

FINAL VERIFICATION REPORT

“SD BIOSUPPLY WASTEWATER TREATMENT AND BIOGAS UTILIZATION PROJECT”

**RINA**

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

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Summary:

RINA Services S.p.A. (RINA), commissioned by South Pole Carbon Asset Management Ltd., verified the greenhouse gas emission reductions reported for the project activity “SD Biosupply Wastewater Treatment and Biogas Utilization Project” in Thailand, VCS Registration Reference N° 416, for the period 01/06/2012 to 14/09/2014 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 3.6 Requirements, 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 SGS (validation report N° CCP.VOL0307 of 19/11/2009) and it was registered under the VCS registration reference N° 416.

The GHG emission reductions were calculated on the basis of the approved methodology AMS-III.H ‘Methane Recovery in Wastewater Treatment’ version 12 of 28/05/2009 and AMS-I.C ‘Thermal energy for user with or without electricity’ version 14 of 29/03/2009 and the monitoring plan included in the registered Project Design Document, version 6.4 of 19/11/2009.

In conclusion, it is RINA’s opinion that the project activity “SD Biosupply Wastewater Treatment and Biogas Utilization Project” in Thailand, VCS project ID 416, 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 12 of 28/05/2009 and AMS-I.C ‘Thermal energy for user with or without electricity’ version 14 of 29/03/2009. 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 01/06/2012 to 14/09/2014 amount to 73,301 tCO₂e.

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1 INTRODUCTION

1.1 Objective

RINA has been commissioned by “South Pole Carbon Asset Management Ltd.” To perform an independent verification of its VCS project, “SD Biosupply Wastewater Treatment and Biogas Utilization Project”, already registered under VCS with Project ID. 416 for the reported GHG emission reductions for the given monitoring period 01/06/2012 up to 14/09/2014. 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 version 3.6 and related rules and guidance. RINA has, based on the recommendations in the latest version of CDM Validation and Verification Standard, 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 & Technical Expert (TA 13.1)	Buragohain	Champok	India
Verifier	Menon	Rekha	India
Technical reviewer	Liu	Huifeng	China

1.4 Summary Description of the Project

The project activity involves installation of an anaerobic wastewater treatment facility at Somdej Flour Mill. The starch plant has a total production capacity of 300 tones of native starch per day generating approximately 2000 m³ of wastewater every production day. Prior to project implementation, the waste water was treated with an open lagoon based pond system with gravitational flow (cascading flow through 8 lagoons). The minimum depth of these ponds being more than 2 m and the average atmospheric temperature in the region about 28°C, these conditions resulted in anaerobic environment within the ponds resulting in methane generation from the organic content of the wastewater, characterized by its COD, which was released into the atmosphere.

The use of UASB technology to treat wastewater enables not only the avoidance of methane into the atmosphere but also capturing of methane produced and meeting the effluent standards. The captured methane (or biogas) is utilized as fuel in existing heat generating devices (boilers) in the plant replacing heavy fuel oil and the surplus biogas, if any, is flared into the atmosphere through an open flare, thereby contributing to greenhouse gas (GHG) emission reduction.

There are two boilers at the starch factory with a total installed capacity of 7.268 MWth in which the biogas is used as fuel along with HFO. The boilers were retrofitted to fire dual fuel during the project implementation. During the 2nd monitoring period the boilers were replaced with new boilers; one in 2010 and the other in 2012.

As per the registered VCS PD (VCS Ref. No: 416) of the VCS project, baseline emissions are calculated as the sum of fugitive methane emissions from lagoons in the baseline case and CO₂ emissions by fossil fuel usage in the boilers in the absence of the project activity. Project emissions are calculated as the fugitive methane emissions from the project activity, the electricity consumption and the fossil fuel consumption in boilers 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 total emission reduction for the 3rd verification period from 01/06/2012 to 14/09/2014 is 73,301 tCO_{2e}. The emission reductions are calculated conservatively as per the applied methodologies.

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)	SD Biosupply Co., Ltd. South Pole Carbon Asset Management Ltd.		
Project Title	SD Biosupply Wastewater Treatment and Biogas Utilization Project		
Location of the project	The project site is located on the site of the SD Starch factory, located at address: 99 Moo 10, Somdej-Khuchinarai Road, Kambong sub-district, Huai Phueng district, Kalasin, approximately 580 km from Bangkok. The project coordinates are 16° 40'40.20"N and 103° 48' 19.67"E		
Methodology(ies)	AMS-III.H 'Methane Recovery in Wastewater Treatment' version 12 of 28/05/2009 AMS-I.C 'Thermal energy for user with or without electricity' version 14 of 29/03/2009		
Sectoral Scope(s)	13 & 1	RINA's Technical Area(s)	13.1
Registered PDD	Version 6.4 of 19/11/2009		
Starting date of the crediting period	01/07/2008		
Project's crediting period	28/03/2006 – 27/03/2016		
Project documentation link	https://mer.markit.com/br-reg/public/project.jsp?project_id=100000000000361 ; accessed on 06/04/2017		

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 (v3.6) and VCS Standard, VCS Version 3 (v3.6). The GHG emission reductions are on the basis of the approved Baseline and monitoring methodology AMS-III.H 'Methane Recovery in Wastewater Treatment' version 12 of 28/05/2009 and AMS-I.C 'Thermal energy for user with or without electricity' version 14 of 29/03/2009.

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 22/03/2017 and version 02 of 31/05/2017 /01/, the emission reduction calculations spreadsheet (VCS416_SD_ex-post_ER calculation_3rdMR_v01_22.03.2017_SPG) version 01 of 22/03/2017 and version 02 (VCS416_SD_ex-post_ER calculation_3rdMR_v02_31052017) submitted on 31/05/2017 /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/	South Pole Carbon Asset Management Ltd.: VCS monitoring report for the project activity "SD Biosupply Wastewater Treatment and Biogas Utilization Project", version 1.0 of 22/03/2017 and version 02 of 31/05/2017
/02/	South Pole Carbon Asset Management Ltd.: VCS project description for project activity "SD Biosupply Wastewater Treatment and Biogas Utilization Project" in India, version 6.4 of 19/11/2009
/03/	South Pole Carbon Asset Management Ltd.: Emission Reduction spread sheet titled "VCS416_SD_ex-post_ER calculation_3rdMR_v01_22.03.2017_SPG" version 01 of 22/03/2017 and 'VCS416_SD_ex-post_ER calculation_3rdMR_v02_31052017' submitted on 31/05/2017
/04/	VCS: VCS Program Guide, VCS Version 3 (v3.6), Requirements Document of 19/10/2016
/05/	VCS: VCS Standard, VCS Version 3 (v3.6), Requirements Document of 19/10/2016
/06/	CDM Executive Board: AMS-III.H 'Methane Recovery in Wastewater Treatment' version 12 of 28/05/2009
/07/	CDM Executive Board: AMS-I.C 'Thermal energy for user with or without electricity' version 14 of 29/03/2009
/08/	VCS: Monitoring report form (MONITORING REPORT: VCS Version 3) , version 03.4 dated

	19/10/2016
/09/	SGS: Validation report (validation report N° CCP.VOL0307 of 19/11/2009) for the project activity "SD Biosupply Wastewater Treatment and Biogas Utilization Project"
/10/	VCS: SD Biosupply Wastewater Treatment and Biogas Utilization Project(ID: 100000000000361) https://mer.markit.com/br-reg/public/project.jsp?project_id=100000000000361 The website is in English language retrieved on 06/04/2017
/11/	Germanischer Lloyd Certification GmbH: Verification report for the project activity 'SD Biosupply Wastewater Treatment and Biogas Utilization Project' covering the monitoring period 01/01/2009 to 31/05/2012
/12/	UNFCCC: SSC_324: Determination of the flare efficiency for project activity involving combustion and/or flaring of recovered methane, dated 29-07-2009
/13/	Article published by Thai Tapioca Starch Association; website http://www.thaiscience.info/Article%20for%20ThaiScience/Article/2/10030389.pdf in English language retrieved on 11/05/2017
/14/	Daily log sheets of SD Biosupply Co., Ltd. a) Wastewater flow meter readings for the period 01/06/2012 to 14/09/2014 b) Methane content (% CH ₄) in biogas for the period 01/06/2012 to 14/09/2014 c) COD measurement of wastewater for the period 01/06/2012 to 14/09/2014 d) Biogas production for the period 01/06/2012 to 14/09/2014 e) Biogas consumption for boilers for the period 01/06/2012 to 14/09/2014 f) Biogas consumption for flare for the period 01/06/2012 to 14/09/2014 g) HFO consumption in boilers for the period 01/06/2012 to 14/09/2014
/15/	Calibration Reports: 1. Wastewater Flow meter (FM1): Serial Number: EB0011320000 Calibrated by Endress + Hauser; Calibration date 15/11/2011 Calibrated by Miracle International Technology Co., Ltd. (MIT); calibration date 17/03/2013 and on 08/01/2014 2. Colorimeter: Serial Number: HAC04109C53333 By EnviScience Company Limited; Calibration date: 26/04/2011, 12/06/2012, 13/05/2013 and 18/09/2014 3. Biogas flow meter of gas production (GM1): Serial Number: EA033E02000 By Endress + Hauser: Calibration date 10/10/2011 By Miracle International Technology Co., Ltd. (MIT): Calibration date 27/05/2013 4. Biogas flow meter of gas production (GM1): Serial Number: 9A070602000 By Miracle International Technology Co., Ltd. (MIT): Calibration date 03/12/2014 5. Portable gas analyser: Serial Number: ARAM-0090 Draeger Safety (Thailand) Ltd.: Test Certificate with Calibration date 18/01/2012, on 20/06/2012, on 06/12/2012, on 10/01/2013, on 24/06/2013, on 04/12/2013 and on 11/06/2014 6. Biogas flow meter to boiler (GM2): Serial Number: EA033D02000 By Endress + Hauser: Calibration Certificate of calibration date 07/10/2011 By Miracle International Technology Co., Ltd. (MIT): Calibration date 27/05/2013 7. Biogas flow meter to flare (GM3): Serial Number: EJ-10209 Miracle International Technology Co., Ltd. (MIT): Calibration date 27/05/2013 8. Oil flow meter (OM1): Serial Number: TMC 4-1-0068-044 Miracle International Technology Co., Ltd. (MIT): Calibration date 28/04/2011, 12/06/2012, 29/05/2013 and on 02/12/2014 9. Oil flow meter (OM1): Serial Number: TMC0157-43 Miracle International Technology Co., Ltd. (MIT): Calibration date 28/04/2011, 12/06/2012, 29/05/2013 and on 02/12/2014
/16/	List of Accredited Laboratories According to ISO/IEC 17025; webpage http://www.tisi.go.th/lab_test/calibrate/class_e.html in English language retrieved on 11/05/2017
/17/	CDM-EB: Guidelines for assessing compliance with the calibration frequency requirements (EB

	52, Annex 60)
/18/	Somdej Flour Co., Ltd.: Starch Production Summary Reports for the years 2012, 2013 and 2014 approved by the Plant Manager
/19/	PEA: Monthly electricity invoices for the months from June 2012 to September 2014
/20/	2006 IPCC Guidelines for National Greenhouse Gas Inventories: Volume 2 Energy
/21/	CDM Executive Board: Tool to determine project emissions from flaring gases containing methane, EB 28, Annex-13 dated 15/12/2006
/22/	Somdej Flour Mill Co., Ltd.: HFO stock register from 01/06/2012 to 15/09/2014
/23/	http://www.engineeringtoolbox.com/gross-net-heating-values-d_420.html accessed on 11/05/2017
/24/	Central Bureau of weights and measures, Govt. of Thailand: Calibration certificate of weighing scale serial number 2006068 dated 28/02/2011 and 12/03/2013

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/	30/03/2017-31/03/2017	Ms. Ladaporn Kat Khunikakorn- Project Manager	Southpole Carbon	Monitoring report, emission reduction calculations, records of monitoring parameters, VCS rules, application of methodology etc.
/b/	30/03/2017-31/03/2017	Ms. Sirinut Raya- Project Manager		
/c/	30/03/2017-31/03/2017	Mr. Santosh Kumar Singh- Director SE Asia		
/d/	30/03/2017-31/03/2017	Ms. Ubonnan Utachkal- Project co-ordinator	Papop Co. Ltd.	Technical aspects of the project activity. Operational life, environmental aspects etc.
/e/	30/03/2017-31/03/2017	Mr. Suchai Rattananadhekul – Engineering Manager		
/f/	30/03/2017-31/03/2017	Mr. Narone Tiyanich- Factory Manager	SD Bio Energy	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.
/g/	30/03/2017-31/03/2017	Mr. Vallop Suricha- Safety Officer		
/h/	30/03/2017-31/03/2017	Mr. Kamtan Muangpan- Mayor of Huayphung sub-district	Mayor of Huayphung sub-district	Stakeholder interaction regarding views and impact from project activity in local area including health, safety and environmental aspects.
/i/	30/03/2017-31/03/2017	Boonlam Sanata	Local Resident	

2.4 Site Inspections

On 30/03/2017 and 31/03/2017, RINA visited SD Biosupply Co., Ltd. Located at 99 Moo 10, Somdej-Khuchinarai Road, Kambong sub-district, Huai Phueng district, Kalasin, analyse. 580 km from Bangkok. The project coordinates are 16° 40'40.20"N and 103° 48' 19.67"E. 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 in the figure below (see Figure 1). The completed verification protocol is enclosed in Appendix A to this report.

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, which refer to CDM rules, have been met.

CARs, CRs identified are included in the verification protocol in Appendix A of this report.

Figure 1 Verification protocol tables

Verification Protocol, Table 1 – Requirement checklist					
Checklist Question	Ref.	MoV	Comments	Draft Conclusion	Final Conclusion
Checklist questions organized	Makes reference to	Explain how conformance with the checklist	The discussion on how the	For CAR, CR and FAR see the definitions	OK is used if the information

in seven different sections.	documents where the answer to the checklist question or item is found.	question investigated. Examples are document review (DR), interview or any other follow-up actions (I), cross checking (CC) with available information relating to projects, (N/A) means not applicable.	is	conclusion is arrived at and the conclusion on the compliance with checklist question so far.	above.	and evidence provided is adequate to demonstrate compliance with VCS requirements which refer to CDM rules.
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Verification Protocol, Table 2: Resolution of Corrective Action Requests and Clarification			
Corrective action requests and/or clarification requests	Reference to Table 1	Response by project participants	Verification Conclusion
The CAR and/or CRs raised in table 1 are repeated here.	Reference to the checklist question number in Table 1 where the CAR or CR is explained.	The responses given by the project participants to address the CARs and/or CRs.	The verification team's assessment and final conclusion of the CARs and/or CRs.

Verification Protocol, Table 3 – Forward Action Requests		
Forward action request	Reference to Table 1	Response by project participants Verification Conclusion
The FAR raised in table 1 is repeated here.	Reference to the checklist question number in Table 1 where the FAR is explained.	Response by the project participants on how forward action request will be addressed.

2.5.1 Forward Action Requests

Based on the review of the validation report /09/ and 2nd verification report /11/, FAR raised during the validation and first verification found closed in 2nd verification. And there was no FAR to be addressed during this 3rd verification.

2.6 Eligibility for Validation Activities

The project activity is registered under VCS registration reference Number 416 /10/, hence this section is not applicable.

3 VALIDATION FINDINGS

The project was validated by SGS (*validation report N° CCP.VOL0307 of 19/11/2009*) and it was registered under the VCS registration reference No-416. This is the 3rd verification assessment for the monitoring period 01/06/2012 to 14/09/2014 by RINA.

3.1 Participation under Other GHG Programs

N/A.

3.2 Methodology Deviations

Methodology applied in the registered project activity remains same; although deviation is applied in calculation formula from the stated one in applied methodology as described below:

Deviation 1:

Determination of MDy:

As per AMS-III.H, version 12 and registered PD, the calculation formula is:

$$MD_y = BG_{bur n,y} * w_{CH_4,y} * D_{CH_4} * FE * GW P_{CH_4}$$

Deviated formula applied in this monitoring period is:

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

Where:

Bgtoflare,y	=	Biogas sent to flare in year y (Nm3/year)
FE	=	Flare efficiency (fraction)
Bgcombusted,y	=	Biogas combusted for gainful use in year y (Nm3/year)
DE	=	Destruction efficiency of biogas combusted for a gainful use (fraction)

On a conservative side DE (destruction efficiency) is taken as 100%.

Since the biogas is combusted in boilers, it is appropriate to consider the destruction efficiency as 100% for the portion of the biogas combusted in boilers. In response to a query, the CDM Small Scale Working Group (SSC WG) committee provides the below response /12/:

“The SSC WG, taking into account the inputs in the submission and public comment received, agreed to clarify that, as in the case of AMS-III.D, if the biogas is combusted for a gainful use of the released energy as in an engine or a power plant, a destruction efficiency of 100% can be used for the portion of biogas that is combusted when applying AMS-III.H, i.e. use a value of 100% for FE in equation 16 in paragraph 32 for the portion of biogas that is combusted for a gainful use”.

Therefore, the approach followed by the PPs is considered to be appropriate and therefore the deviation is accepted. Further, the deviation found applied in last verification (2nd monitoring period) and accepted /11/.

Deviation 2:

Determination of EG_{thermal} :

As per AMS-I.C, version 14 and registered PD, the calculation formula is:

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

Methodology requires ‘metering the thermal and/or electrical energy produced’; (i) in the case of heat energy (e.g. hot air, hot water), direct measurement of flow and temperature is required. However, direct measurement of temperature (in and out) and flow of the thermal fluid were not conducted and deviation is applied to estimate EG_{thermal} based on amount of heat required for starch drying which in turn is estimated on heat requirements per tonne of starch based on historical data. The approach estimates the thermal energy delivered by the project activity based on historical fuel oil consumption and starch production for the given year. The conservativeness of approach is ensured by comparing the total energy delivered by the fuels burnt in the project activity and thermal energy estimate based on historical fuel oil consumption values.

Justification of acceptance: The baseline emissions due to thermal energy generation by the boilers can also be estimated based on the fuel consumption. Prior to the implementation of the project activity, HFO was used as fuel in boilers. From the available fuel consumption and dry starch production details, the specific fuel consumption is calculated to be 33.8, 34.7 and 36.5 Litres per ton of dry starch during the years 2002, 2003 and 2004 respectively. This is as per historical dry starch production and fuel oil consumption details as already verified in last verification report /11/. Therefore, the lowest value based on the historical specific fuel consumption (33.8 lit/ton) of the plant has been considered by the PPs for baseline emission calculations for thermal energy generation. It has been found from Thai Tapioca Starch Association /13/, and from last verification report /11/, the range of HFO consumption is from 28 Litres per ton to 47 Litres per ton and the average value is 37.5 Litres per ton. On a conservative side the thermal energy required for drying of starch has been estimated by two approaches; one by the historical specific fuel consumption and the starch production during the year and the other by the actual fuel consumption (biogas and HFO) in the year. Lowest of the values during the year has been considered for calculating the baseline emissions.

The deviation has been transparently described in section 2.2 of the MR. The verification team is of the opinion that the approach followed by the PPs is appropriate and hence the deviation is accepted.

3.3 Project Description Deviations

N/A.

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. All the physical components and project boundary are in conformity with the description in registered VCS PD. The project activity was implemented in August 2005 and in operation since then. Based on the VCS PD and the available information at VCS database it is confirmed that the project's crediting period is from 28/03/2006 to 27/03/2016. While the 1st verification covered the period from 28/03/2006 to 31/12/2008, the 2nd verification covers the period from 01/01/2009 to 31/05/2012. Both first and second verification completed successfully.

The project activity involves capturing of methane generated from the wastewater treatment through UASB technology. The captured methane (biogas) is utilized as fuel in thermal oil boilers replacing heavy fuel oil.

There are two thermal oil boilers located in the starch factory for drying purpose. The existing boilers were replaced with new boilers during the second monitoring period; one in 2010 and the other in 2012 as verified from previous verification report /11/ and site visit. RINA verification team has also verified that all the parameters are monitored as described in the monitoring plan of the VCS PD in order to estimate the emission reduction.

As per the applied methodologies; AMS-III.H, version 12 and AMS-I.C., version 14 /10/, 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 Warming Potential for	Data based on registered PD /02/ and validation	21	The value is ex-ante fixed for 10 years crediting period as per the registered PD, which has been

Methane (GWP _{CH4}) in tCO ₂ e/tCH ₄	report /09/		justified and validated by validation DOE to follow the applied methodology and tool /02/, /09/.
Methane producing capacity of the wastewater (B _{0,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,i})	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 k (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/.
Chemical oxygen demand removal efficiency of baseline treatment system (COD _{removal efficiency-baseline}); %	Data based on registered PD /02/ and validation report /09/	87.62%	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/.
Emission factor of fossil fuel replaced-residual fuel oil ($EF_{FF,FO2}$); tCO_2/TJ	Data based on registered PD /02/ and validation report /09/	77.4	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/	0.521	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/.
Density of methane at normal condition ($T=273.15$ K, $p=101.325$ kPa) of the biogas in the year y (D_{CH4}); kg/m^3	Data based on registered PD /02/ and validation report /09/	0.716	The value is ex-ante fixed for 10 years crediting period as per the registered PD, which has been justified and validated by validation DOE to follow the applied methodology and tool /02/, /09/.
Efficiency of the boiler using fossil fuel that would have been used in the absence of the project activity ($\eta_{BL,thermal}$); %	Data based on registered PD /02/ and validation report /09/	100	The value is ex-ante fixed for 10 years crediting period as per the registered PD, which has been justified and validated by validation DOE to follow the applied methodology and tool /02/, /09/.
Net Calorific Value of fuel oil displaced by biogas (NCV_{HFO}); $TJ/tonne$	Data based on registered PD /02/ and validation report /09/	0.0404	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	$Q_{ww,y}; m^3$	
Description	Volume of wastewater treated in year y	
Source of data to be used	Measured – Volumetric flow meters	
Value of monitored parameter for the monitoring period	Period	Value (m ³)
	01/06/2012 to 31/12/2012	242,320
	01/01/2013 to 31/12/2013	405,745
	01/01/2014 to 14/09/2014	423,434
	The values mentioned in the monitoring report and ER sheet have been verified with the daily log book reports /14/. 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	Electromagnetic flow meter	
	Serial number	EB0011320000
	Model	Promag 10W
Accuracy of the monitoring equipment	VCS PD does not specify the accuracy of monitoring equipment. However, the PP has installed electromagnetic flow meter with an accuracy class of 0.5%. The accuracy of the meters represents good monitoring practice.	
Measuring/Reading/Recording frequency	Continuous monitoring, record 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 2 years or as per the manufacturer's recommendation. 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 01/06/2012 to 14/09/2014. The flow meter was calibrated on 15/11/2011 (with validity until 14/11/2013), on 17/01/2013 (with validity until 16/01/2015) and on 08/01/2014 (with validity until 07/01/2016) /15/. 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
	EB0011320000	Calibrated by Endress + Hauser; Calibration date 15/11/2011 /15/ Calibrated by Miracle International Technology Co., Ltd. (MIT); calibration

	date 17/03/2013 and on 08/01/2014 /15/
Does the calibration of meters have been done by an accredited person or institution?	Endress + Hauser is the manufacturer of the flow meter and Miracle International Technology Co., Ltd. (MIT) is accredited calibration laboratory for flow measurement in accordance with ISO/IEC17025 No. 0147 issued by the Thai Industrial Standards Institute (TISI) /16/

Data/Parameter	Assessment		
Data Unit	COD _{ww,untreated,y;} mg/l		
Description	COD of wastewater entering the treatment plant		
Source of data to be used	Measured-Colorimeter analysis		
Value of monitored parameter for the monitoring period	Period	Lower Value	Higher Value
	01/06/2012 to 31/12/2012	23,296	23,296
	01/01/2013 to 31/12/2013	25,555	25,555
	01/01/2014 to 14/09/2014	22,999	26,298
	The values mentioned in the monitoring report and ER sheet have been verified with the daily reports approved by the Plant Manager/14/. The reported values in the MR and ER sheet were found to be consistent with the daily reports and the operator log sheet information. However, for the calibration delay error factor has been applied and corrected values are reported for emission reduction calculations.		
Monitoring equipment	Portable colorimeter		
	Serial number	HAC04109C53333	
	Model	DR/890	
Accuracy of the monitoring equipment	VCS PD does not specify the accuracy of monitoring equipment. However, the accuracy of the calorimeter is 0.24%. The accuracy of the meters represents good monitoring practice.		
Measuring/Reading/Recording frequency	Daily. The measured data is logged in daily basis and reported to Biogas Supervisor. The Biogas Supervisor checks the values and enters the data in another sheet, calculates the daily average from the 3 readings. 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 colorimeter is calibrated annually or as per manufacturer's recommendation. From the calibration reports it is learnt that the recommended calibration frequency by the calibration agency is 1 year.		

Does the calibration cover the monitoring period? Has the calibration frequency been respected?	The monitoring period is from 01/06/2012 to 14/09/2014. The calorimeter was calibrated on 26/04/2011 (with validity until 25/04/2012), on 12/06/2012 (with validity until 11/06/2013), on 13/05/2013 (with validity until 12/05/2014) and on 18/09/2014 (with validity until 17/09/2015) /15/. There was calibration gap from 01/06/2012 to 12/06/2012 however, the plant was found shutdown during that period. In addition, there was calibration gap from 12/05/2014 to 18/09/2014 and to cover the calibration delay PP has applied maximum error factor over the measured value from 12/05/2014 to 14/09/2014 as per calibration guidelines of CDM /17/.	
Calibration certificates	Meter no.	Calibration details
	HAC04109C53333	By EnviScience Company Limited; Calibration date: 26/04/2011, 12/06/2012, 13/05/2013 and 18/09/2014 /15/
Does the calibration of meters have been done by an accredited person or institution?	EnviScience Company Limited found credible for calibration of the calorimeter /15/	

Data/Parameter	Assessment		
Data Unit	COD _{y,out,UASB} ; mg/l		
Description	COD of wastewater exiting the UASB treatment plant		
Source of data to be used	Measured-Colorimeter analysis		
Value of monitored parameter for the monitoring period	Period	Lower Value	Higher Value
	01/06/2012 to 31/12/2012	859	859
	01/01/2013 to 31/12/2013	711	711
	01/01/2014 to 14/09/2014	504	571
	The values mentioned in the monitoring report and ER sheet have been verified with the daily reports approved by the Plant Manager/ 14 /. The reported values in the MR and ER sheet were found to be consistent with the daily reports and the operator log sheet information. However, for the calibration delay error factor has been applied and corrected values are reported for emission reduction calculations.		
Monitoring equipment	Portable colorimeter		
	Serial number	HAC04109C53333	
	Model	DR/890	
Accuracy of the monitoring equipment	VCS PD does not specify the accuracy of monitoring equipment. However, the accuracy of the calorimeter is 0.24%. The accuracy of the meters represents good monitoring practice.		
Measuring/Reading/Recording frequency	Daily.		

	The measured data is logged in daily basis and reported to Biogas Supervisor. The Biogas Supervisor checks the values and enters the data in another sheet, calculates the daily average from the 3 readings. 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 colorimeter is calibrated annually or as per manufacturer's recommendation. From the calibration reports it is learnt that the recommended calibration frequency by the calibration agency is 1 year.	
Does the calibration cover the monitoring period? Has the calibration frequency been respected?	The monitoring period is from 01/06/2012 to 14/09/2014. The calorimeter was calibrated on 26/04/2011 (with validity until 25/04/2012), on 12/06/2012 (with validity until 11/06/2013), on 13/05/2013 (with validity until 12/05/2014) and on 18/09/2014 (with validity until 17/09/2015) /15/. There was calibration gap from 01/06/2012 to 12/06/2012 however, the plant was found shutdown during that period. In addition, there was calibration gap from 12/05/2014 to 18/09/2014 and to cover the calibration delay PP has applied maximum error factor over the measured value from 12/05/2014 to 14/09/2014 as per calibration guidelines of CDM /17/.	
Calibration certificates	Meter no.	Calibration details
	HAC04109C53333	By EnviScience Company Limited; Calibration date: 26/04/2011, 12/06/2012, 13/05/2013 and 18/09/2014 /15/
Does the calibration of meters have be done by an accredited person or institution?	EnviScience Company Limited found credible for calibration of the calorimeter /15/	

Data/Parameter	Assessment
Data Unit	$S_{final,PJ,y}$; tonnes/and type of application
Description	Amount of final sludge generated by the wastewater treatment in the year y and type of application/disposal.
Source of data to be used	Sludge profile in case of any produced sludge is being taken out of the plant. Weighing equipment available at site are used before using the material for any other purpose.
Value of monitored parameter for the monitoring period	Zero (0). No sludge was removed during the monitoring period. This is confirmed through onsite interviews.
Monitoring equipment	N/A
Accuracy of the monitoring equipment	N/A
Measuring/Reading/Recording	Whenever the sludge is removed, the quantity shall be

frequency	recorded and documented. However, no sludge was removed during the monitoring period.
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

Data/Parameter	Assessment												
Data Unit	BG _{prod,y} ; Nm ³												
Description	Amount of biogas produced by the digester												
Source of data to be used	Measured using Gas flow meter (GM1)												
Value of monitored parameter for the monitoring period	<table border="1"> <thead> <tr> <th>Period</th><th>Value</th></tr> </thead> <tbody> <tr> <td>01/06/2012 to 31/12/2012</td><td>1,933,325</td></tr> <tr> <td>01/01/2013 to 31/12/2013</td><td>3,242,687</td></tr> <tr> <td>01/01/2014 to 14/09/2014</td><td>3,939,113</td></tr> </tbody> </table> The values mentioned in the monitoring report and ER sheet have been verified with the daily reports approved by the Plant Manager/14/. 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	01/06/2012 to 31/12/2012	1,933,325	01/01/2013 to 31/12/2013	3,242,687	01/01/2014 to 14/09/2014	3,939,113				
Period	Value												
01/06/2012 to 31/12/2012	1,933,325												
01/01/2013 to 31/12/2013	3,242,687												
01/01/2014 to 14/09/2014	3,939,113												
Monitoring equipment	<table border="1"> <thead> <tr> <th colspan="2">Gas flow meter (upto 22/01/2014)</th></tr> </thead> <tbody> <tr> <td>Serial number</td><td>EA0033E02000</td></tr> <tr> <td>Make</td><td>Endress+Hauser</td></tr> </tbody> </table> <table border="1"> <thead> <tr> <th colspan="2">Gas flow meter (from 23/01/2014)</th></tr> </thead> <tbody> <tr> <td>Serial number</td><td>9A070602000</td></tr> <tr> <td>Make</td><td>Endress+Hauser</td></tr> </tbody> </table>	Gas flow meter (upto 22/01/2014)		Serial number	EA0033E02000	Make	Endress+Hauser	Gas flow meter (from 23/01/2014)		Serial number	9A070602000	Make	Endress+Hauser
Gas flow meter (upto 22/01/2014)													
Serial number	EA0033E02000												
Make	Endress+Hauser												
Gas flow meter (from 23/01/2014)													
Serial number	9A070602000												
Make	Endress+Hauser												
Accuracy of the monitoring equipment	VCS PD does not specify the accuracy of monitoring 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 $\pm 1.5\%$. The accuracy of the meters represents good monitoring practice.												

Measuring/Reading/Recording frequency	Daily. The measured data is logged in daily basis and reported to Biogas Supervisor. The Biogas Supervisor checks the values and enters the data in another sheet that consist of daily values of the parameters. 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 2 years or as per the manufacturer's recommendation.	
Does the calibration cover the monitoring period? Has the calibration frequency been respected?	The monitoring period is from 01/06/2012 to 14/09/2014. The existing flow meter (EA0033E02000) was calibrated on 10/10/2011 (valid until 09/10/2013), on 27/05/2013 (with validity until 26/05/2015) /15/ which got replaced with new meter (9A070602000) on 23/01/2014 and calibrated on 03/12/2014 (valid until 02/12/2016) /15/. Therefore calibration frequency has been respected during the monitoring period.	
Calibration certificates	Meter no.	Calibration details
	EA0033E02000	By Endress + Hauser: Calibration date 10/10/2011 and on 27/05/2013 by Miracle International Technology Co., Ltd. (MIT) /15/
	9A070602000	By Miracle International Technology Co., Ltd. (MIT): Calibration date 03/12/2014
Does the calibration of meters have be done by an accredited person or institution?	Endress + Hauser is the manufacturer of the flow meter and Miracle International Technology Co., Ltd. (MIT) is accredited calibration laboratory for flow measurement in accordance with ISO/IEC17025 No. 0147 issued by the Thai Industrial Standards Institute (TISI) /16/.	

Data/Parameter	Assessment		
Data Unit	W_{CH_4} , %		
Description	Methane content in the biogas in the year y		
Source of data to be used	Measured using portable gas analyzer		
Value of monitored parameter for the monitoring period	Period	Lower Value	Higher Value
	01/06/2012 to 31/12/2012	66	67
	01/01/2013 to 31/12/2013	65	66
	01/01/2014 to 14/09/2014	61	62
	The values mentioned in the monitoring report and ER		

	sheet have been verified with the daily reports approved by the Plant Manager/ 14 /. 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	Portable gas analyzer	
	Serial number	ARAM-0090
	Make	Draeger
Accuracy of the monitoring equipment	VCS PD does not specify the accuracy of monitoring equipment. However, the accuracy of gas analyser is $\pm 0.9\%$. The accuracy of the meters represents good monitoring practice.	
Measuring/Reading/Recording frequency	Daily. The measured data is logged in daily basis and reported to Biogas Supervisor. The Biogas Supervisor checks the values and enters the data in another sheet that consist of daily values of the parameters. 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?	According to manufacturer's recommendation, the gas analyzer shall be calibrated once in 6 months.	
Does the calibration cover the monitoring period? Has the calibration frequency been respected?	The monitoring period is from 01/06/2012 to 14/09/2014. The gas analyser was calibrated on 18/01/2012 (valid until 17/07/2012), on 20/06/2012 (with validity until 19/12/2012), on 06/12/2012 (valid until 05/06/2013), on 10/01/2013 (valid until 09/07/2013), on 24/06/2013 (valid until 23/12/2013), on 04/12/2013 (valid until 03/06/2014) and on 11/06/2014 (valid until 10/12/2014) / 15 /. There was calibration delay from 03/06/2014 to 10/06/2014. To cover the calibration delay PP has applied maximum error factor over the measured value from 03/06/2014 to 10/06/2014 as per calibration guidelines of CDM / 17 /.	
Calibration certificates	Meter no.	Calibration details
	ARAM-0090	By Draeger Safety (Thailand) Ltd: Calibration date 18/01/2012, on 20/06/2012, on 06/12/2012, on 10/01/2013, on 24/06/2013, on 04/12/2013 and on 11/06/2014 / 15 /
Does the calibration of meters have be done by an accredited person or institution?	Draeger Safety (Thailand) Ltd. Is the manufacturer of the portable gas analyser and therefore credible for calibration / 15 /.	

Data/Parameter	Assessment
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Data Unit	BG _{combusted,y} ; Nm ³		
Description	Amount of biogas sent to boiler in year y		
Source of data to be used	Measured-Gas flow meter (GM2)		
Value of monitored parameter for the monitoring period	Period	Value	
	01/06/2012 to 31/12/2012	1,474,895.00	
	01/01/2013 to 31/12/2013	2,665,325.00	
	01/01/2014 to 14/09/2014	3,075,654.00	
	The values mentioned in the monitoring report and ER sheet have been verified with the daily reports approved by the Plant Manager/ 14/ . 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	Thermal mass flow meter		
	Serial number	EA033D02000	
	Make	Endress+Hauser	
Accuracy of the monitoring equipment	VCS PD does not specify the accuracy of monitoring 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 ±1.5%. RINA, based on the experience of verifying similar other projects, understands that the accuracy of the meters represents good monitoring practice.		
Measuring/Reading/Recording frequency	The parameter is measured on a continuous basis and recorded by the gas flow meter. The measured data is logged in daily basis and reported to Biogas Supervisor. The Biogas Supervisor checks the values and enters the data in another sheet that consist of daily values of the parameters. 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 2 years or as per the manufacturer's recommendation.		
Does the calibration cover the monitoring period? Has the calibration frequency been respected?	The monitoring period is from 01/06/2012 to 14/09/2014. The flow meter was calibrated on 07/10/2011 (valid until 06/10/2013), on 27/05/2013 (with validity until 26/05/2015) / 15/ . Therefore calibration frequency has been respected during the monitoring period.		
Calibration certificates	Meter no.	Calibration details	
	EA033D02000	By Endress + Hauser: Calibration date 07/10/2011 and on 27/05/2013 by Miracle International Technology Co., Ltd. (MIT) / 15/	

Does the calibration of meters have been done by an accredited person or institution?	Endress + Hauser is the manufacturer of the flow meter and Miracle International Technology Co., Ltd. (MIT) is accredited calibration laboratory for flow measurement in accordance with ISO/IEC17025 No. 0147 issued by the Thai Industrial Standards Institute (TISI) /16/.
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Data/Parameter	Assessment								
Data Unit	$BG_{to\text{flare},y}/FV_{RG,h}; Nm^3$								
Description	Amount of biogas (volumetric flow) sent to flare system								
Source of data to be used	Measured-Gas flow meter (GM3)								
Value of monitored parameter for the monitoring period	<table border="1"> <thead> <tr> <th>Period</th><th>Value</th></tr> </thead> <tbody> <tr> <td>01/06/2012 to 31/12/2012</td><td>0</td></tr> <tr> <td>01/01/2013 to 31/12/2013</td><td>9,196</td></tr> <tr> <td>01/01/2014 to 14/09/2014</td><td>13,714</td></tr> </tbody> </table> The values mentioned in the monitoring report and ER sheet have been verified with the daily reports approved by the Plant Manager/14/. 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	01/06/2012 to 31/12/2012	0	01/01/2013 to 31/12/2013	9,196	01/01/2014 to 14/09/2014	13,714
Period	Value								
01/06/2012 to 31/12/2012	0								
01/01/2013 to 31/12/2013	9,196								
01/01/2014 to 14/09/2014	13,714								
Monitoring equipment	<table border="1"> <tr> <td colspan="2">Thermal mass flow meter</td></tr> <tr> <td>Serial number</td><td>EJ-10209</td></tr> <tr> <td>Make</td><td>Endress+Hauser</td></tr> </table>	Thermal mass flow meter		Serial number	EJ-10209	Make	Endress+Hauser		
Thermal mass flow meter									
Serial number	EJ-10209								
Make	Endress+Hauser								
Accuracy of the monitoring equipment	VCS PD does not specify the accuracy of monitoring equipment. RINA, based on the experience of verifying similar other projects, confirms that the accuracy of 1.5% for oil flow meters represents good monitoring practice.								
Measuring/Reading/Recording frequency	The parameter is measured on a continuous basis in fuel oil meter. The measured data is logged in daily basis and reported to Biogas Supervisor. The Biogas Supervisor checks the values and enters the data in another sheet that consist of daily values of the parameters. The practice found to be followed during site visit and consistent with 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 flow meter is calibrated at least once every 2 years or as per the manufacturer's recommendation.								

Does the calibration cover the monitoring period? Has the calibration frequency been respected?	The monitoring period is from 01/06/2012 to 14/09/2014. The flow meter was calibrated on 27/05/2013 (with validity until 26/05/2015) /15/. There has been calibration delay from 01/06/2012 to 27/05/2013. To cover the calibration delay PP has applied maximum error factor over the measured value from 01/06/2012 to 27/05/2013 as per calibration guidelines of CDM /17/. Although, as per record verified during site visit there was no flare during that period.	
Calibration certificates	Meter no.	Calibration details
	EJ-10209	By Miracle International Technology Co., Ltd.: Calibration date 27/05/2013 /15/
Does the calibration of meters have been done by an accredited person or institution?	Miracle International Technology Co., Ltd. (MIT) is accredited calibration laboratory for flow measurement in accordance with ISO/IEC17025 No. 0147 issued by the Thai Industrial Standards Institute (TISI) /16/.	

Data/Parameter	Assessment	
Data Unit	FC _{HFO,V,i} Liters/y	
Description	Quantity of fossil fuel co-fired or fired along with biogas during a year y	
Source of data to be used	Measured by continuous Fuel oil meter (OM1 and OM2)	
Value of monitored parameter for the monitoring period	Period	Value
	01/06/2012 to 31/12/2012	6,830
	01/01/2013 to 31/12/2013	590
	01/01/2014 to 14/09/2014	40
	The values mentioned in the monitoring report and ER sheet have been verified with the daily reports approved by the Plant Manager/14/. The reported values in the MR and ER sheet were found to be consistent with the daily reports and the operator log sheet information. The fuel consumption was also crosschecked with the fuel purchase and stock records of Purchase Department, Somdej Flour Mill Co., Ltd. /22/. The quantity was comparable.	
Monitoring equipment	Oil Meter	
		Boiler 1 (OM1) Boiler 2 (OM2)
	Serial number	TMC 4-1-0068-044 TMC0157-43
	Make	ABB ABB
Accuracy of the monitoring equipment	VCS PD does not specify the accuracy of monitoring 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 ±1%. RINA, based on the experience of verifying similar other projects, understands that the accuracy of the meters represents good monitoring practice.	

Measuring/Reading/Recording frequency	The parameter is measured on a continuous basis and recorded by the gas flow meter. The measured data is logged in daily basis and reported to Biogas Supervisor. The Biogas Supervisor checks the values and enters the data in another sheet that consist of daily values of the parameters. 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 oil meter shall be calibrated at least once in two years or as per the manufacturer's recommendations. PP has followed yearly calibration during the monitoring period.	
Does the calibration cover the monitoring period? Has the calibration frequency been respected?	The monitoring period is from 01/06/2012 to 14/09/2014. Both the oil meters were calibrated on 28/04/2011 (with validity until 27/04/2012), on 12/06/2012 (with validity until 11/06/2013), on 29/05/2013 (with validity until 28/05/2014) and on 02/12/2014 (valid until 01/12/2015) /15/. There is calibration gap for from 01/06/2012 to 12/06/2012 from 28/05/2014 to 14/09/2014. To cover the calibration delay PP has applied maximum error factor over the measured value for the gap period as per calibration guidelines of CDM /17/.	
Calibration certificates	Meter no.	Calibration details
	TMC 4-1-0068-044	By Miracle International Technology Co., Ltd.: Calibration date 28/04/2011, 12/06/2012, 29/05/2013 and on 02/12/2014/15/
	TMC0157-43	
Does the calibration of meters have be done by an accredited person or institution?	Miracle International Technology Co., Ltd. (MIT) is accredited calibration laboratory for flow measurement in accordance with ISO/IEC17025 No. 0147 issued by the Thai Industrial Standards Institute (TISI) /16/.	

Data/Parameter	Assessment
Data Unit	$EG_{\text{thermal,v}}$ TJ/year
Description	Net quantity of thermal energy supplied by the dual fuel operated boiler (using biogas and HFO) after implementation of the project activity. The value is calculated based on measurements of operational parameters of the boiler as described below
Source of data to be used	In this monitoring period, the direct measurement of temperature (in and out) and the flow of the thermal fluid was not conducted and deviation approach as explained in section 3.2 of this report is applied. Therefore, the amount of dry starch is the monitored parameter in order to calculate the thermal energy required in the project activity

Value of monitored parameter for the monitoring period	Period	Value (TJ)
	01/06/2012 to 31/12/2012	34.82
	01/01/2013 to 31/12/2013	57.48
	01/01/2014 to 14/09/2014	64.38
	The values in the MR and ER sheet were verified with the log records starch production/18/ and average HFO consumption for starch production as estimated conservatively from historical data. 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	N/A	
Accuracy of the monitoring equipment	N/A	
Measuring/Reading/Recording frequency	N/A	
Calcualtion method (if applicable)	This parameter is calculated based on the quantity of dry starch production and average HFO consumption for starch production as estimated conservatively from historical data. This approach is explained in section 3.2 of this report in detail.	
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 be done by an accredited person or institution?	N/A	

Data/Parameter	Assessment	
Data Unit	EC _v ; MWh	
Description	Electricity from the grid consumed by the project activity (wastewater treatment, biogas recovery and biogas utilization/flaring systems)	
Source of data to be used	Electricity transmission meter provided at point of supply to entire wastewater treatment plant	
Value of monitored parameter for the monitoring period	Period	Value
	01/06/2012 to 31/12/2012	336
	01/01/2013 to 31/12/2013	546

	01/01/2014 to 14/09/2014	602
	The values in the MR and ER sheet have been verified with the monthly invoices sent by the PEA which are more authentic /19/. The reported values have been found correct.	
Monitoring equipment	PEA electricity meter	
	Serial number	25249127
Accuracy of the monitoring equipment	VCS PD does not specify the accuracy of monitoring equipment. The accuracy of the energy meter is 0.5s. The meter is owned by PEA and hence accuracy complies the national standard.	
Measuring/Reading/Recording frequency	The parameter is measured continuously by energy meter provided at the point of supply to the wastewater treatment plant. Record of monthly consumption is as per PEA monthly invoice.	
Calcualtion method (if applicable)	N/A.	
Calibration		
Calibration frequency/interval Is the calibration interval in line with the monitoring plan of the PD?	Since the meter is owned by the PEA, the calibration is carried out by the PEA. It is also confirmed from the onsite verification that the meter is well secured and sealed by the PEA. The PP is not authorized to touch the meter.	
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 be done by an accredited person or institution?	N/A	

Data/Parameter	Assessment
Data Unit	$\eta_{\text{Flare-h y}}$ %
Description	Flare efficiency
Source of data to be used	Default value for open flares as per "Tool to determine project emissions from flaring gases containing methane" and flame detection records
Value of monitored parameter for the monitoring period	0%. The flare efficiency shall be determined based on the flame detection period. According to the monitoring plan of the VCS PD, "The default factor of 50% might be only applied if a flame is detected at the flare for more than 20 minutes in hour h, whenever biogas is sent to the flare system. If the biogas is sent to the flare for a period shorter than one hour, the flare detection signal shall be available for at least 1/3 of this period, following the same logic of the

	flaring tool (20 minutes out of 1 hour). If these conditions are not met, 0% default value should be used for this period". Since the flame detection period was not monitored properly during the monitoring period as verified during site visit, 0% flare efficiency is considered conservatively as per the tool.
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

Data/Parameter	Assessment	
Data Unit	$Q_{\text{starch},y}$; Tonnes	
Description	Quantity of dry starch produced	
Source of data to be used	Starch plant record	
Value of monitored parameter for the monitoring period	Period	Value
	01/06/2012 to 31/12/2012	28,436
	01/01/2013 to 31/12/2013	45,333
	01/01/2014 to 14/09/2014	50,772
	The values in the MR and ER sheet have been verified with the monthly starch production summary records /18/. The reported values have been found correct.	
Monitoring equipment	Serial number	2006068
	Make	LINEAR
Accuracy of the monitoring equipment	VCS PD does not specify the accuracy of monitoring equipment. The accuracy of the weigh bridge is $\pm 10\text{kg}$. The weighbridge is calibrated by govt. agency and hence	

	accuracy complies the national standard.	
Measuring/Reading/Recording frequency	The parameter is measured daily and monthly recorded.	
Calcualtion method (if applicable)	N/A.	
Calibration		
Calibration frequency/interval Is the calibration interval in line with the monitoring plan of the PD?	Calibration frequency is at least once two years as per calibration records conducted by govt. agency.	
Does the calibration cover the monitoring period? Has the calibration frequency been respected?	The monitoring period is from 01/06/2012 to 14/09/2014. The weighbridge (with serial no. 2006068) was calibrated on 28/02/2011 (with validity until 27/02/2013), on 12/03/2013 (with validity until 11/03/2015) and on 17/03/2015 (with validity until 16/03/2017) /15/. There is calibration gap for from 27/02/2013 to 12/03/2013. To cover the calibration delay PP has applied maximum error factor over the measured value for the gap period as per calibration guidelines of CDM /17/.	
Calibration certificates	Weigh Bridge	Calibration details
	2006068	By Central Bureau of weights and measures, Govt. of Thailand dated 28/02/2011 and 12/03/2013 /24/
Does the calibration of meters have be done by an accredited person or institution?	The calibrating agency is government agency accredited for calibration /24/	

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 capturing and utilisation in onsite boilers was estimated by measuring the required parameters using appropriate monitoring equipment and using the formulae described in the methodologies; AMS III.H., version 12 and AMS I.C., version 14 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 12 is calculated as below:

$$BE_{ww,treatment,y} = \sum_i Q_{ww,i,y} * COD_{removed,i,y} * MCF_{ww,treatment,BL,i} * B_{o,ww} * UF_{BL} * GWP_{CH4}$$

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 1,071,499 m^3 . RINA has verified the values in the monitoring report /01/ against the daily recording of volume of the wastewater treated digesters/14/, which is in line with the requirements of the registered monitoring plan /02/ and the applied monitoring methodology AMS-III.H version 12 /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) /14/. 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 of 87.62% determined *ex-ante* considering COD campaign data /02/. 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 (from 3 samples) is reported in ER sheet. RINA has verified the values in the monitoring report /01/ against the Original test reports of the $COD_{ww,untreated,y}$, /14/ which is in line with the requirements of the registered monitoring plan /02/ and the applied monitoring methodology AMS-III.H version 12 /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}) (0.94) /03/

Global Warming Potential for methane (GWP_{CH4}) is 21 as per IPCC /02/.

Therefore, $BE_{ww,treatment,y}$ for the monitoring period from 01/06/2012 to 14/09/2014 is **74,829.751tCO_{2e}**

Baseline emissions related to heat generation as per AMS-I.C, version 14 is calculated as below:

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

As explained in section 3.2 of this report (deviation 2), $BE_{thermal,CO2,y}$ is determined from the amount of biogas combusted in boiler for starch production ($BG_{combusted,y}$). $BG_{combusted,y}$ during the monitoring period was recorded to be 7,215,874 Nm³ as verified from daily log book records /14/.

Methane fraction (W_{CH4}) of biogas as monitored daily and recorded during the monitoring period with 95% confidence level arrived to be 66% from 01/06/2012 to 31/12/2012, 65% from 01/01/2013 to 31/12/2013 and 61% from 01/01/2014 to 14/09/2014 /14/, /03/. NCV of biogas is taken as 0.05 TJ/tonne as per publicly available document /23/. The NCV value of biogas is equivalent of IPCC default value /20/ and hence accepted. Accordingly, $EG_{thermal,y}$ from biogas consumption is calculated for the monitoring period to be 164.12 TJ. As explained in section 3.2 of this report (deviation 2), $EG_{thermal,y}$ is also calculated based on historical average HFO consumption per ton of starch production (33.8 lit/ton) and monitored starch production during the monitoring period. Starch production during the monitoring period is 124,541.90 tonnes as verified from starch production summary report of Somdej Flour Co., Ltd. /18/. Accordingly, $EG_{thermal,y}$ based on historical approach is calculated to be 157.92 TJ. Lower of the above two options i.e. 156.68 TJ is considered as $EG_{thermal,y}$ for the monitoring period (yearly average value is considered out of the two options). CO₂ emission factor per unit of energy of the fuel that would have been used in the baseline plant in (tCO₂/TJ) is fixed ex-ante to be 77.40 and efficiency of the plant using fossil fuel that would have been used in the absence of the project activity ($\eta_{BL,thermal}$) is considered 100% as fixed ex-ante /02/. Accordingly, $BE_{thermal,CO2,y}$ during the monitoring period is arrived to be **12,127.14tCO₂e**.

Project Emissions:

Project emissions related to methane avoidance component as per AMS-III.H, version 12 is calculated as below:

$$PE_y = PE_{power,y} + PE_{ww,treatment,y} + PE_{fugitive,y} + PE_{flaring,y}$$

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 from grid (EC_y) is monitored to be 1,483.97 MWh during the monitoring period as per monthly PEA invoices /19/. Therefore considering EF_y as 0.521 tCO₂e/MWh (Fixed ex-ante), $PE_{power,y}$ is estimated to be **773.15 tCO₂e** 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:

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

Flow of wastewater treated in the year y ($Q_{ww,y}$): The reported value during the monitoring period is 1,071,499 m³. RINA has verified the values in the monitoring report /01/ against the daily recording of volume of the wastewater treated digesters/14/, which is in line with the requirements of the registered monitoring plan /02/ and the applied monitoring methodology AMS-III.H version 12 /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) /14/. 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.

$COD_{removed,PJ,k,y}$: $COD_{out,UASB}$ exiting the UASB treatment plant are analysed daily (Colorimeter analysis) from sample of wastewaters and average of 3 samples value is reported in ER sheet. RINA has verified the values in the monitoring report /01/ against the Original test reports /14/ which is in line with the requirements of the registered monitoring plan /02/ and the applied monitoring methodology AMS-III.H version 12 /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 21 as per IPCC /02/. Methane producing capacity of the wastewater ($B_{o,ww}$) 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 **2,762 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 21 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:

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

Flow of wastewater treated in the year y ($Q_{ww,y}$) during the monitoring period is 1,071,499 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 (Colorimeter analysis) from sample of wastewater entering digesters and leaving the digester and average value of three 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 /14/ which is in line with the requirements of the registered monitoring plan /02/ and the applied monitoring methodology AMS-III.H version 12 /06/. $MEP_{ww,treatment,y}$ for the monitoring period is 4,703.20 tonnes and $PE_{fugitive,ww,y}$ for the monitoring period is **9,876.71 tCO₂e** /03/.

Project Emissions from flaring in year y ($PE_{flare,y}$) is calculated as per the “Tool to determine project emissions from flaring gases containing methane” version 01 /13/ and as follows:

$$PE_{flare,y} = \sum_{h=1}^{8760} TM_{RG,h} * (1 - \eta_{flare-h}) * GWP_{CH_4} / 1000$$

Global Warming Potential for methane (GWP_{CH_4}) is fixed 21 as per IPCC /02/. Flare efficiency in hour ‘h’ ($\eta_{flare,h}$) is 0% as explained in section 4.1 of the report under ‘data parameters monitored’. This is considered conservative approach to estimate project emission from flaring.

Mass flow rate of methane in the residual gas in hour ‘h’ ($TM_{RG,h}$) is calculated as per the ‘Tool to determine project emissions from flaring gases containing methane’ as follows:

$$TM_{RG,h} = FV_{RG,h} * fv_{CH_4,RG,h} * \rho_{CH_4,n,h}$$

Density of methane at normal condition ($\rho_{CH_4,n,h}$) is fixed ex-ante to be 0.716 kg/m³ as per the ‘Tool to determine project emissions from flaring gases containing methane’ and fixed ex-ante /02/.

Biogas sent to flare ($FV_{RG,h} / Q_{biogas,flare,y}$) is recorded 22,910 Nm³ for the monitoring period. The reported values are cross checked against the daily recordings of log book and found to be correct /14/. For fraction of methane ($fv_{CH_4,RG,h} / W_{CH_4}$) daily monitoring and recording during the monitoring period with 95% confidence level arrived to be 67% from 01/06/2012 to 31/12/2012, 66% from 01/01/2013 to 31/12/2013 and 62% from 01/01/2014 to 14/09/2014 /14/, /03/. It is to be noted that as per the flaring tool, monitoring of $fv_{CH_4,RG,h}$ is only applicable in case of continuous monitoring of the flare efficiency /21/. $PE_{flaring,y}$ for the monitoring period is **218.29 tCO₂e** /03/.

Project emissions related to HFO consumption as per AMS-I.C, version 14 is calculated as below:

$$PE_{FC,y} = FC_{HFO,y} * NCV_{HFO} * EF_{HFO,CO_2}$$

Amount of fossil fuel (HFO) used in boiler in monitored in oil meter continuous basis and recorded daily /14/. The recorded value during the monitoring period is 6.94 ton. NCV of HFO is fixed ex-ante to be 0.04TJ/ton and EF_{HFO,CO_2} is also fixed ex-ante to be 77.40 tCO₂/TJ. Therefore, $PE_{FC,y}$ calculated for the monitoring period is **21.69 tCO₂e**.

Leakage Emissions:

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

Emission Reductions:

The emission reduction (ER) is the sum of the ER from type I component ($BE_{thermal,y}$) and the ER achieved from the type III component of the project activity ($ER_{y,ex post}$). ER from the type I component ($BE_{thermal,y}$) for this monitoring period is 12,126 tCO₂e. Project emissions related to type I consumption ($PE_{FC,y}$) is 23tCO₂e (roundup value).

As per applied methodologies AMS-III.H version 12 and registered VCS-PD, the emission reductions achieved from type III component ($ER_{y,ex post}$) in any year are the lowest value of the following:

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

For the current monitoring period the achieved $BE_{y,ex post} = BE_{www,treatment,y}$ is 74,829.751tCO₂e, achieved $PE_{y,ex post}$ is 13,630.15 tCO₂e and $LE_{y,ex post}$ is zero as explained in above.

As per equation 16 of AMS-III.H, version 12, 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 22,910Nm³ and $BG_{combusted,y}$ is 7,115,874 Nm³.

RINA has verified the values in the monitoring report /01/ against the daily recording of the amount of biogas flared ($BG_{toflare}/FV_{RG,h}$) and biogas fired in boiler ($BG_{combusted,y}$) /14/, which is in line with the requirements of the registered monitoring plan /02/ and the applied monitoring methodology AMS-III.H version 12 /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' /21/. Global Warming Potential for methane (GWP_{CH_4}) is fixed 21 as per IPCC /02/. Flare efficiency in hour 'h' ($FE/\eta_{flare,h}$) is 0% for the current monitoring period in line with the tool as explained in section 4.1 of this report. This is considered conservative approach. Methane fraction (W_{CH_4}) is as per continuous measurement and daily records /14/. The reported value ensure lower value in 90/10 confidence level for conservative estimation.

Therefore, MD_y achieved during 01/06/2012 to 14/09/2014 amounts to 68,906tCO₂ equivalent /03/.

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

$$= \min(74,829.751 - 13,630.15 - 0), (68,906 - 773.15 - 0)$$

$$= 61,199 \text{ tCO}_2\text{e}$$

Emission reductions achieved from type-I component is

$$\begin{aligned} \text{ER}_y &= \text{BE}_{\text{thermal},y} - \text{PE}_{\text{FC},y} \\ &= 12,126 - 23 \\ &= 12,103 \text{ tCO}_2\text{e} \end{aligned}$$

Therefore, overall emission reductions achieved from the project activity during the monitoring period is **73,301 tCO₂e** (round down value).

The emission reductions achieved during the monitoring period is 67% higher than estimated in registered VCS-PD. The primary reasons are increased number of operating days and the quality of raw material which resulted in higher wastewater generation. It is also evident from the specific wastewater generation that the specific wastewater generation during the monitoring period is around 8.6 m³ per ton of dry starch while it was considered as 4.7 m³/ton as per the VCS PD/02/. The number of operating days depends upon the availability of raw material. Due to business priority during the monitoring period, the starch factory operated the plant for more number of days. However, the availability and quality of raw material depends on several factors which are beyond the control of project proponents. 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, biogas consumption for flaring, methane concentration of biogas, quantity of HFO fired in boilers etc. were verified with the log book values to ensure that there is no over estimation of the VCU. 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, fuel oil meters, COD meter, 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 production of biogas generation. 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. 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 Services Spa (RINA) has performed verification of the emission reductions reported for the project activity “SD Biosupply Wastewater Treatment and Biogas Utilization Project” in Thailand, VCS Registry Project ID 416, for the period 01/06/2012 to 14/09/2014, with regard to the relevant requirements for VCS activities. The project participants of the “SD Biosupply 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 6.4 of 19/11/2009
- 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 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 03/05/2017 for the “SD Biosupply Wastewater Treatment and Biogas Utilization Project” in Thailand for the period 01/06/2012 to 14/09/2014 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 12 of 28/05/2009 and AMS-I.C 'Thermal energy for user with or without electricity' version 14 of 29/03/2009 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 01/06/2012 to 14/09/2014 is amount to.

Verification period: From 01/06/2012 to 14/09/2014

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

Year	Baseline emissions or removals (tCO ₂ e)	Project emissions or removals (tCO ₂ e)	Leakage emissions (tCO ₂ e)	Net GHG emission reductions or removals (tCO ₂ e)
01/06/2012 to 31/12/2012	19,098	3,007	0	16,091
01/01/2013 to 31/12/2013	34,577	5,227	0	29,350
01/01/2014 to 14/09/2014	33,280	5,420	0	27,860
Total	86,955	13,654	0	73,301

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: 17/04/2017
Description of CR				
a) <i>PP is requested to provide copy of fuel stock register</i> b) <i>PP is requested to clarify how the monitoring of methane content after UASB complies the monitoring requirement of methane content to account biogas utilization at boiler and flare.</i> c) <i>The calibration details mentioned in MR does not cover the monitoring period for FM1, GM1, GM2, GM3, gas analyzer, OM1 and OM 2.</i>				
Project participant response				Date: 03/05/2017
a) The evidences of fuel stock is submitted to DOE. b) In this monitoring period, the methane content in the project was measured after the UASB system. The measurement was conducted at the location where the biogas flow measurement takes place. In addition, the monitored data was measured by portable gas analyser with a periodical measurements at a 95% confidential level. This is in line with the latest version of AMS.III.H c) The calibration details of following monitoring equipment: FM1, GM1, GM2, GM3, gas analyser, OM1 and OM2 are included in the revised MR				
Documentation provided by project participant				
<i>Records of fuel stock, calibration certificates, revised MR.</i>				
DOE assessment				Date: 18/05/2017
a) The fuel consumption crosschecked with the fuel purchase and stock records of Purchase Department, Somdej Flour Mill Co., Ltd. The quantity was comparable and hence accepted. b) PP's response is accepted since as per the flaring tool monitoring of methane fraction in the exhaust gas of the flare is applicable in case of enclosed flare and continuous monitoring of the flare efficiency. During this monitoring period continuous monitoring of flare efficiency was not done and conservatively 0% flare efficiency is considered. Hence, methane fraction value measured after UASB is accepted. c) The calibration details are corrected in the revised MR and details found consistent with calibration records. Hence, accepted. In summary, CR was closed.				

Table 3. CAR from this verification

CAR ID	01	Section no.	4.2	Date: 17/04/2017
Description of CAR				
a) <i>Quantity of wastewater in ER sheet for the month of July 2012, year 2013 and year 2014 are not consistent with log books.</i> b) <i>For the year 2014, GM1 values found not consistent in ER sheet.</i> c) <i>The serial number of oil meter (OM 1) mentioned in MR is not correct when checked during site visit.</i>				
Project participant response				Date: 03/05/2017
a) The quantity of wastewater in the ER sheet for the year 2012, year 2013 and year 2014 has been revised and consistent with the log sheet records. The evidence records of FM 1 as following details; - Data log sheet year 2012 as Att-2.1 (totalize number: date 01/06 - "187053" to date 29/12 - "429373") - Data log sheet year 2013 as Att-2.2 (totalize number: date 07/01 - "429373" to date 17/01 - "449360", Reset meter on date - 17/01 "0" to date 28/12 - "385758") - Data log sheet year 2014 as Att-2.3 (totalize number: date 06/01 - "385758" to date 08/01 - "389921", Reset meter on date 08/01- "0" to date 15/09 - "419271") b) The value of GM1 in the ER sheet has been revised as per the log sheet records of year 2014 (Att-2.3, totalize number: date 06/01 - "7384339" to 25/01 "7642455", Reset meter on date 26/01 - "0" to date 15/09 - "3680997"). c) The serial number of oil meter (OM1) is TMC-4-1-0068-44. The detail in MR has been corrected. Please see the evidence as Att-2.4.				
Documentation provided by project participant				
<i>Revised MR and revised ER sheet.</i>				
DOE assessment				Date: 18/05/2017
The errors in reporting in emission reduction sheet for wastewater flow, biogas flow (GM1) are corrected and found consistent with log book records. Also the oil meter details of boiler 1 is corrected in MR. Hence, response is accepted and CAR is closed.				

Table 4. FAR from this verification

FAR ID	xx	Section No.		Date: DD/MM/YYYY
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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

CERTIFICATO DI QUALIFICA PER GLI SCHEMI VOLONTARI* QUALIFICATION CERTIFICATE FOR VOLUNTARY SCHEMES*

Si attesta che il sig./sig.ra:
We declare that Mr/Mrs/Ms:

Champok Buragohain

è qualificato come:
is qualified as:

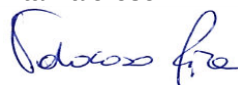
TEC, VAL, VER, TL

per le seguenti aree tecniche:
for the following technical areas:

AREE TECNICHE TECHNICAL AREAS	DESCRIZIONE DELL'AREA TECNICA TECHNICAL AREA DESCRIPTION	SCOPO SETTORIALE SECTORAL SCOPE
1.2	Renewables	1
2.1	Electricity distribution	2
13.1	Solid waste and wastewater	13
13.2	Manure	13

REVISIONE REVISION	DATA DATE	MOTIVAZIONI PER LA REVISIONE REASON FOR THE REVISION
0	19/07/2016	First issue with new template (this certificate is linked to CDM qualification)

Responsabile di schema
Scheme Leader
Rita Valoroso



*SCHEMI VOLONTARI/ VOLUNTARY SCHEMES: ACR American Carbon Registry, CCB The Climate, Community & Biodiversity Alliance, GS Gold Standard, JI Joint Implementation, SCS Social Carbon Standard, VCS Verified Carbon Standard.

TEC: Technical expert; VAL: Validator; VER: Verifier; TL: Team leader; FIN EXP: Financial Expert; ITRP: Independent technical reviewer

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VCSA	per condurre la Validazione e la Verifica di Progetti VCS to carry out Validation and Verification of VCS Projects
GS Foundation	per condurre la Validazione e la Verifica di Progetti GS to carry out Validation and Verification of GS Projects
Ecologica Institute	per condurre la Validazione e la Verifica di rapporti SCS to carry out Validation and Verification of SCS Reports
American Carbon Registry ACR	per condurre la Validazione e la Verifica di Progetti ACR to carry out Validation and Verification of ACR projects
The Climate, Community & Biodiversity Alliance CCB	per condurre la Validazione e la Verifica di Progetti co-benefit CCB to carry out Validation and Verification of co-benefit CCB projects

CERTIFICATO DI QUALIFICA PER GLI SCHEMI VOLONTARI* QUALIFICATION CERTIFICATE FOR VOLUNTARY SCHEMES*

Si attesta che il sig./sig.ra:
We declare that Mr/Mrs/Ms:

Rekha Menon

è qualificato come:
is qualified as:

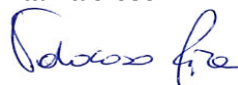
TEC, VAL, VER, TL, ITRP

per le seguenti aree tecniche:
for the following technical areas:

AREE TECNICHE TECHNICAL AREAS	DESCRIZIONE DELL'AREA TECNICA TECHNICAL AREA DESCRIPTION	SCOPO SETTORIALE SECTORAL SCOPE
1.2	Renewables	1
2.1	Electricity distribution	2
13.1	Solid waste and wastewater	13
13.2	Manure	13
14.1	Afforestation and reforestation	14

REVISIONE REVISION	DATA DATE	MOTIVAZIONI PER LA REVISIONE REASON FOR THE REVISION
0	19/07/2016	First issue with new template (this certificate is linked to CDM qualification)

Responsabile di schema
Scheme Leader
Rita Valoroso



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Ecologica Institute	per condurre la Validazione e la Verifica di rapporti SCS <i>to carry out Validation and Verification of SCS Reports</i>
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CERTIFICATO DI QUALIFICA PER GLI SCHEMI VOLONTARI* QUALIFICATION CERTIFICATE FOR VOLUNTARY SCHEMES*

Si attesta che il sig./sig.ra:
We declare that Mr/Mrs/Ms:

Hui Feng Liu

è qualificato come:
is qualified as:

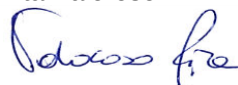
TEC, VAL, VER, TL, ITRP

per le seguenti aree tecniche:
for the following technical areas:

AREE TECNICHE TECHNICAL AREAS	DESCRIZIONE DELL'AREA TECNICA TECHNICAL AREA DESCRIPTION	SCOPO SETTORIALE SECTORAL SCOPE
1.1	Thermal energy generation	1
1.2	Renewables	1
8.1	Mining and mineral processes	8
9.2	Iron, steel and Ferro alloy production	9
13.1	Solid waste and wastewater	13

REVISIONE REVISION	DATA DATE	MOTIVAZIONI PER LA REVISIONE REASON FOR THE REVISION
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Scheme Leader
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