 15/05/2019

2.3 Interviews

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

	Date	Name and Role	Organization	Topic
/a/	24/04/2019	Ms. Sirinut Raya-Project Manager	South Pole Carbon Asset Management Ltd.	Monitoring report, emission reduction calculations, records of monitoring parameters, VCS rules, application of methodology etc.
/b/	24/04/2019	Ketmanee Poomehaweng-Safety officer	P.S.C Starch Products Public Company Limited	Technical aspects of the project activity. Operational life, environmental aspects etc. Operational details of the project, management structure, legal compliance, health, safety and environmental aspects, data monitoring and recording procedure, safety practices, production controls, internal audits etc.
/c/	24/04/2019	Piyanuch Lalun – Environmental officer		
/d/	24/04/2019	Manus Boonprakab-Manager		
/e/	24/04/2019	Sukanda Kuakitkul-QA/QC supervisor		
/f/	24/04/2019	K. Prawin Thelasawat	Village Head- Nong-ta-kian tong village	Stakeholder interaction regarding views and impact from project activity in local area including health, safety and environmental aspects.
/g/	24/04/2019	K.Sirinun Sae-koh	Villager- Nong-ta-kian tong village	
/h/	24/04/2019	K.Wichuda Sae teow	Villager- Nong-ta-kian tong village	

2.4 Site Inspections

On 24/04/2019, RINA team visited P.S.C Starch Products Public Company Limited located at 999 Nongya Bothong road, Nongyai District, Chonburi Province , Thailand , about 150km away from Bangkok. During the on-site assessment of the project, there were no hindrance and all the equipment's and the systems were accessible. RINA assessed the implementation and operation of the proposed project activity, reviewed the information flows for generating, aggregating and reporting the monitoring parameters, interviewed key personnel of the plant to confirm the operational and data collection procedures, cross-checked between information provided in the monitoring report and data plant, checked the monitoring equipment, reviewed calculations and assumptions made in determining the GHG data and emission reductions, checked the 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

The objective of this phase of the verification is to resolve any outstanding issues which need to be clarified for RINA's positive conclusion on the project description. To guarantee transparency a verification protocol has been customized for the project. The protocol shows in a transparent manner the requirements, means of verification and the results from verifying the identified criteria. The verification protocol consists of three tables; the different columns in these tables are described below.

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

- Non-conformities with the monitoring plan or methodology are found in monitoring and reporting, or if the evidence provided to prove conformity is insufficient;
- Mistakes have been made in applying assumptions, data or calculations of emission reductions that will impair the estimate of emission reductions;
- Issues identified in a FAR during validation to be verified during verification have not been resolved by the project participants.

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

In summary, 1 CR and 2 CARs were raised during this verification which were closed successful and details are given under Appendix B of this report.

2.5.1 Forward Action Requests

Based on the review of the validation report /09/ and previous verification report /10/, no FAR found raised which needs to be closed during this verification.

2.6 Eligibility for Validation Activities

The project activity is registered under VCS registration reference Number 417 /07/, hence this section is not applicable.

3 VALIDATION FINDINGS

The project was validated by TUV Nord (validation report N° 53219108-08/509 of 18/11/2009) and it was registered under the VCS registration reference N° 417. The crediting period is from 01/12/2009 – 30/11/2019. The project has completed 3 verification upto 31/12/2017. This is the 4th verification assessment for the monitoring period 01/01/2018 to 31/12/2018 by RINA.

3.1 Participation under Other GHG Programs

N/A.

3.2 Methodology Deviations

The verification team confirm that the registered VCS PD complies the requirements in the applied methodology AMS-III.H 'Methane recovery in wastewater treatment' version 13. No methodology deviations applied during this monitoring period.

3.3 Project Description Deviations

Two deviations are applied during this monitoring period which are discussed below:

Description of Deviations	Assessment
Deviation 1: During registration of the project it was envisaged that treated COD measurement shall be taken at after CL 2 and after CL 3 (Registration project boundary diagram). However, during implementation, the treated wastewater from CL3 is sent to CL1. Then the last unit for closed anaerobic system is CL2 before discharge to pond system. The $COD_{ww,discharge,PJ,y}$ is changed to be the COD of treated wastewater from CL2.	The verification team of the opinion that the deviation is in compliance to the methodology. In line with the methodology the final emission reduction is the minimum of COD approach and MDy approach. Therefore, the change will not affect the conservative estimation of emission reductions. Further, the approach has been applied sine previous verifications. Therefore, the deviation is accepted by the verification team.
Deviation 2: $COD_{y,ww,untreated,starch}$, $COD_{y,ww,untreated,sweetener}$, $COD_{y,ww,untreated,ethanol}$, $COD_{y,ww,treated,CL2}$, $COD_{y,ww,treated,CL3}$ and $COD_{y,ww,treated,lagoon}$ are not measured on daily basis as per the monitoring plan for COD parameters in the registered VCS PD.	The revised approach is in line with the methodology provisions. The deviation is transparently described in the monitoring report and calculation is presented in the emission reduction worksheet. Further, the deviation has been applied since previous verifications. Therefore, the deviation is accepted by the

The wastewater analysis of the samples were carried out by internal laboratory, but not on every operational days. As per AMS-III.H, 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 is followed applying standard statistical calculation.	verification team.
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3.4 Grouped Project

This project is not a grouped project. Hence, this section is not applicable.

4 VERIFICATION FINDINGS

4.1 Project Implementation Status

On the basis of the on-site visit and the reviewed project documentation, the verification team confirms that the project was implemented as described in the registered VCS PD version 3.1 except the deviations described above. All the physical components and project boundary are in conformity with the description in registered VCS PD version 3.1. The project activity was implemented in December 2009 and in operation since then. Based on the VCS PD and the available information at VCS database it is confirmed that the project's first crediting period is from 01/12/2009 – 30/11/2019.

The project activity involves capturing of methane generated from the wastewater treatment through UASB technology and covered lagoons. The captured methane (biogas) is utilized as fuel in thermal oil boilers replacing heavy fuel oil. However, PP has decided not to claim any emission reductions from fossil fuel replacement.

As per the applied methodologies; AMS-III.H, version 13, the project boundary is defined as below:

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

Based on document review and onsite verification, it is confirmed that all the emission sources within the boundary have been considered appropriately. Monitoring of all parameters during the monitoring period is followed as per registered monitoring plan except the deviations described in section 3.2 above.

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

DATA/PARAMETER Unit	Source of data	Reported value for the project period	Assessment/Observation
Global	Data based on	25	The value is ex-ante fixed for 10

Warming Potential for Methane (GWP_{CH_4}) in tCO_2e/tCH_4	registered PD /02/ and validation report /09/		years crediting period as per the registered PD, which was initially 21 as per the registered VCS PD. However, as per VCS standard 3.7 and deviation applied in last verification the value is updated to 25 as per IPCC fourth assessment report. Hence, correct value is considered.
Methane producing capacity of the wastewater ($B_{o,ww}$); kg CH_4/kg COD	Data based on registered PD /02/ and validation report /09/	0.21	The value is ex-ante fixed for 10 years crediting period as per the registered PD, which has been justified and validated by validation DOE to follow the applied methodology and tool /02/, /09/.
Model correction factor to account for model uncertainties (UF_{BL})	Data based on registered PD /02/ and validation report /09/	0.94	The value is ex-ante fixed for 10 years crediting period as per the registered PD, which has been justified and validated by validation DOE to follow the applied methodology and tool /02/, /09/.
Model correction factor to account for model uncertainties (UF_{PJ})	Data based on registered PD /02/ and validation report /09/	1.06	The value is ex-ante fixed for 10 years crediting period as per the registered PD, which has been justified and validated by validation DOE to follow the applied methodology and tool /02/, /09/.
Methane correction factor for baseline wastewater treatment systems i ($MCF_{ww,treatment, BL,lagoon}$)	Data based on registered PD /02/ and validation report /09/	0.8	The value is ex-ante fixed for 10 years crediting period as per the registered PD, which has been justified and validated by validation DOE to follow the applied methodology and tool /02/, /09/.
Methane correction factor for project wastewater treatment systems equipped with biogas recovery ($MCF_{ww,treatment, PJ,k}$)	Data based on registered PD /02/ and validation report /09/	0.8	The value is ex-ante fixed for 10 years crediting period as per the registered PD, which has been justified and validated by validation DOE to follow the applied methodology and tool /02/, /09/.
Methane correction factor for	Data based on registered PD /02/ and validation	0.8	The value is ex-ante fixed for 10 years crediting period as per the registered PD, which has been

project wastewater treatment systems not equipped with biogas recovery (MCF _{ww,treatment,PJ,lagoon})	report /09/		justified and validated by validation DOE to follow the applied methodology and tool /02/, /09/.
Methane correction factor based on discharge pathway in the project situation (MCF _{ww,PJ,discharge})	Data based on registered PD /02/ and validation report /09/	0.8	The value is ex-ante fixed for 10 years crediting period as per the registered PD, which has been justified and validated by validation DOE to follow the applied methodology and tool /02/, /09/.
Capture efficiency of the biogas recovery equipment in the wastewater treatment systems (CFE _{ww})	Data based on registered PD /02/ and validation report /09/	0.9	The value is ex-ante fixed for 10 years crediting period as per the registered PD, which has been justified and validated by validation DOE to follow the applied methodology and tool /02/, /09/.
Chemical oxygen demand removal efficiency of baseline treatment system for the starch and sweetener plants ($\eta_{BL,starch}$); %	Data based on registered PD /02/ and validation report /09/	98.61%	The value is ex-ante fixed for 10 years crediting period as per the registered PD, which has been justified and validated by validation DOE to follow the applied methodology and tool /02/, /09/.
Chemical oxygen demand removal efficiency of baseline treatment system for the ethanol plants ($\eta_{BL,ethanol}$); %	Data based on registered PD /02/ and validation report /09/	87.76%	The value is ex-ante fixed for 10 years crediting period as per the registered PD, which has been justified and validated by validation DOE to follow the applied methodology and tool /02/, /09/.
Flare efficiency (%)	Data based on registered PD /02/ and validation report /09/	50%	Default value taken as per applicable tool which has been justified and validated by validation DOE to follow the applied methodology and tool

			/02/, /09/.
Total electrical capacity of the equipment installed in the project activity (Pel; kW)	Data based on registered PD /02/ and validation report /09/	245.1	The value is ex-ante fixed for 10 years crediting period as per the registered PD, which has been justified and validated by validation DOE to follow the applied methodology and tool /02/, /09/.
CO ₂ emission factor for grid power (EF _y); tCO ₂ /MWh	Data based on registered PD /02/ and validation report /09/	0.5057	The value is ex-ante fixed for 10 years crediting period as per the registered PD, which has been justified and validated by validation DOE to follow the applied methodology and tool /02/, /09/.

RINA is able to confirm that the Data and parameters fixed ex ante have been implemented in full compliance with the registered monitoring plan.

Data parameters monitored:

Data/Parameter	Assessment	
Data Unit	Q _{y,ww,starch} m ³	
Description	Volume of wastewater treated in the year y from the starch plant	
Source of data to be used	Measured – Volumetric flow meters	
Value of monitored parameter for the monitoring period	Period	Value (m ³)
	01/01/2018 to 31/12/2018	791,093
	The values mentioned in the monitoring report and ER sheet have been verified with the daily log book reports /11/. The reported values in the MR and ER sheet were found to be consistent with the daily reports and the operator log sheet information.	
Monitoring equipment	Serial number	3K672016320307
	Model	ABB, FEV11
Accuracy of the monitoring equipment	VCS PD does not specify the accuracy of monitoring equipment. However, the PP has installed flow meter with an accuracy class of 0.4%. The accuracy of the meters represents good monitoring practice.	
Measuring/Reading/Recording frequency	Continuous monitoring, recording on the daily basis. The practice found to be followed during site visit and consistent with registered monitoring plan.	
Calcualtion method (if applicable)	N/A.	
Calibration		
Calibration frequency/interval Is the calibration interval in line with the monitoring plan of the PD?	The flow meter is calibrated at least once every 3 years. This is consistent with registered monitoring plan and previous verifications and hence accepted.	

Does the calibration cover the monitoring period? Has the calibration frequency been respected?	The monitoring period is from 01/01/2018 to 31/12/2018. The flow meter was calibrated on 16/08/2016 (valid until 15/08/2019) and on 05/03/2018 (valid until 04/03/2021) /12/. Hence, the calibration of flow meter covers the monitoring period. The calibration frequency of the meter has been checked with calibrations records and found that the calibration frequency has been respected.	
Calibration certificates	Serial no.	Calibration details
	3K672016320307	Calibrated by ABB on 16/08/2016 and on 05/03/2018 by Miracle International /12/
Does the calibration of meters have been done by an accredited person or institution?	ABB is the manufacturer of the flow meter and credible to calibrate the flow meter. Similarly, Miracle International Technology Co. Ltd. is accredited agency /13/	

Data/Parameter	Assessment	
Data Unit	$Q_{y,ww,sweetner}; m^3$	
Description	Volume of wastewater treated in the year y from the sweetener plant	
Source of data to be used	Measured – Volumetric flow meters	
Value of monitored parameter for the monitoring period	Period	Value (m ³)
	01/01/2018 to 31/12/2018	451,361
	The values mentioned in the monitoring report and ER sheet have been verified with the daily log book reports /11/. The reported values in the MR and ER sheet were found to be consistent with the daily reports and the operator log sheet information.	
Monitoring equipment	Flow meter	
	Serial number	6201472
	Model	Rosemount, M4Q4
Accuracy of the monitoring equipment	VCS PD does not specify the accuracy of monitoring equipment. However, the PP has installed flow meter with an accuracy class of 0.35%. The accuracy of the meters represents good monitoring practice.	
Measuring/Reading/Recording frequency	Continuous monitoring, recording on the daily basis. The practice found to be followed during site visit and consistent with registered monitoring plan.	
Calcualtion method (if applicable)	N/A.	
Calibration		
Calibration frequency/interval Is the calibration interval in line with the monitoring plan of the PD?	The flow meter is calibrated at least once every 3 years. This is consistent with registered monitoring plan and previous verifications and hence accepted.	

Does the calibration cover the monitoring period? Has the calibration frequency been respected?	The monitoring period is from 01/01/2018 to 31/12/2018. The flow meter was calibrated on 26/12/2017 (valid until 25/12/2020) /12/. Hence, the calibration of flow meter covers the monitoring period. The calibration frequency of the meter has been checked with calibrations records and found that the calibration frequency has been respected.	
Calibration certificates	Meter no.	Calibration details
	6201472	Calibrated by Miracle International on 26/12/2017 /12/
Does the calibration of meters have been done by an accredited person or institution?	,Miracle International Technology Co. Ltd. is accredited agency /13/	

Data/Parameter	Assessment	
Data Unit	Q _{y,ww,ethanol} ; m ³	
Description	Volume of wastewater treated in the year y from the ethanol plant	
Source of data to be used	Measured – Volumetric flow meters	
Value of monitored parameter for the monitoring period	Period	Value (m ³)
	01/01/2018 to 31/12/2018	422,362
	The values mentioned in the monitoring report and ER sheet have been verified with the daily log book reports /11/. The reported values in the MR and ER sheet were found to be consistent with the daily reports and the operator log sheet information.	
Monitoring equipment	Flow meter	
	Serial number (used until 11/06/2018)	S5G802553736
	Model	Yokogawa, APX1500
	Serial number (used from 12/06/2018)	3K672018091156
	Model	ABB, FEP300
Accuracy of the monitoring equipment	VCS PD does not specify the accuracy of monitoring equipment. However, the PP has installed flow meter with an accuracy class of 0.35% (S5G802553736) and 0.40% (3K672018091156). The accuracy of the meters represents good monitoring practice.	
Measuring/Reading/Recording frequency	Continuous monitoring, recording on the daily basis. The practice found to be followed during site visit and consistent with registered monitoring plan.	
Calcualtion method (if applicable)	N/A.	
Calibration		

Calibration frequency/interval Is the calibration interval in line with the monitoring plan of the PD?	The flow meter is calibrated at least once every 3 years. This is consistent with registered monitoring plan and previous verifications and hence accepted.	
Does the calibration cover the monitoring period? Has the calibration frequency been respected?	The monitoring period is from 01/01/2018 to 31/12/2018. The flow meter S5G802553736 was calibrated on 26/12/2017 (valid until 25/12/2020) and flow meter 3K672018091156 was calibrated on 08/03/2018 (valid until 07/03/2021) /12/. Hence, the calibration of flow meter covers the monitoring period. The calibration frequency of the meter has been checked with calibrations records and found that the calibration frequency has been respected.	
Calibration certificates	Meter no.	Calibration details
	S5G802553736	Calibrated by Miracle International on 26/12/2017 /12/
	3K672018091156	Calibrated by ABB on 08/03/2018 /12/
Does the calibration of meters have been done by an accredited person or institution?	Miracle International Technology Co. Ltd. is accredited agency /13/ and ABB is the manufacturer of the flow meter and hence credible to calibrate.	

Data/Parameter	Assessment		
Data Unit	COD _{y,ww,untreated,starch} ; mg/l		
Description	COD of wastewater from starch plant : CS1		
Source of data to be used	Measured – Titrimetric analysis		
Value of monitored parameter for the monitoring period	Period	Value (mg/l)	
	01/01/2018 to 31/12/2018	Higher	Lower
		20,612	17,182
	The values mentioned in the monitoring report and ER sheet have been verified with the daily reports /11/. The reported values in the MR and ER sheet were found to be consistent with the daily reports and the operator log sheet information.		
Monitoring equipment	NA		
Accuracy of the monitoring equipment	NA		
Measuring/Reading/Recording frequency	Daily. The closed reflux titrimetric method is well documented and well accepted by international standards.		
Calculation method (if applicable)	N/A.		
Calibration			

Calibration frequency/interval Is the calibration interval in line with the monitoring plan of the PD?	NA
Does the calibration cover the monitoring period? Has the calibration frequency been respected?	NA
Calibration certificates	NA
Does the calibration of meters have been done by an accredited person or institution?	NA

Data/Parameter	Assessment		
Data Unit	COD _{y,ww,untreated,sweetner} ; mg/l		
Description	COD of wastewater from sweetener plant : CS2		
Source of data to be used	Measured – Titrimetric analysis		
Value of monitored parameter for the monitoring period	Period	Value (mg/l)	
	01/01/2018 to 31/12/2018	Higher	Lower
		19,309	15,395
	The values mentioned in the monitoring report and ER sheet have been verified with the daily reports /11/. The reported values in the MR and ER sheet were found to be consistent with the daily reports and the operator log sheet information.		
Monitoring equipment	NA		
Accuracy of the monitoring equipment	NA		
Measuring/Reading/Recording frequency	Daily. The closed reflux titrimetric method is well documented and well accepted by international standards.		
Calcualtion method (if applicable)	N/A.		
Calibration			
Calibration frequency/interval Is the calibration interval in line with the monitoring plan of the PD?	NA		
Does the calibration cover the monitoring period? Has the calibration frequency been respected?	NA		

Calibration certificates	NA
Does the calibration of meters have be done by an accredited person or institution?	NA

Data/Parameter	Assessment		
Data Unit	COD _{y,ww,untreated,ethanol} ; mg/l		
Description	COD of wastewater from ethanol plant : CS3		
Source of data to be used	Measured – Titrimetric analysis		
Value of monitored parameter for the monitoring period	Period	Value (mg/l)	
	01/01/2018 to 31/12/2018	Higher	Lower
		54,283	49,308
		The values mentioned in the monitoring report and ER sheet have been verified with the daily reports /11/. The reported values in the MR and ER sheet were found to be consistent with the daily reports and the operator log sheet information.	
Monitoring equipment	NA		
Accuracy of the monitoring equipment	NA		
Measuring/Reading/Recording frequency	Daily. The closed reflux titrimetric method is well documented and well accepted by international standards.		
Calcualtion method (if applicable)	N/A.		
Calibration			
Calibration frequency/interval Is the calibration interval in line with the monitoring plan of the PD?	NA		
Does the calibration cover the monitoring period? Has the calibration frequency been respected?	NA		
Calibration certificates	NA		
Does the calibration of meters have be done by an accredited person or institution?	NA		

Data/Parameter	Assessment
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Data Unit	COD _{y,ww,treated} (CL 2); mg/l		
Description	COD of wastewater exiting the covered lagoon 2 treatment process : CS4		
Source of data to be used	Measured – Titrimetric analysis		
Value of monitored parameter for the monitoring period	Period	Value (mg/l)	
	01/01/2018 to 31/12/2018	Higher	Lower
		11,044	9,099
	The values mentioned in the monitoring report and ER sheet have been verified with the daily reports /11/. The reported values in the MR and ER sheet were found to be consistent with the daily reports and the operator log sheet information.		
Monitoring equipment	NA		
Accuracy of the monitoring equipment	NA		
Measuring/Reading/Recording frequency	Daily. The closed reflux titrimetric method is well documented and well accepted by international standards.		
Calcualtion method (if applicable)	N/A.		
Calibration			
Calibration frequency/interval Is the calibration interval in line with the monitoring plan of the PD?	NA		
Does the calibration cover the monitoring period? Has the calibration frequency been respected?	NA		
Calibration certificates	NA		
Does the calibration of meters have be done by an accredited person or institution?	NA		

Data/Parameter	Assessment		
Data Unit	COD _{y,ww,treated} (CL 3); mg/l		
Description	COD of wastewater exiting the covered lagoon 3 treatment process : CS5		
Source of data to be used	Measured – Titrimetric analysis		
Value of monitored parameter for the monitoring period	Period	Value (mg/l)	
	01/01/2018 to 31/12/2018	Higher	Lower
		6,190	3,780

	The values mentioned in the monitoring report and ER sheet have been verified with the daily reports /11/. The reported values in the MR and ER sheet were found to be consistent with the daily reports and the operator log sheet information.
Monitoring equipment	NA
Accuracy of the monitoring equipment	NA
Measuring/Reading/Recording frequency	Daily. The closed reflux titrimetric method is well documented and well accepted by international standards.
Calculation method (if applicable)	N/A.
Calibration	
Calibration frequency/interval Is the calibration interval in line with the monitoring plan of the PD?	NA
Does the calibration cover the monitoring period? Has the calibration frequency been respected?	NA
Calibration certificates	NA
Does the calibration of meters have been done by an accredited person or institution?	NA

Data/Parameter	Assessment				
Data Unit	$W_{CH_4,y}$, %				
Description	Methane content in the biogas in the year y				
Source of data to be used	Measured using online gas analyzer				
Value of monitored parameter for the monitoring period	<table border="1"> <thead> <tr> <th>Period</th><th>Value</th></tr> </thead> <tbody> <tr> <td>01/01/2018 to 31/12/2018</td><td>53%</td></tr> </tbody> </table> The average value mentioned in the monitoring report and ER sheet have been verified with the daily reports /11/. The reported values in the MR and ER sheet were found to be consistent with the daily reports and the operator log sheet information.	Period	Value	01/01/2018 to 31/12/2018	53%
Period	Value				
01/01/2018 to 31/12/2018	53%				
Monitoring equipment	<table border="1"> <tbody> <tr> <td>Serial number</td><td>96159</td></tr> <tr> <td>Model</td><td>UNION, INCA 4002 T099-01</td></tr> </tbody> </table>	Serial number	96159	Model	UNION, INCA 4002 T099-01
Serial number	96159				
Model	UNION, INCA 4002 T099-01				
Accuracy of the monitoring equipment	VCS PD does not specify the accuracy of monitoring equipment. However, the accuracy of gas analyser is 1% as per the specification of the equipment.				

Measuring/Reading/Recording frequency	Continuously using a continuous analyser. Values are recorded hourly and summarized to daily average for emission reduction calculations. The procedure is consistent with the registered monitoring plan.	
Calculation method (if applicable)	N/A.	
Calibration		
Calibration frequency/interval Is the calibration interval in line with the monitoring plan of the PD?	The analyser is calibrated at least once every 3 years as per registered monitoring plan.	
Does the calibration cover the monitoring period? Has the calibration frequency been respected?	The monitoring period is from 01/01/2018 to 31/12/2018. The gas analyser was calibrated on 14/03/2017 (valid until 13/03/2020) /12/. Therefore, calibration cover the monitoring period.	
Calibration certificates	Serial no.	Calibration details
	96159	By AWJ Innovation Co. Ltd.: Calibration date on 14/03/2017 /16/
Does the calibration of meters have be done by an accredited person or institution?	AWJ Innovation Co. Ltd. is credible to calibrate gas analysers (https://www.awj.co.th/service%20%20calibration.html).	

Data/Parameter	Assessment		
Data Unit	BG _{combusted,y} ; Nm ³		
Description	Amount of biogas combusted for gainful use in the year y		
Source of data to be used	Measured using Gas flow meter (GM 1 & GM2)		
Value of monitored parameter for the monitoring period	Period	Value (Nm ³)	
	01/01/2018 to 31/12/2018	8,355,426	
	The value is the total summarized value of GM1 (biogas to starch boilers) and GM 2 (biogas to turbine generator). Monitored values of GM1 and GM 2 mentioned in the monitoring report and ER sheet have been verified with the daily reports /11/. The reported values in the MR and ER sheet were found to be consistent with the daily reports and the operator log sheet information.		
Monitoring equipment	Gas flow meter		
	Serial number	GM 1	503208
		GM 2 (up to 07/10/2018)	630166
		GM 2 (from 08/10/2018)	630165
	Model	GM 1	FCI, ST51
		GM 2	FCI, ST51
Accuracy of the monitoring	VCS PD does not specify the accuracy of monitoring		

equipment	equipment. However, it was observed during the verification site visit that the PP has a good monitoring practice and installed meters of good accuracy in the order of 2%. The accuracy of the meters represents good monitoring practice.	
Measuring/Reading/Recording frequency	Continuous monitoring and daily recording for emission reduction calculation.	
Calcualtion method (if applicable)	N/A.	
Calibration		
Calibration frequency/interval Is the calibration interval in line with the monitoring plan of the PD?	The flow meter is calibrated at least once every 3 years as per registered monitoring plan.	
Does the calibration cover the monitoring period? Has the calibration frequency been respected?	The monitoring period is from 01/01/2018 to 31/12/2018. The flow meter GM 1 (503208) is calibrated on 20/12/2017 (valid until 19/12/2020) and GM 2 (630166) calibrated on 20/12/2017 (valid until 19/12/2020) and 630165 is calibrated on 12/11/2018 (valid until 11/11/2021) /12/. However, the flow meter 630166 was replaced on 08/10/2018 and new meter 630165 was installed. Calibraton gap applied from 08/10/2018 to 12/11/2018 for GM 2. The maximum error margin of the equipment over the measured value is applied conservatively.	
Calibration certificates	Meter no.	Calibration details
	503208	By Miracle International Technology Co. Ltd: Calibration date 21/12/2017 /12/
	630166	By Miracle International Technology Co. Ltd: Calibration date 20/12/2017 /12/
	630165	By Miracle International Technology Co. Ltd: Calibration date 12/11/2018 /12/
Does the calibration of meters have be done by an accredited person or institution?	Miracle International Technology Co. Ltd. is accredited to calibrate the flow meter /13/	

Data/Parameter	Assessment
Data Unit	EC _y ; MWh
Description	Electricity consumption by wastewater treatment system and biogas plant in year y
Source of data to be used	Maximum rated consumption is calculated by multiplying total electrical capacity with 8,760 hours and 10% additional factor to be conservative.
Value of monitored parameter for the monitoring period	2,361 MWh. The connected load is as per actual rated capacity of equipments connected to the project activity.

Monitoring equipment	N/A
Accuracy of the monitoring equipment	N/A
Measuring/Reading/Recording frequency	N/A
Calculation method (if applicable)	N/A.
Calibration	
Calibration frequency/interval Is the calibration interval in line with the monitoring plan of the PD?	N/A
Does the calibration cover the monitoring period? Has the calibration frequency been respected?	N/A
Calibration certificates	N/A
Does the calibration of meters have been done by an accredited person or institution?	N/A

4.2 Accuracy of GHG Emission Reduction and Removal Calculations

GHG emissions reductions for the project and the baseline scenario were correctly calculated using the formulae described in the applied methodology for this project. The verification team has reviewed the emission reduction (ER) spread sheet and checked all the formulae and found they are correct and in line with the monitoring plan of the registered PD and the applied monitoring methodology.

The emission reduction due to methane avoidance is calculated by measuring the required parameters using appropriate monitoring equipment and applying the formulae described in the methodology; AMS III.H., version 13 and the VCS PD except the deviations described in the above section 3.2. All the ex-ante parameters which are used in the calculation of emission reduction are presented in section 4.1 of this report. It is confirmed that all the ex-ante parameters have been correctly used in the emission reduction calculation. 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.

Baseline Emissions:

Baseline emissions related to methane avoidance as per AMS-III.H, version 13 is calculated as below:

$$BE_{\text{WW,treatment},y} = \sum Q_{\text{WW},i,y} * COD_{\text{removed},i,y} * MCF_{\text{WW,treatment,BL},i} * B_{\text{CH}_4} * UF_{\text{BL}} * GWP_{\text{CH}_4}$$

Volume of wastewater treated in baseline wastewater treatment system i ($Q_{ww,i,y}$) in year y (m^3). The reported value during the monitoring period is 1,664,815 m^3 . RINA has verified the values in the monitoring report /01/ against the daily recording of volume of the wastewater treated digesters/11/, which is in line with the requirements of the registered monitoring plan /02/ and the applied monitoring methodology AMS-III.H version 13 /06/. Daily wastewater flow to digester is recorded in log books as per readings in flow meter totalizer (difference of previous days reading and the reporting day) /11/. When the mill does not operate the reported value is kept as zero and the emission reduction worksheet represents the same /03/. Hence, RINA was able to determine that all data applied in the emission reduction calculation spread sheet /03/ and monitoring report /01/ were correct and from the original data.

Chemical oxygen demand removed by baseline treatment system i in year y ($COD_{removed,i,y}$) in tonnes/ m^3 , measured as the difference between inflow COD and the outflow COD in system i . In line with the methodology and registered VCS PD, $COD_{removed,y}$ is estimated considering *ex-post* monitored value of $COD_{ww,untreated,y}$ and COD removal efficiency determined *ex-ante* considering COD campaign data /02/. COD removal efficiency determined *ex-ante* for starch plant is 98.61% and for ethanol plant is 87.76%. This is as per registered VCS-PD and applied methodology /02/,/03/,/06/. $COD_{ww,untreated,y}$ is analyzed daily (colorimetric method) in in-house laboratory from sample of wastewater entering digesters and average daily value is reported in ER sheet. RINA has verified the values in the monitoring report /01/ against the Original test reports of the $COD_{ww,untreated,y}$ /11/ which is in line with the requirements of the registered monitoring plan /02/ and the applied monitoring methodology AMS-III.H version 13 /06/.

Methane correction factor for baseline wastewater treatment system i ($MCF_{ww,treatment,BL,i}$) has been fixed *ex-ante* as 0.8 for anaerobic deep lagoon /03/.

Methane producing capacity of the wastewater ($B_{o,ww}$) (IPCC default value for domestic wastewater of 0.21 kg CH_4 /kg COD) /06/.

Model correction factor to account for model uncertainties (UF_{BL}) is 0.94 /03/. Global Warming Potential for methane (GWP_{CH_4}) is 25 as per IPCC /02/.

Therefore, $BE_{ww,treatment,y}$ for the monitoring period from 01/01/2018 to 31/12/2018 is **152,127.01 tCO_{2e}**.

Project Emissions:

Project emissions related to methane avoidance component as per AMS-III.H, version 13 is calculated as below:

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

Emissions from electricity consumption in the year y ($PE_{power,y}$) is calculated as follows:

$$PE_{power,y} = EC_y * EF_y$$

Electricity consumed by biogas system is considered as per paragraph 35 of AMS-III.H version 13 considering maximum xonnected load. Accordingly, electricity consumption during the monitoring period is 2,361 MWh. Grid emission factor is 0.5057 tCO_{2e}/MWh fixed *ex-ante* /02/. Therefore $PE_{power,y}$ is estimated to be **1,194.16 tCO_{2e}** for the current monitoring period.

Emissions from wastewater treatment system affected by the project activity and not equipped with biogas recovery system and are calculated as per AMS-III.H and as follows:

$$PE_{ww,treatment,y} = Q_{ww,y} * COD_{removed,PJ,lagoon,y} * MCF_{ww,treatment,PJ,lagoon} * B_{o,ww} * UF_{PJ} * GWP_{CH_4}$$

Flow of wastewater treated in the year y ($Q_{ww,y}$): The reported value during the monitoring period is 1,664,815 m³. RINA has verified the values in the monitoring report /01/ against the daily recording of volume of the wastewater treated digesters/11/, which is in line with the requirements of the registered monitoring plan /02/ and the applied monitoring methodology AMS-III.H version 13 /06/. Daily wastewater flow to digester is recorded in log books as per readings in flow meter totalizer (difference of previous days reading and the reporting day) /11/. When the mill does not operate the reported value is kept as zero and the emission reduction worksheet represents the same /03/. Hence, RINA was able to determine that all data applied in the emission reduction calculation spread sheet /03/ and monitoring report /01/ were correct and from the original data.

$COD_{removed,PJ,lagoon,y}$: Chemical oxygen demand removed by project secondary wastewater treatment system in year y (tonnes/m3), are analysed daily from sample of wastewaters and average value is reported in ER sheet. RINA has verified the values in the monitoring report /01/ against the Original test reports /11/ which is in line with the requirements of the registered monitoring plan /02/ and the applied monitoring methodology AMS-III.H version 13 /06/.

Methane correction factor for project wastewater treatment system k without biogas recovery ($MCF_{ww,treatment,PJ,k}$) is fixed ex-ante to be 0.8 as per registered VCS-PD /02/.

Global Warming Potential for methane (GWP_{CH_4}) is fixed 25 as per IPCC /02/. Methane producing capacity of the wastewater (Bo_{ww}) is fixed ex-ante to be 0.21 kg CH₄/kg COD as per IPCC /02/. Model correction for uncertainties (UF_{PJ}) is fixed ex-ante to be 1.06 as per registered VCS-PD /02/ and applied methodology /06/.

Accordingly, $PE_{ww,treatment,y}$ for the monitoring period is **77,405.95 tCO₂e**.

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

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

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

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

$$PE_{fugitive,ww,y} = (1 - CFE_{ww}) * MEP_{ww,treatment,y} * GWP_{CH_4}$$

Capture efficiency of the biogas recovery equipment in the wastewater treatment (CFE_{ww}) is fixed ex-ante to be 0.9 as per registered VCS-PD /02/. Global Warming Potential for methane (GWP_{CH_4}) is fixed 25 as per IPCC /02/.

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

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

Flow of wastewater treated in the year y ($Q_{ww,y}$) during the monitoring period is 1,664,815 m³ as explained in above. Methane producing capacity of the wastewater ($B_{o,ww}$) is fixed ex-ante to be 0.21 kg CH₄/kg COD /02/. Model correction factor to account for model uncertainties (UF_{PJ}) is fixed ex-ante to be 1.06 /02/. Methane correction factor for wastewater treatment system k equipped with biogas recovery ($MCF_{ww,treatment,PJ,k}$) is fixed ex-ante to be 0.8 as per registered PD /02/. $COD_{removed,PJ,k,y}$ is calculated as the difference between $COD_{ww,untreated,y}$ and $COD_{ww,treated,y}$ /03/. $COD_{ww,untreated,y}$ and $COD_{ww,treated,y}$ is analyzed daily from sample of wastewater entering digesters and leaving the digester and average value of samples on daily basis is reported in ER sheet /03/. RINA has verified the values in the monitoring report /01/ against the Original test reports /11/ which is in line with the requirements of the registered monitoring plan /02/ and the applied monitoring methodology AMS-III.H version 13 /06/. $MEP_{ww,treatment,y}$ for the monitoring period is 5,841 tonnes and $PE_{fugitive,ww,y}$ for the monitoring period is **14,602.51** tCO_{2e} /03/.

Project Emissions from flaring is zero as there was no flaring during the monitoring period.

Leakage Emissions:

In line with applied methodologies and registered VCS-PD, there is no leakage emissions. Hence, LE_y is zero.

Emission Reductions:

As per applied methodologies AMS-III.H version 13 and registered VCS-PD, the emission reductions achieved ($ER_{y,ex\ post}$) in any year are the lowest value of the following:

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

For the current monitoring period the achieved $BE_{y,ex\ post} = BE_{ww,treatment,y}$ is 152,127.01 tCO_{2e}, achieved $PE_{y,ex\ post}$ is 93,203 tCO_{2e} and $LE_{y,ex\ post}$ is zero as explained in above. $PE_{biomass}$ is not applicable as there was no biomass consumption in the project activity.

As per AMS-III.H, version 13, in case of flaring/combustion MD_y will be measured using the conditions of the flaring process:

$$MD_y = BG_{burnt,y} * W_{CH_4,y} * D_{CH_4} * FE * GWP_{CH_4}$$

Following deviation 1 as explained in section 3.2 of this report, MD_y is calculated during this monitoring period as follows:

$$MD_y = W_{CH_4} * D_{CH_4} * GWP_{CH_4} * [(BG_{toflare,y} * FE) + (BG_{combusted,y} * DE)]$$

$BG_{toflare}/FV_{RG,h}$ during the monitoring period is zero and $BG_{combusted,y}$ is 8,355,426 Nm³.

RINA has verified the values in the monitoring report /01/ against the daily recording of the amount of biogas fired in boiler and turbine ($BG_{combusted,y}$) /11/, which is in line with the requirements of the registered monitoring plan /02/ and the applied monitoring methodology AMS-III.H version 13 /06/. Density of methane at normal condition (D_{CH_4}) is fixed ex-ante to be 0.716 kg/m³ as per the 'Tool to determine project emissions from flaring gases containing methane'. Global Warming Potential for methane (GWP_{CH_4}) is fixed 25 as per IPCC /02/. Destruction efficiency (DE) is taken as 100% conservatively. Methane fraction (W_{CH_4}) is as per continuous measurement and daily records /11/.

Therefore, MD_y achieved during 01/01/2018 to 31/12/2018 amounts to 79,595 tCO₂ equivalent /03/.

$$\begin{aligned}
 ER_{y,ex\ post} &= \min((BE_{y,ex\ post} - PE_{y,ex\ post} - LE_{y,ex\ post}), (MD_y - PE_{power,y} - PE_{biomass,y} - LE_{y,ex\ post})) \\
 &= \min(152,127.01 - 93,203 - 0), (79,595 - 1,194 - 0 - 0) \\
 &= 58,924 \text{ tCO}_2\text{e}
 \end{aligned}$$

Therefore, overall emission reductions achieved from the project activity during the monitoring period is **58,924 tCO₂e** (round down value).

The higher emission reductions achieved during the monitoring period compared to estimate in registered VCS-PD is due to increased quantity of wastewater during the monitoring period and baseline scenario considered a 75% conservative value in input parameters. The verification team confirms that the increase in emission reduction is justified.

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. Inlet and outlet COD of UASB, quantity of wastewater through UASB, biogas production, biogas consumption for boilers, methane concentration of biogas etc. were verified with the log book values to ensure that there is no over estimation of the VCUs. The provided data was found to be of adequate quality.

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.

All the meters (wastewater flow meter, biogas flow meters and gas analyser) were calibrated at appropriate calibration frequency (described in section 4.1) to ensure the quality of the data. For any delay in calibration, maximum error factor of the instrument is applied over the measured value to estimate emission reductions conservatively.

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.

RINA is of the opinion that this method of estimation is accurate and results in conservative estimation of emission reduction and is line with the applicable VCS requirements.

4.4 Non-Permanence Risk Analysis

There is no non-permanence risk rating determined by the project proponent.

5 SAFEGUARDS

5.1 No Net Harm

The project involves treatment of wastewater and capture of biogas from wastewater treatment system. Generated biogas is used in boiler which replaces HFO consumption. Therefore, the project results in avoidance of methane emissions and CO₂ emissions which otherwise would have been there without the project activity. However, PP is claiming emission reduction only

from methane avoidance and no emissions are claimed from fossil fuel replacement. Therefore, there is no negative environmental impact from the project activity. In addition, due to the project activity, jobs are created in local level as verified during site visit interview and raw materials are procured from local area which has improved socio-economic impacts in the project area. Therefore, there is no net harm from the project activity.

5.2 Local Stakeholder Consultation

Local stakeholder consultation is not applicable for the project proponent during verification. PP organized stakeholder consultation during validation of the project activity which was validated by the validation agency/09/. RINA has interacted local stakeholders during this verification site visit and details are summarized in section 2.3 of this report. There was no negative comment or feedback from local stakeholders as recorded by RINA during site visit.

6 VERIFICATION CONCLUSION

RINA Service Spa (RINA) has performed verification of the emission reductions reported for the project activity "P.S.C Starch Wastewater Treatment and Biogas Utilization Project" in Thailand, VCS Registry Project ID 417, for the period 01/01/2018 to 31/12/2018, with regard to the relevant requirements for VCS activities. The project participants of the "P.S.C Starch Wastewater Treatment and Biogas Utilization Project" project are responsible for:

- the preparation of greenhouses gas emissions data and the reported greenhouse gas emission reductions from the project on the basis set out in the monitoring plan contained in the registered project design document version 03.1 of 18/11/2009
- the development and maintenance of records and reporting procedures in accordance with that plan, including the calculation and determination of greenhouse gas emission reductions of the project.

It is the responsibility of RINA to express an independent verification opinion about the project's conformity with the requirements of VCS Standard version 3 (v 3.7) and GHG program applied, on the reported greenhouse gas emission reductions from the project.

Based on documented evidence and corroborated by an on-site assessment RINA can confirm that:

- the project has been implemented and operated as per the registered VCS-PD;
- the monitoring report and other supporting documents provided are complete and verifiable and in accordance with the applicable VCS Standard version 3 requirements;
- the monitoring is in place as per the applied baseline and monitoring methodology;
- the monitoring plan in the registered VCS-PD is as per the applied baseline and monitoring methodology.

It is RINA's opinion that the GHG emission reduction stated in the monitoring report version 02 of 03/05/2019 for the "P.S.C Starch Wastewater Treatment and Biogas Utilization Project" in Thailand for the period 01/01/2018 to 31/12/2018 are fairly stated. The GHG emission reductions were calculated correctly on the basis of the approved monitoring methodology CDM Executive Board: AMS-III.H 'Methane Recovery in Wastewater Treatment' version 13 and the monitoring plan contained in the registered VCS-PD.

Hence RINA is able to certify that the emission reduction from the project during the monitoring period 01/01/2018 to 31/12/2018 is amount to 58,924 tCO₂.

Verification period: From 01/01/2018 to 31/12/2018

Verified GHG emission reductions and removals in the above verification period:

Year	Baseline	Project emissions	Leakage	Net GHG emission
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	emissions or removals (tCO ₂ e)	or removals (tCO ₂ e)	emissions (tCO ₂ e)	reductions or removals (tCO ₂ e)
01/01/2018 to 31/12/2018	152,127	93,203	0	58,924
Total	152,127	93,203	0	58,924

APPENDIX A: ABBREVIATIONS

Abbreviations	Full texts
BE	Baseline Emissions
CAR	Corrective Action Request
CDM	Clean Development Mechanism
CDM M&P	Modalities and Procedures CDM
CER(s)	Certified Emission Reduction(s)
CH ₄	Methane
CR	Clarification Request
CO ₂	Carbon dioxide
CO ₂ e	Carbon dioxide equivalent
COD	Chemical Oxygen Demand
CRT	Coordination and Technical Control Staff
DCI	Certification Division of RINA Services Spa
DNA	Designated National Authority
DOE	Designated Operational Entity
EB	Executive Board
EF	Emission Factor
ER	Emission Reductions
FAR	Forward Action Request
GHG(s)	Greenhouse gas(es)
GWP	Global Warming Potential
HFO	Heavy Fuel Oil
IPCC	Intergovernmental Panel on Climate Change
LoA	Letter of Approval
MoV	Means of Verification
MR	Monitoring Report
NGO	Non-governmental Organization
ODA	Official Development Assistance
PDD	Project Design Document

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

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

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

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

Table 2. CR from this verification

CR ID	01	Section no.	4.3	Date: 27/04/2019
Description of CR				
1. <i>PP is requested to submit copies of calibration certificates of all monitoring equipments covering the monitoring period.</i> 2. <i>The serial number of GM 1 seen during site visit is not consistent with the serial number provided in the monitoring report. Kindly clarify with details.</i>				
Project participant response				Date: 03/05/2019
1. The calibration certificates of all monitoring equipments have been provided in the attached folder; Att02. 2. The serial number in the monitoring report has been revised. The reason of the inconsistent number comes from the typo error during developing monitoring report. Please check Table5 under Appendix of previous issued monitoring report or as attached file, Att03. PP has also provided the record of meter change in the excel calculation sheet.				
Documentation provided by project participant				
Att02 Calibration Att03 3rd MR				
DOE assessment				Date: 20/05/2019
The calibration records are consistent with details provided in MR and ER sheet. Emission reductions are calculated considering calibration plan of equipments and wherever there is any calibration gap, PP has applied maximum error of the equipment over the measured value. Details of all measuring equipments are also consistent in the MR and hence CR is closed.				

Table 3. CAR from this verification

CAR ID	01	Section no.	3.2	Date: 27/04/2019
Description of CAR				

1. *The monitored totalizer value presented for FM2 is not consistent to represent cumulative value of flow. For example value on 04 February 2018 is 20,746 and on 06 February 2018 it is 710. Similarly 09 March 2018 and 12 March 2018, 5 June 2018 and 06 June 2018, 24 June 2018 and 25 June 2018 etc. Kindly clarify.*
2. *The reported totalized value on 01 February 2018 for GM2 is not consistent with log book records.*
3. *The reported totalized value on 24 June 2018 for GM1 is not consistent with log book records.*
4. *While calculating the average value for monitored parameters, it is seen that zero reported value is also considered, due to which the correct average value is not arrived at.*
5. *As per log book record monitored data is available for CS 1 on 31 January 2018.*
6. *There is no value reported for fraction of CH₄ from 19 Dec 2018 to 27 Dec 2018. Kindly clarify.*

Project participant response**Date:** 03/05/2019

1. The high temperature of sweetener wastewater and the amount of suspended sludge in the wastewater are the reason of the discontinuous totalized number of FM2 during 2018. Some of those discontinuous are the result of the internal resetting, which has been done manually. The record of those dates with clarification of the discontinuous had been prepared in ER calculation sheet. Though the meter has been maintenance and calibrated as per the requirement, thus no calibration error has been applied during this monitoring period. For those mentioned date above please find clarification below
 - a. 04 February 2018 is 20,746 and on 06 February 2018 it is 710:
PO has done the internal reset with the meter on the 05/02/2018
 - b. 09 March 2018 and 12 March 2018:
PO has done the internal reset with the meter on the 10/03/2018
 - c. 5 June 2018 and 06 June 2018:
PO has done the internal reset with the meter on the 06/06/2018, though the record value in the log-sheet shows 557 as in the ER calculation sheet.
 - d. 24 June 2018 and 25 June 2018:
High suspended solid in the wastewater & high temperature of the wastewater coming out of the sweetener production causing the meter sensor reading inconsistently.
2. The totalized value on 01 February 2018 of GM2 has been revised to "451,895" and is now consistent with log book records. Please see the MR & ER calculation sheet version 2.0 and att01 for more detail.
3. The totalized value on 24 June 2018 of GM1 has been revised to "916,535" and is now consistent with log book records. Please see the MR & ER calculation sheet version 2.0 and att01 for more detail
4. PP has revised the calculation formula for average value of each monitoring parameters, thus the monitored values are now correct average. Please see MR & ER calculation sheet version 2.0 for more detail.
5. The monitored value of COD on 31/01/2018 in the ER calculation sheet has been revised to "29,280" and is now consistent with the log sheet. Please see the MR & ER calculation sheet version 2.0 and att01 for more detail.
6. The reason of no fraction of CH₄ value reported during 19/12/2018 to 27/12/2018 is because the methane analyzer had a minor problem with the turbine within the analyzer. PO had ordered the part for replacement. The invoice from the equipment provider has been provided as attached, Att04.

Documentation provided by project participant

Att01 Log sheet	
Att04 Invoice for methane analyser part	
VCS417PSC_ER calculation sheet, ver 2.0	
VCS417PSC_MR, ver 2.0	
DOE assessment	Date: 20/05/2019
1. PP's justification is reasonable to accept. Further, from the emission reduction worksheet it appears PP has taken conservative values only. Hence issue is closed. 2. PP has corrected the input value as per comment and reported value is now consistent with log book record. 3. PP has corrected the input value as per comment and reported value is now consistent with log book record. 4. PP has corrected the calculation to arrive average value not accounting zero reported values and hence correct average value has been provided in the emission reduction worksheet. 5. PP has corrected the input value as per comment and reported value is now consistent with log book record. 6. PP's justification for monitoring of methane fraction is accepted and consistent with records. Further average value of the monitoring period is considered and hence response is accepted. In summary, CAR is closed.	

CAR ID	02	Section no.	4.1	Date: 27/04/2019
Description of CAR				
The monitoring flow diagram presented (figure 3) does not show the methane concentration analyzer point.				
Project participant response				Date: 03/05/2019
<i>The monitoring point of methane analyser has been updated under figure 3, monitoring flow diagram. Please check MR version 2.0.</i>				
Documentation provided by project participant				
VCS417PSC_MR, ver 2.0				

DOE assessment	Date: 20/05/2019
The updated monitoring flow diagram is now representative of actual monitoring arrangement and consistent with registered monitoring plan. Hence CAR is closed.	

Table 4. FAR from this verification

FAR ID	xx	Section No.	Date: DD/MM/YYYY
Description of FAR			
<i>No FAR raised during this verification.</i>			
Project participant response			Date: DD/MM/YYYY
Documentation provided by project participant			
DOE assessment			Date: DD/MM/YYYY